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Assessing the Vulnerability of a Coastal Community to Storm Surge: The Case of Barangay Baseco, City of Manila

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Abstract

Disasters in the form of typhoon and storm surge-induced flooding can be very destructive for coastal communities. This study presents a quantitative framework for measuring the vulnerability of a coastal community in the City of Manila. The framework is adapted from the Vulnerability and Capacity Assessment (VCA) method presented by Prabhakar (2015), drawing on the Intergovernmental Panel on Climate Change (2007) concept of vulnerability. The study incorporates socio-economic factors and storm surge characteristics to ascertain the leading factors of vulnerability from a household perspective. Criteria were selected from different local and international methods used to assess climate change induced vulnerability of communities. Study findings draw on survey, key informant interview, estimation of spatial attributes and applicable published census data. The assessment results show that BASECO is highly vulnerable to storm surge impacts with an overall vulnerability score of 0.74 out of 1.00. While exposure is moderate with an index of 0.51 due to coastal flooding and extent of population exposed, sensitivity is high with 0.61 and adaptive capacity with 0.38 index value. This study suggests the updating of city's land use plan and zoning policy based on hazard and risk information to guide medium term measures, such as relocation or settlement upgrading programs.

Introduction

Future projections of climate change and accelerated sea-level rise (SLR) are of increasing global concern, especially for coastal communities. The IPCC (2014) projects that by the end of century there will likely be an increase in the intensity and magnitude of storm events and other climate-induced hazards (IPCC, 2014:10). For the past decade, governments have been turning their attention to what these changes mean for communities. Recent initiatives have been noted in many countries and this includes attributes that shape vulnerability.

In the Philippines, for instance, climate change vulnerability and disaster risk assessment adopted by Housing Land Use and Regulatory Board (HLURB) incorporates institutional and physical attributes of local governments to inform land use decisions. The limitation of this approach, however, is that it does not elucidate socio-economic and site-specific

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elements intrinsic to social systems or communities. Recent initiatives have been noted in many countries and this includes attributes that shape vulnerability.

The past three assessments of IPCC (2001, 2007, and 2014) repeatedly emphasized that vulnerable populations, mostly in developing and less developed states, suffer the greatest impact of climate impacts. Located in fringes of urbanizing areas and coastal regions, vulnerable populations are characterized by persistent socio-economic marginality that limit their capacities to cope and adjust to the dynamic disaster risks (IPCC, 2014:10).

The Philippines is no stranger to this situation. The country lies in the southwestern section of the Northwest Pacific basin which generates an average of 19-20 tropical cyclones per year, of which seven (7) to nine (9) make landfall (Lapidez et al. 2015:11). The Philippine Statistics Authority (PSA), in 2015, reported that the country's urban population is 44.3%, where at least 60% are residing in 832 coastal municipalities and 25 coastal cities (DENR, 2001:3). PSA also projected that the urban population will increase to 52% by 2020, largely through in-migration. Based on the study by Lapidez et al. (2015), the City of Manila is among 30 coastal zones with an elevation of less than three (3) meters above mean sea level and is highly exposed to storm surge. The highest in-migration rate would continue to be in Metro Manila, as it remains to be the center of economic, socio-cultural, and political activities in the country (PSA, 2018:16).

In Metro Manila alone, about 37% of the 2010 population or over 4 million people live in slum areas and this is expected to reach 9 million by 2050 (Ballesteros, 2010:2). The growing population in coastal areas translates to immense pressure on government to provide more job opportunities, housing, and basic services while ensuring security from both natural and man-made risks. Communities in informal settlements are particularly confronted with increasing physical, economic, social and environmental risks on a day-to-day basis, with declining capacity to effectively cope with such risks.

As the effects of climate change worsen and impacts are mediated through different pathways, measuring vulnerability at the local scale will remain to be context-based. Thus common measures are broadly related to the features of hazards: prevailing socio-economic conditions that predispose communities to harm and local capacity to adapt to changing risks. Even with disparities in results, these assessments are central to community-based adaptation and sustainable policy actions (Füssel and Klein, 2006:5).

Research Objectives

The study determines the level of vulnerability of the community of BASECO using an indicator-based assessment. It used widely adopted and tested socio-economic factors of social vulnerability to recommend potential adaptation strategies for the consideration of the city government and other organizations working on community resilience. The study has the following objectives of i) analyzing the temporal and spatial factors that contribute to the community's exposure to hazard; ii) explaining the socio-economic factors that predispose the community to adverse impacts of storm surge; iii) determining the level of capacity of the community as well as implementation challenges of current adaptation efforts to minimize the impacts of the hazard; and iv) identifying the potential strategies for adaptation to reduce storm surge vulnerability.

Review of Literature

Literature review focuses on climate change vulnerability and disaster management that provided theoretical and analytical foundation for this study. It also discusses the general trends and different approaches in social vulnerability assessment as well as the implication on community level and strategic risk management and adaptation. Manila Bay has a total area of 1,994 sq. km with a coastline stretching over 190 kilometers (Manila Bay Area Atlas, 2015:12). The bay has a great ecological and socioeconomic importance. It sustains economies and provides livelihoods through fisheries, ports, and tourism that act as barriers for land based pollution discharging to the sea. Storm surge is the change in sea level resulting from extreme meteorological conditions which is one of the most severe hazards that threaten low-lying coastal areas. In the Philippines, storm-related rainfall can also cause inland flooding and is responsible for more than half of the deaths associated with tropical storms (NOAA, 2013:13). The Philippine Atmospheric Geophysical and Astronomical Services Administration (PAGASA) reported that Typhoons Glenda (2014), Pablo (2012), Pedring (2011), and Frank (2008) caused considerable damage in some cities along Manila Bay, including the City of Manila.

An increasing trend in the mean sea level of Manila Bay has been observed since 1965 and continues today (Perez, 1996:14). The bay area, due to tropical cyclones, is already subject to several hazards including floods and storm surges. The shoreline has changed greatly since 1990 due to land reclamation for housing, ports, coastal roads, buildings, and other urbanized developments adding to the threat of inundation. In the recent decades, several typhoons made a landfall in the country and directly impacted Manila Bay. The coastal flooding generated by Typhoon Pedring in September 2011 caused unprecedented flooding in Roxas Boulevard (located in the City of Manila) and damaged sea walls and other structures fronting Manila Bay. A super typhoon can generate a storm surge height of more than 20 feet above sea level (Weather Philippines Foundation, 2017:18).

The Philippine planning system has been well defined for many years. In reality, the system has been characterized by multiple policies of different authorities with overlapping mandates. The LGU is responsible for the development and planning for its land use. HLURB, in 2014, released an updated guide for the preparation of a comprehensive land use plan (CLUP). The CLUP is the main planning instrument that aims to provide a sound foundation for managing past, current, and projected land use as well as the allocation of land resource use within the political jurisdiction of a municipality or city. HLURB's Supplemental Guidelines on Mainstreaming Climate and Disaster Risks in the Comprehensive Land Use Plans integrates Climate and Disaster Risk Assessment (CDRA) in the preparation of a risk-sensitive CLUP. The results are intended to guide LGUs to pursue risk-based land use policies and development programs contained in the Comprehensive Development Plans (CDP).

In the last three global assessments on climate change impacts and vulnerability (IPCC 2001, 2007, 2015), policy discourse has shifted from biophysical impacts of climate change to socio-ecological impacts, more particularly the pathways through which these impacts occur. With this shift came a multitude of definitions and interpretations of vulnerability but two dominant views remained: the scientific framing and the human security framing (Hinkel and Wolf, 2010:6).

There are several assessment methods applied by different organizations to examine community and household level vulnerability. This study reviews some of the prominent methods which were compared based on their alignment with the determinants of vulnerability introduced by IPCC whether qualitative or quantitative used exposure, sensitivity, and capacity as key determinants. Most VCA methodologies have utilized participatory approaches involving communities at the local level. For example, to assess exposure tools such as seasonal calendar, historical timelines, and rain calendars were used. For assessing sensitivities, tools such as hazard mapping, hazard trend analysis, and ranking of hazard impact was done while using a livelihood matrix. For assessing adaptive capacity, tools such as social maps, resource maps, Venn diagrams, and preference ranking were used. Although most VCAs use quantitative approaches to exposure, sensitivity, and capacity model, some VCAs are qualitative. It is difficult to understand, in terms of severity, how vulnerabilities in one location can be compared with those at another location.

The described methods are well-recognized tools for vulnerability assessment. IUCN provided guidelines that is widely accepted by climate change experts and are being implemented in different parts of the world for vulnerability and adaptation analysis. The V2R framework is a means to an end: the increased resilience of poor people's livelihoods to multi-hazards and an uncertain future in their local contexts. Local needs are an important aspect of V2R and this enables tangible benefits that can be seen. Table 1 shows a comparison on the different types of vulnerability assessment methods that are being used by different development organizations nationally and internationally. The comparison was done on the basis of IPCC vulnerability assessment concept because it is the most recent and well-accepted concept globally.

The methodology aspects have been compared with different sets of parameters considered by different organizations to assess community's vulnerability. The determinants that qualify vulnerability components were compared with existing methodological framework developed by different organizations and these are rated as (a) specific and strategic components of the framework, (b) unspecific, implied or potential component of the framework, and (c) not included and addressed in the framework. The described assessment criterion covers all the aspects of vulnerability components define by IPCC.

Table 1: Climate change vulnerability and risk assessment parameters considered by different organizations

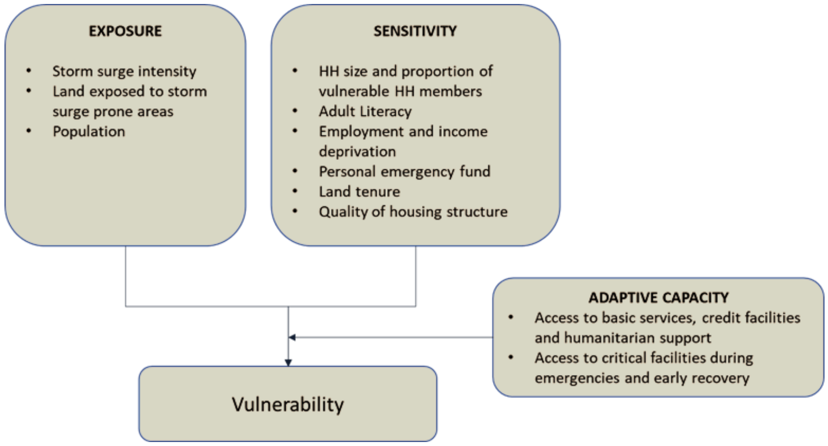
Framework	Vulnerability	Exposure				Sensitivity				Adaptive Capacity			
	IPCC Vulnerability =f(E,S,AC)	Current climate trends	Climate induced events	Climate projections	Community based and scientific data	Current hazard trends	Bio physical impact	Livelihood impact	Hazard prioritization	Coping strategies	Livelihood assets	Community awareness	Capacity to plan and effect change
Climate Vulnerability and Capacity Analysis (CVCA, Care Int'l 2009)	+	+	+	+	+	+	+	+	+	+	+	-	+
A Framework for Social Adaptation to Climate Change (IUCN 2010)	+	+	-	+	+	+	+	+	+	+	+	+	+
V2R Framework (Practical action 2012)	+	+	+	+	-	+	+	+	+	+	+	+	-
Household Assessment Tool (Shelter Cluster Philippines 2014)	+	+	+	-	+	-	+	+	-	+	+	+	-
Vulnerability and Capacity Assessment (VCA, Prabhakar, S.V.R.K. 2015)	+	+	+	+	+	+	+	+	+	+	+	+	+
Social Vulnerability Assessment Tools for Climate Change and DRR Programming (UNDP 2017)	+	+	+	+	+	+	+	+	-	+	+	-	-

Notes: + (plus) means applicable or accommodated; – (minus) means did not or not fully accommodated according to the assessment criteria.

Source: Adopted from Practical Action Nepal et al. 2010 and modified by author.

Research Methodology

This research adopted a case study method, which enabled the examination of the socio-economic context that shapes the vulnerability of an urban community to storm surge impacts. According to Yin (1984), a case study method selects a small geographical area or a very limited number of individuals as the subjects of study (Yin 1984). The research combines quantitative and qualitative techniques to operationalize the study framework (Figure 1). This study used the concept of contextual vulnerability from the IPCC, where vulnerability is defined as the degree to which a system is susceptible to and unable to cope with the adverse effects of climate change (IPCC, 2001:7, 2007:8 and Füssel, 2009:5).



Source: Adapted from IPCC, 2007.

Figure 1: Conceptual framework of the study

The study adapted the Vulnerability and Capacity Assessment Index (VCAI) developed by Prabhakar (2015). This method builds on existing vulnerability assessment tools as well as the gaps and limitations of the methods: V2R Framework, Climate Vulnerability and Capacity Analysis (CVCA), Framework for Social Adaptation to Climate Change and Social Vulnerability Assessment Tools for Climate Change and DRR Programming. The VCAI incorporates current circumstances of vulnerability such as current climate trends, climate projections, and climate-induced events (Prabhakar). It espouses the vulnerability concept by IPCC and examines the three components of exposure, sensitivity, and adaptive capacity using indicators applied in small inland fishermen community for climate resilience and livelihood security in Madhya Pradesh, India (Pravakar, 2015:15). For application in this study, the indicators were also reviewed for their applicability to the study context, specifically availability of data based on established measures of well-being, climate and hazard conditions, and local risk management practices. In estimating the level of vulnerability, the following formula was used:

Vulnerability Index (VCAI) = (E+S)-C …….. (1)

Where,

E is exposure value obtained by averaging the normalized exposure indicators;

S is the sensitivity value obtained by averaging the normalized sensitivity indicators;

C is the capacity value obtained by averaging the normalized capacity indicators and adopting the inverse value.

The VCA index was computed using several sets of indicators for quantifying exposure, sensitivity, and capacity components. The responses with the highest proportion for each variable were used as the observed indicator value. Since the data were expressed in different units of measurement (i.e. rainfall in millimeters (mm) or income in Php), the VCA method used linear normalization technique to transform these into unit-less indicator scores in a scale of 0-1. These were then compared with available regional and national data from published census and studies identifying the minimum and maximum values for the current or past years, depending on data availability. The final index was interpreted using the descriptive categories in the VCA method as shown in Table 2.

Table 2: Level of vulnerability according to vulnerability score

Level of Vulnerability	Vulnerability Score
Extremely Vulnerable	>0.80 - 1.00
Highly Vulnerable	>0.60 - 0.80
Moderately Vulnerable	>0.40 – 0.60
Slightly Vulnerable	>0.20 – 0.40
Least Vulnerable	0 – 0.20

Source: Vulnerability and Capacity Assessment Index (Prabhakar, 2015:15).

The study started with the verification of commonly used indicators of vulnerability components in terms of relevance to climate risk management and documented effect on vulnerability. The indicators were selected based on the factors like hazard Level, exposed elements, demographics, socio –economic, access to Services, access to critical facilities. The researcher adopted the technical definition of the indicators from PSA and other published definitions.

Primary data was collected through a survey questionnaire and key informant interviews. The 138 households that comprised the sample were divided into the eleven (11) residential clusters, which provided a sound coverage and illustration of welfare and economic conditions of households. The semi-structured interview was also done to draw the observations and recommendation from local authorities in DRRM, barangay affairs and risk management.

Data collection followed through household survey and spatial analysis of select physical attributes. Secondary data from government agency reports, and studies by international development organizations were also obtained as input to the VCA Index method, discussed further in the succeeding sections. The component indexes and overall vulnerability index were then derived and supplemented by a description of cluster-specific conditions to ascertain potential differential physical vulnerabilities.

The assessment results were used to initially formulate adaptation options, based on relevant practices climate risk management. The results were verified with local authorities and risk analysis expert, whose inputs and recommendations were later synthesized and elaborated by the researcher. At the end of this study, a set of recommended potential adaptation strategies were formulated for possible consideration of the community and the local government (Figure 2).

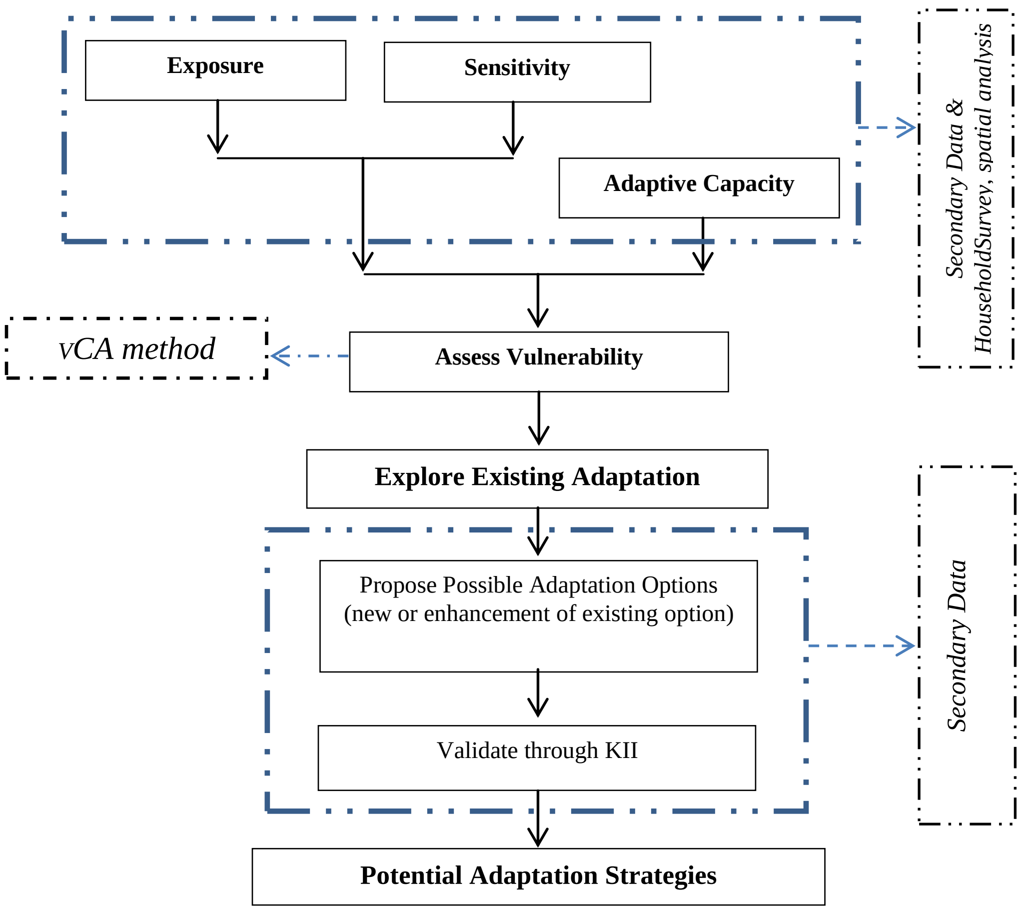
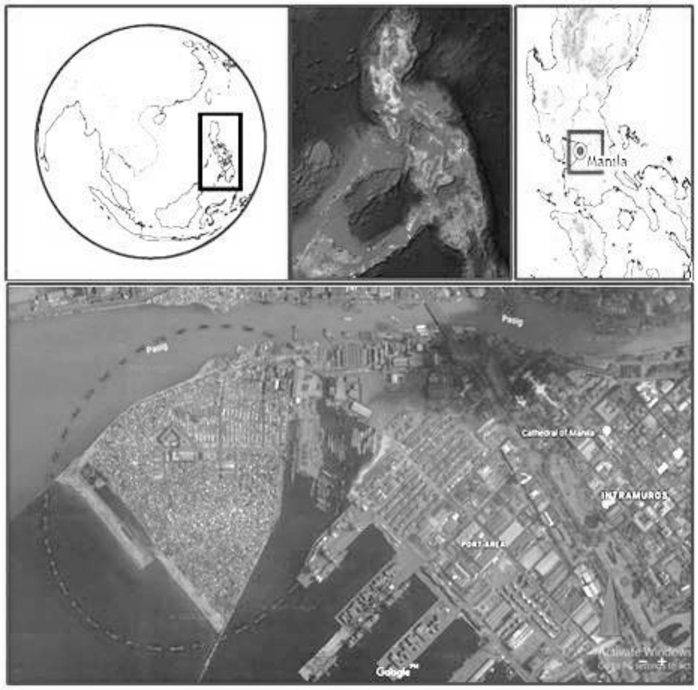


Figure 2: Analytical framework of the research

Profile of the Study Area

BASECO consists of Engineer's Island and two stone breakwaters that extend out to Manila Bay. The island had been a ship loading and unloading site and ship repair yard for many years. A census tagging operation followed in 2002 led by the City of Manila, which recorded a total of 6,060 families mostly living below poverty and own the housing unit they occupied. BASECO is classified as an urban barangay and the largest residential settlement in the Port Area. According to PSA (2010), there are 13,276 households in the area. For the past decade, BASECO posted a 3.5% annual growth rate, which is much higher than the national rate of 2.4% (Ballesteros, 2010:2). The total land area of BASECO is 54 has and land use type is predominantly residential. There are no major commercial establishments or facilities, only some small-scale businesses and retail shops.



Source: Google Earth, 2018.

Figure 3: Location of the Study Area

The population density of BASECO is estimated at 1,042 persons per hectare, which is relatively higher compared to other barangays located at the City of Manila. BASECO, as shown in Figure 3, is bounded by Pasig River on its northern side, by Manila Bay on its western side, by the Port Area on its southern side, and Intramuros on its eastern side. The barangay is 3.5 km away from the Manila City Hall.

Analysis and Results

This segment presents the current vulnerability of BASECO to the adverse impacts of storm surge such as loss and damage to property, temporary displacement, and disruption of economic activities. The discussion is structured based on three (3) components of vulnerability: exposure, sensitivity and adaptive capacity.

Exposure describes the magnitude of the hazard, the valued assets, and population that are likely to interact with the hazard primarily due to their location. This study considered five (5) factors of exposure for BASECO: annual precipitation, maximum height of storm surge, peak wind speed, population affected, and land inundated due to storm surge.

In order to effectively manage risk, it is essential to understand how vulnerability is generated, how it increases, and how it builds up (Ribot, 1996:17). Vulnerability describes a set of conditions of people that were derived from the historical and prevailing cultural, social, environmental, political, and economic contexts. In this sense, vulnerable groups are not only at risk because they are exposed to a hazard but more as a result of marginality, of everyday patterns of social interaction and organization, and access to resources (Watts and Bohle, 1993:19). Based on the data presented and the descriptive categories of vulnerability in the VCAI method, BASECO can be considered highly vulnerable to storm surge impacts, with index of 0.74 (Figure 4).

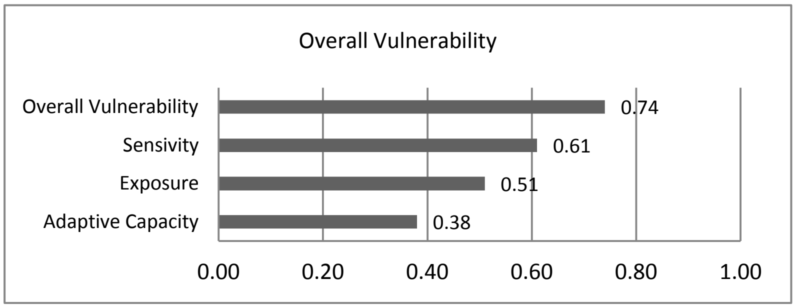


Figure 4: Vulnerability

Of the three determinants of vulnerability, sensitivity has the highest contribution to the vulnerability of households in BASECO (S=0.61). This appears to be attributed mostly to family size (0.94), housing structure (0.85), dependent population (0.82), poverty incidence (0.78), unemployed household members (0.77), and population density (0.74) as shown in Figure 5.

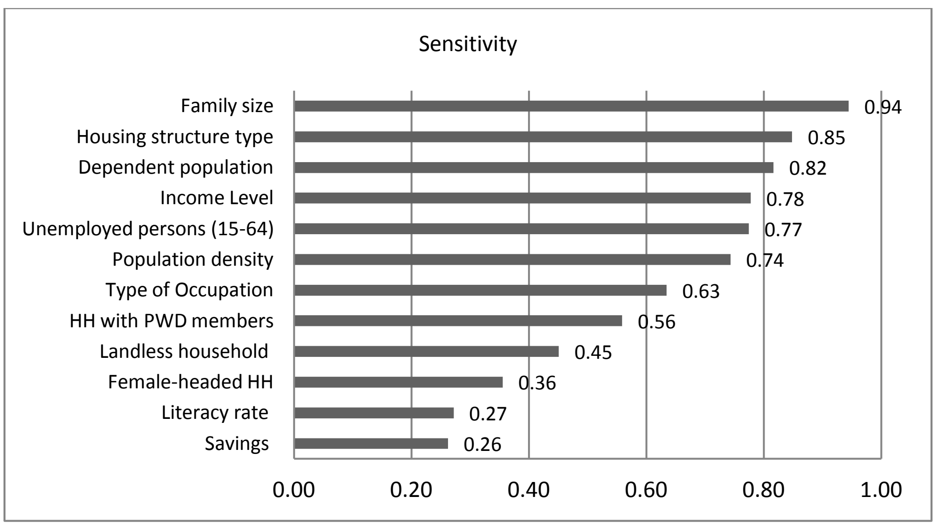


Figure 5: Adaptive capacity

Family size, dependent population, unemployed members, and income level appear to be mutually reinforcing elements. Households with meager income have more members that are economically inactive. Population density and housing structure both represent physical sensitivity. The former poses challenges in the physical disaster operations where aid delivery or emergency evacuation may be hampered by congestion. Poorly built houses especially in several clusters are more prone to damages. In addition, the moderate contribution of household members with disabilities and irregular incomes sources are significant concerns for policy.

Exposure contributes less to vulnerability with an index of 0.64. In terms of hazard characteristics, the inland reach of coastal flooding at 0.75 (Figure 6) and estimated magnitude of population located in the hazard area the highest contribution to exposure with 0.75. Surge height, which represents the force of moving coastal waters inland, has moderate contribution owing to the breakwater and barriers that temper the current of coastal floods.

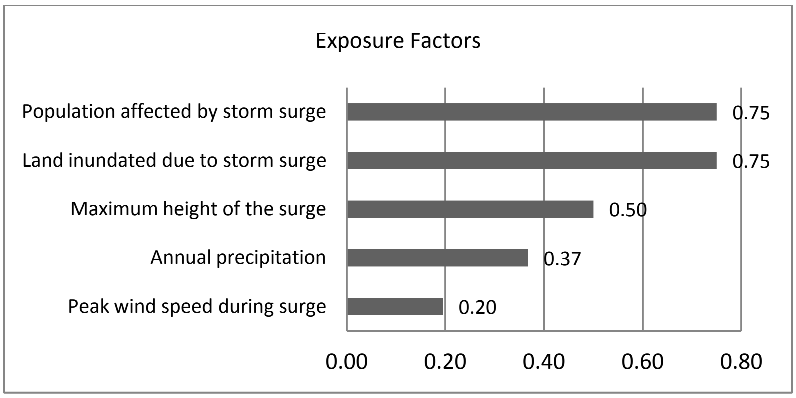


Figure 6: Exposure

The adaptive capacity of the community is low with an inverse index of 0.38. This may be attributed to perceived inadequacies in some critical services and resources which are unable to relieve existing stresses on the families' current social and economic condition especially during disaster and its aftermath.

The community, with support from government and other organizations, is capable of addressing primary education needs of their children, cover for health and minor emergencies (through health insurance and informal credit facilities), and continue with productive work based on access to power supply. However, these are outweighed by the limited access to sanitation facilities (0.67), water supply (0.56), evacuation centers (0.50), and access to communication facilities or risk information (0.45) as shown in Figure 7.

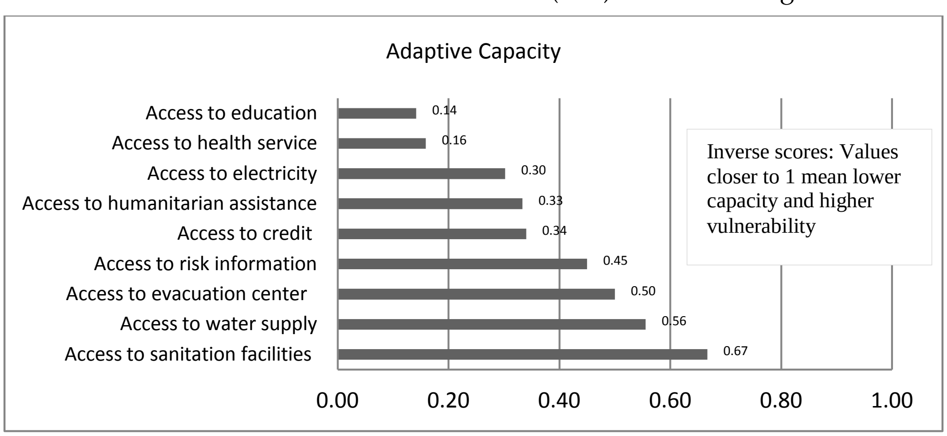


Figure 7: Adaptive capacity

In addition, it is important to note that there are possible differential vulnerabilities among residential clusters based on physical attributes. Based on proximity to the coastline, quality of housing structure, distance from evacuation centers, it can be inferred that households living in Locations 1, 2, 3, 5, 10 and 11 appear to be more vulnerable than the other residential clusters. These conditions can inform the prioritization of DRRM services such as emergency evacuation, relief operations, or housing support. Table 3 shows the details of vulnerability calculation of different locations of the study area.

Table 3: Estimated physical vulnerability by residential cluster

Survey Location	Residential Cluster	Proximity to coastline (within 200)	Area exposed to flooding	Distance to Evacuation center (1km)	At least 50% of housing structures made of temporary materials	Potential Physical Vulnerability
1	Gasangan					4 - Very high
2	Aplaya					3 - High
3	Block 2,4,5,6 Old site					3 - High
4	Block 7, 8, 9 old site and extension area					1- Low
5	New site					2 - Moderate
6	Tambakan and Block 5					1 –Low
7	Block 1 (Dubai and ext.)					1 - Low
8	Habitat					0 - Very Low
9	Gawad Kalinga					1 – Low
10	Block 15 A&15 B					2 – Moderate
11	Block 17 &18					4 -Very High

Key informants from the DRRM Office, Barangay, and University of the Philippines Project NOAH, concurred with the findings of the study and cited institutional concerns that need to be addressed to reduce vulnerability. They recommended the relocation of highly vulnerable groups but claim there are material constraints to this measure, as the following:

- Difficulty in finding a site to relocate human settlement because population density is already high in that area. According to Project NOAH projections, there is a limited amount of land in the study area that can be considered as a risk-free zone.

- In cases when a relocation site was available, site development became another source of difficulty because of the limited resources of the barangay and insufficient budgetary allocation from the central government.
- Identifying beneficiaries and awarding of housing units is difficult because of recommendations for relatives and supporters based on political interests. Prioritizing beneficiaries on the basis of a set of criteria needs to be strictly enforced.
- Usually the relocation sites are located far from the city because of high land prices within the area. This may impose a negative impact in relation to livelihood options. Additionally, some households sell or rent out their new houses in the relocation sites because these are far from their source of livelihood; they tend to continue with their accustomed source of livelihood in the vulnerable and high-risk areas.

The interviewees also recommended other actions to improve current risk management included policy practices, such as:

- Local government units need to be more attentive and give a higher priority to addressing threats of natural disasters in development plans, and instead, preference is given to incorporate disaster prevention, mitigation, and relief into disaster contingency plans.
- Households and communities that have experienced climate-related disasters have implemented adaptation measures, which were mostly temporary in nature. This requires better risk reduction education, not just emergency management. More sustainable solutions will, however, need a support from policy makers and other organizations.
- Adaptation strategies and options need to be identified and selected following a thorough evaluation of risks and potential.
- Political leaders need to mainstream risk management and adaptation in the government's resource allocation or budgeting system and expand short-term policy targets to more strategic goals.
- There is a need to build uniformity on views among local and national stakeholders for climate change policies and actions. This will help in closing the existing gaps in knowledge and understanding of climate change and the measures required to address it.
- There is lack of permanent staff in DRRM and CCA sector employment; allocation of risk allowance for emergency period is low and compensation is low. Security and support for continuing competency development of DRRM frontline service providers are needed. This includes improving compensation packages of these workers to minimize quick turnover of staff.

Conclusion and Recommendations

Conclusion

The vulnerability of a community to a flood hazard is commonly measured using socioeconomic indicators or calculating physical flood extents, however, their combined impact is often ignored. This study set out to contribute to this field by examining the socio-economic factors that tend to shape the vulnerability of BASECO community. From the preceding chapter, the vulnerability of BASECO, specifically the households, are largely a function of non-climatic conditions that characterize development failures. It is not the intensity of natural hazards but the community's sensitivity and low adaptive capacity that give a more significant influence the high level of vulnerability of households (0.74) to the impacts of typhoon-generated storm surge. Of the three components, sensitivity had the highest contribution with a 0.61 index. This was followed by exposure with an index of 0.51, and adaptive capacity with an index of 0.38.

Exposure to storm surge can be greatly attributed to the magnitude of the population and extent of coastal flooding induced by storm surge. The community's sensitivity to sustain loss and damage from storm surge appears to be mainly a function of large family size, housing condition in terms of structure, income and employment challenges and population density that limits the physical space for efficient mobility during disasters operations and delivery of basic services. The relatively low adaptive capacity of the community can be attributed mainly to their limited access to potable water supply, sanitation facilities, emergency shelters, and communication facilities. Although access to credit appears to offset resource needs especially during emergencies, the dependence on informal financing scheme may work to aggravate poverty. In terms of cluster-specific vulnerability, it is possible that Gasangan (Location 1), New site area (Location 5), and Blocks 17 and 18 (Location 11) are more vulnerable to disaster impacts compared to the other clusters. This is based on estimated proximity to the coastline (less than 200 meters), land area affected, housing condition and distance from the nearest emergency shelter. The disparity suggests a uniform approach to risk management may not be as effective for these settlements as it would be for other residential clusters.

The local DRRM Office, barangay authority, and risk assessment expert confirmed these results citing that these have been their observations on the community and other similar settlements in the city even in the previous years. The vulnerability factors were linked to institutional issues that constrain effective relocation programs required by existing laws on socialized housing, DRRM, and the Supreme Court Continuing Mandamus on the rehabilitation of Manila Bay. These policies intend to restore the quality of Manila Bay and connected waterways, while ensuring the safety of riverine and coastal settlements from environmental hazards and climate risks. Another issue cited is the preference for the local government disaster and contingency management on relief and evacuation over more sustainable measures like disaster prevention and mitigation. Finally, there is the issue on weak investment decisions of the local and national governments prioritize short-term gains with little regard for future risks.

Recommendations

Households and communities that have experienced climate-related disasters have implemented adaptation measures, which are mostly temporary in nature. It is essential for the LGUs and decision makers to identify factors or measures and policy options that could improve the adaptive capacity of vulnerable households and communities in dealing with the impacts of climate change. Lessons learned from the previous disasters are not systematically integrated in policies and regulations, which results in cyclical patterns of vulnerability. Incremental changes have been made such as flood control systems but these are located in more developed areas like the city core. A more focused attention to vulnerable populations and underdeveloped areas can benefit local governments in the future. The following sections are some of the recommended actions.

Land Use Management and Risk-sensitive Land Use Planning: Proper zoning and land use planning should incorporate no-build zones or higher development controls in high-risk areas near the coastline. Where possible, mangrove plantation and recreational areas can be pursued. Local policies may also consider conditional built zones (e.g. only buildings with special reinforcements and business establishments but no residences) for commercial and other uses. For low and moderately vulnerable zones, land could be developed for habitation only if appropriately protected with warning systems and physical protection systems are installed.

Restructuring Housing Units and Use of Storm Surge Resilient Housing Materials: There is the need for clear guidelines and monitoring of housing units in the areas to ensure these are up to Code. As BASECO compound was previously a dumpsite, the load-bearing capacity of the soil is not suitable for multi-storied buildings. However, with some engineering interventions, small to medium rise buildings may be possible to be built. Additionally, land tenure issues need to be resolved, in order to encourage longer-term homeowner investment in disaster resilient infrastructure. Green technologies, environment-friendly approaches should also be part of DRR preparedness embedded in local development regulations.

Employment Generation and Alternative Livelihood Options: Disaster-related damages impact to livelihoods limiting household income that can create diverse consequences as health issues, and food security. Most of the households are engaged in informal sector employment (fishing, daily labor, retail trade, etc.), which are highly dependent on weather conditions. To reduce this vulnerability, it is recommended for the LGU to develop secondary and tertiary sources of income for the community. Skills development training, micro-enterprise development in the small-scale industry, and arranging credit facilities for the small-scale entrepreneurs will increase income diversity and reduce vulnerability to shocks.

Emergency Preparedness: Early action from local leaders can help minimize losses and facilitate early recovery. Awareness campaigns and more frequent evacuation drills should be carried out based on different hazard scenarios, at the minimum worst-case scenarios from projected storm surge. With simulated drills, the city government and barangay council could test their disaster preparedness plans and responses and make adjustments in areas that need more preparation. Advanced backup system for electricity and communications need to be installed and stay active in case of emergencies.

Construction of Multipurpose Building or Evacuation Centers: It is a common practice for local governments to absorb large numbers of evacuees in available emergency shelters without inspecting the readiness of these structures. Often, these facilities do not have enough water supply, proper ventilation, toilet facilities, and lighting, and other amenities for vulnerable groups. An ideal multi-purpose evacuation center should incorporate shelter standard amenities such as kitchen, storage room for goods and supplies, clinic, toilets, shower rooms, sleeping quarters, learning space, counseling area, and other amenities. These should be designed as inclusive facilities attuned to the needs of vulnerable populations like elders, children, mothers, and persons with disabilities.

Improvement of Sanitation, Drainage, and Waste Management: Poor sanitation conditions are due to a variety of social and economic factors. A high level of subsidy for latrine construction of communal sanitation facilities is essential. Moreover, the risk of contamination of groundwater is high - all of these need to be taken into account when constructing pit-based latrines. After a storm surge event, floodwater submerges the community because of inadequate drainage systems. There is no proper management of solid wastes and domestic wastewater – including septage. These are carried by storm water to surrounding water bodies during flooding. An integrated wastewater management system is essential in reducing vulnerability.

Improvement of Dike System and Stone Breakwaters Near the Shoreline: Storm surge control measures need to be upgraded to meet current and future needs. The areas near the coastline in Barangay BASECO needs stone breakwaters and an improved dike system to make the community resilient. To date, a concrete barrier in the area covers a limited stretch. There is a need to cover the total perimeter of the shoreline fronting the settlement. More importantly, the wall needs to have adequate height to account for sea level change and changing surge height as evidenced by past natural disasters.

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