



Project Report: 2013-32

Economic Analysis of Climate Change Adaptation Strategies in Selected Coastal Areas in Indonesia, Philippines and Vietnam

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Acknowledgments

The authors extend their deepest gratitude to the International Development Research Center (IDRC) and the Swedish International Development Cooperation Agency (Sida) through the Economy and Environment Program for Southeast Asia (EEPSEA) for providing the financial support that made this project possible. The authors would especially like to thank Dr. Herminia A. Francisco, EEPSEA Director, for her technical support and guidance throughout the conduct of the study. The technical support of Dr. Canesio Predo of EEPSEA is also very much appreciated.

The authors are also thankful to the Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA) under its Seed Fund for Research and Training (SFRT) Program for providing additional financial and technical support particularly for the policy component of the study. The authors would especially like to thank Dr. Gil C. Saguiguit Jr, SEARCA Director and Dr. Mercedita A. Sombilla, former Manager of the Research and Development Department of SEARCA.

We would also like to acknowledge the contribution of the individual team members for each site: Indonesia (Siti Hajar Suryawati, Ivonne M. Radjawane and Klaudia O. Sembiring), Batangas (Imelda M. de los Reyes and Frank G. Ilustrado), Palawan (Melissa Theodora U. Macasaet and Nelly I. Mendoza) and Vietnam (Bui N. P. Thien Chuong, Le T. Huyen Trang, Nguyen T. Tram Anh and Curtis M. Jolly) whose commitment to the project and the activities pursued allowed the team to complete the work within the project duration.

The comments and recommendations of the EEPSEA resource persons/reviewers (Dr. David James and Prof. Nancy Olewiler) as well as the panel during the technical report presentation of project results in the Biannual Meeting in Cambodia in 2012 that helped in further improving and refining the study are also very much appreciated.

The authors are also grateful for the support of concerned agencies and institutions such as the Municipality of San Juan, University of Batangas, City Government of Puerto Princesa, Palawan State University, Department of Science and Technology (DOST), Bureau of Fisheries and Aquatic Resources (BFAR) in the Philippines; Institut Teknologi Bandung, Ministry of Public Works, Ministry of Marine Affairs and Fisheries in Indonesia; and Nha Trang University in Vietnam.

The project will not be successful without the help and participation of key informants, FGD and validation participants, survey respondents, enumerators, other local government officials and residents in the study areas. To everyone, the authors extend their sincerest appreciation and thanks.

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Executive Summary

This report is an account of a cross-country study that covered Vietnam, Indonesia and the Philippines. Covering four sites (one each in Indonesia and Vietnam) and two sites in the Philippines, the study documented the impacts of three climate hazards affecting coastal communities, namely typhoon/flooding, coastal erosion and saltwater intrusion. It also analyzed planned adaptation options, which communities and local governments can implement, as well as autonomous responses of households to protect and insure themselves from these hazards. It employed a variety of techniques, ranging from participatory based approaches such as community hazard mapping and Focus Group Discussions (FGDs) to regression techniques, to analyze the impact of climate change and the behavior of affected communities and households.

Results show that households in coastal communities face a confluence of risks and often adapt simultaneously to these risks. These risks have the most impact on the sources and types of livelihoods of households. Foregone income due to these risks was in fact found to be higher than the value of damages from loss of assets including damage to houses. Foregone income in the end affected consumption patterns. Using the Vulnerability as Expected Poverty (VEP) as a measure, it was found that the incidence of vulnerable households is highest in Palawan, Philippines (56%), followed by Vietnam (46%), Batangas, Philippines (42%) and then Indonesia (35%). The mean vulnerability estimate for Palawan is 0.51, which means that on average the probability that households will fall below the minimum consumption level (at which they will be considered poor) is 51%. For Vietnam, the mean vulnerability is 0.43, while Batangas and Indonesia have mean estimates of 0.38 and 0.37, respectively.

Various planned adaptation options, which communities and local governments can implement, were studied using cost effectiveness analysis. A consistent and common result across three sites is that ecosystem-based approaches (or natural barriers such as mangroves) are more cost effective than hard infrastructure investments. There also seem to be a preponderance of protective measures when, in fact, the main impact or risk from these hazards is really on the livelihoods of coastal-based communities. In Batangas, for example, it was found that livelihood diversification is a viable planned adaptation measure.

Factors that determine autonomous or private responses to climate hazards were also assessed. It was found that there are geographical and spatial differences in adaptation patterns, suggesting that households react rationally to the degree of threats from the hazards. For instance, households near riverbanks are more likely to employ autonomous adaptation strategies against flooding. Evidence was also found that planned adaptation “crowds out” private or autonomous adaptation. Presence of natural barriers such as mangroves and riverbank rehabilitation schemes result in less likelihood of autonomous adaptation to flooding and saltwater intrusion being pursued. Income from external sources, such as disaster relief, also tends to crowd out autonomous adaptation. Social capital, which was represented by the number of people from whom the respondents can turn to for loans with some level of certainty, had a positive effect on the likelihood of autonomous adaptation. There was also some gender dimension in adaptation. In particular, households with more female members have lower likelihood of pursuing autonomous adaptation to flooding and typhoon, but higher adaptation to saltwater intrusion. Unfortunately the study did not assess the reasons for this behavior in more detail, as this was not part of the original design.

1.0 Introduction

Coastal and marine ecosystems are vital to most Southeast Asian countries primarily because most of the countries in this region depend on fish and other marine products to fuel their economy and feed their population. Furthermore, the people living in coastal areas and dependent on this resource base are among the poorest in the region. Thus, governments have been concerned about the environmental problems confronting these ecosystems and the populations dependent on them.

With climate change, coastal ecosystems and associated populations are even more at risk. Most of the attendant effects of climate change, like sea level rise (and subsequent salt water intrusion) and sea surface temperature rise, emanate from the sea. Thus, while environmental externalities have been traced from the ridge to the reefs in the past, climate change has pushed the need to look at effects from the reefs to the ridge. Coastal ecosystems and the communities dependent on them have in fact become more vulnerable, requiring more focused efforts and packages of support from government and private sectors alike.

There is still a dearth of literature on why some households self-protect and self-insure against climate hazards while others do not. What are the determinants of autonomous adaptation? As there is heightened concern on climate change, what are the possible interactions between public initiatives and autonomous initiatives? Does the presence of public intervention substitute for private defense or insurance against climate-related risks?

What complicates the analysis is that hazards are often interrelated and occur simultaneously. The study therefore attempted to provide a cross-country comparison on adaptation behaviors and to understand this within the unique context of multiple hazards that often confronts households in coastal communities.

The study in general assessed public (planned) and private (autonomous) adaptation strategies pursued by coastal communities against multiple climate-related hazards – to gain a better understanding of the risks associated with climate change and assess adaptation strategies and policy options to address these risks more efficiently. Specifically the objectives of this study included:

1. Validating and assessing climate change impacts on selected coastal areas in Indonesia, Philippines and Vietnam;
2. Identifying vulnerabilities and adaptation strategies of households and communities;
3. Evaluating the cost-effectiveness of planned adaptation strategies to climate change in selected coastal areas in the three countries;
4. Exploring and identifying emerging issues in the assessment of vulnerability and economic analysis of adaptation;
5. How climate change policies can be mainstreamed in the development agenda and programs.

The study covered four study areas in three Southeast Asian countries significantly affected by climate change (Figure 1). Table 1 presents a summary of the specific study sites and partner institutions in the project areas.



Figure 1. Location of the study sites.
Source: <https://maps.google.com/>

Table 1. Summary of the specific study sites and partner institutions.

Study Site	Municipality/Barangays	Research Partners
Jakarta Bay, Indonesia	Sub-District of Cilincing, Kalibaru, Marunda and Rorotan in the District of Cilincing and Sub-District of Kamal Muara and Muara Angke in the District of Penjaringan	Research Center for Marine Fisheries Socio-Economics – Ministry of Marine Affairs and Fisheries; Faculty of Earth Science and Technology; Institut Teknologi Bandung; Ministry of Public Works
Honda Bay, Palawan	Babuyan and Binduyan in Puerto Princesa	Palawan State University; City Government of Puerto Princesa
Batangas	Catmon and Hugom in San Juan, Batangas	University of Batangas; Municipality of San Juan
Vietnam	Ben Tre Province	Nha Trang University

2.0 Research Methodology

Climate change in general affects coastal communities through a rise in sea surface temperature (SST), sea level rise (SLR) and changes in precipitation (both in terms of intensity and pattern). As a consequence water resources, agriculture, human health, fisheries, tourism and human settlements in vulnerable areas are at risk. This study argues however, that coastal communities face a **confluence** of risks. For instance, typhoons result in both inundation and coastal erosion. Thus focusing on SLR alone and

attributing all damages to SLR can be misleading, as the impact of SLR is often magnified by storm surges and typhoons. This study therefore considered multiple threats from typhoon/flooding, coastal erosion and saltwater intrusion as the primary hazards or risks associated with climate change to which communities and households react and pursue adaptation measures.

Individual country studies adopted a common framework in analyzing climate change hazards, vulnerabilities, impacts, and adaptation options. Figure 2 illustrates the flow of methodologies used to address differences in situations across sites and the commonalities that allowed comparisons and generation of lessons learned.

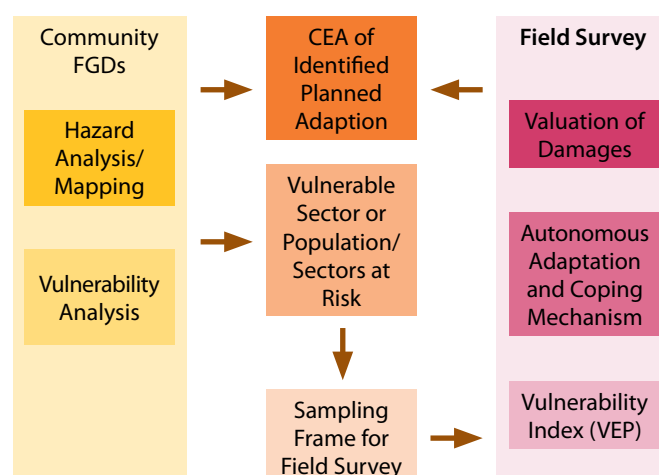


Figure 2. General flow of methodologies.

The study used a community-based/participatory assessment of the bio-geophysical impacts of climate hazards to analyze the vulnerability of coastal communities and assess impacts of hazards directly from the point of view of those affected themselves.

Focus Group Discussions (FGDs) were also conducted to: a) identify relevant issues related to climate change and its impacts; b) gather information to refine the household survey instrument; and c) determine adaptation activities and policies already being undertaken (i.e. autonomous adaptation). The study adopted Klein and Nicholls (1998) to identify and classify adaptation options: managed retreat, accommodation, and protection (Table 2).

Table 2. General adaptation strategies

Strategy	Options
Managed retreat	No development in susceptible areas Conditional phased-out development Relocation projects
Accommodation	Modification of land use Modification of building styles and codes Strict regulation of hazard zones Hazard insurance
Protection	Hard structural options: Dikes, levees and floodwalls Seawalls, revetments and bulkheads Detached breakwaters Floodgates and tidal barriers Saltwater intrusion barriers Soft structural options: Periodic beach nourishment Dune/wetland restoration and creation

Quantitative assessment of household vulnerability used the concept of Vulnerability as an Expected Poverty (VEP) an econometric approach to measure vulnerability of households defined as the probability that households or individuals will move to poverty in the future or fall below a minimum consumption threshold level, given certain shocks (Chaudhuri 2003). These shocks may include the occurrence of climate extremes or climate variability. The analytical procedure followed the work of Chaudhuri et al. (2002) and Deressa et al. (2008).

The study used World Bank's minimum consumption threshold level of US\$1.25 per capita per day. The analysis was based on the assumption that climate extremes or climate shocks, particularly typhoon, flood and drought, will have an influence on the probability that households' consumption will fall below a given minimum level (Deressa et al. 2009).

The Cost-Effectiveness Analysis (CEA) on the other hand was used to assess the economic viability of different planned adaptation options, i.e. adaptation options that can be implemented by communities or local governments. The decision criterion of CEA was to choose the option that can achieve a specific objective at the least cost. In cases where the objective of adaptation is multiple, CEA was applied when one objective can be expressed in the other by assigning importance (weight) to the objectives.

To analyze the choice of autonomous adaptation strategies employed by households the study used the discrete choice model. While it is common in the literature to use a probit model, households respond to a confluence of events, and coastal communities often face simultaneous hazards. Thus, there is prudence in looking at decisions as if they were interrelated, which entails examining collectively the decisions to adapt against several hazards.

3.0 Study Results

3.1 Climate change hazards, impacts and other issues in the study areas

The most common and dominant threats in all the study sites are sea level rise (SLR) and extreme events such as typhoons, and to some degree storm surges. The attendant bio-geophysical impacts from the confluence of these hazards are coastal erosion, flooding/inundation and saltwater intrusion. Table 3 presents the summary of climate change issues and related concerns raised in the project sites.

There were also various factors that exacerbate damages from these bio-geophysical impacts. For example in San Juan, Batangas, sand quarrying has hastened coastal erosion from rising sea levels and storm surges. Illegal fishing confounds the impact of SLR on declining fish stock and recruitment potential. Charcoal making also has led to a decrease in the mangrove area in the study site. The same contributory factors were observed in Palawan but an additional factor noted is extensive foreshore development that hastened coastal erosion. In Jakarta Bay, Indonesia, land subsidence caused partly by groundwater extraction has exacerbated the effects of the rising sea.

3.2 Initiatives on climate change adaptation and disaster mitigation

There is a variety of autonomous adaptation documented in the study sites. The behavior of households in choosing responses to climate change is quite diverse. For instance, in Vietnam rainwater harvesting was reported as a response to saltwater intrusion but not at both sites in the Philippines which also experienced saltwater intrusion. Annexes 1–4 enumerate current and potential initiatives on climate change adaptation and disaster mitigation in the study areas. Some of the initiatives respond to the attendant confounding factors but may not contribute directly to increasing the adaptive capacity of households. Nevertheless, they are important in so far as creating an environment that enhances the effects of planned as well as autonomous adaptations.

3.3 Vulnerability assessment and impacts of climate hazards

Participatory mapping activities were conducted to illustrate detailed village layout and infrastructure as perceived by the residents themselves. These are vital to capture a better understanding of the livelihood strategies and assets of the communities, their dependence on different resources, perceived climate changes, their capacity to cope with these changes and assess their needs. They also provide information on the role of different institutions in supporting them to cope with and adapt to perceived changes. In addition, hazard and physical vulnerability mapping activities helped to identify the areas and resources perceived to be at risk from climate hazards. Table 4 presents the primary hazards identified in each study site based on the vulnerability matrix and comparative ranking of hazards.

Table 3. Summary of climate change hazards, impacts and other issues in the study sites.

Batangas	Indonesia	Palawan	Vietnam
Hazards - Sea level rise - Coastal erosion Confounding environmental issues: - Sand quarrying - Illegal charcoal making using mangroves & other species - Illegal fishing using blasting and cyanide (non-resident) - Use of fine mesh net and superlight in fishing Impacts - Damage to property (hotels, resort, houses and boat) during typhoon or low pressure area - Coral bleaching and increasing number of crown-of-thorns starfish - Impacts to livelihood and tourism in vulnerable coastal areas - A number of houses relocated because of coastal erosion - Houses, boats, and trees washed out during typhoons - Decrease in fish catch during typhoons - Mangrove areas, coral reefs, marine protected area and beaches also found at risk due to climate change	Hazards - Coastal erosion and seawater intrusion - Coastal or tidal flooding - Sea level rise Confounding environmental issues - Loss of most of mangrove and coastal ecosystems - Loss of biological diversity and habitat degradation - Large population size that creates economic difficulties and social problems - Pollution that affects water quality, frequency of flooding, soil erosion, and quality of river systems - Absence of a synchronized single fisheries policy in the area due to overlapping jurisdictions Impacts - Land subsidence, coastal inundation and coastal abrasion - Sea water intrusion has reached the National Monument - Increased turbidity of water affecting photosynthesis - Decreasing water quality - Disturbance to the flow of shipping to the port access - Change in the pattern of flow, bathymetry and coast line - Sediment accumulation in the entrance of harbor lanes, which increase costs (related to dredging)	Hazards - More frequent and intense typhoons - Floods Confounding environmental issues - Mangroves cut for charcoal, housing and fencing materials - Weak enforcement of coastal laws - Illegal fishing - Burning of some upland areas to give way for rice farming (kaingin) - Growing private beach front property development for housing and resorts - Lack of protection for the fish sanctuary because the guard house was destroyed by a typhoon Impacts - Water advances towards their homes - Change in the fish species caught - More houses and more bancas were destroyed as a result of typhoons - Coral bleaching outside of the sanctuary decreased area of land due to coastal erosion - Increased temperature killed a substantial number of the traditionally gleaned shells along the coastline - Sea water is hotter during the 3–4 pm gleaning activity - Landslide; siltation extends up to 2 kilometers on both sides of a nearby river - Bangus fry collected for the past 5–6 years declined significantly	Hazards - More frequent and intense typhoons - Destructive flood and tidal surges from 1996 to 2008 - Salty droughts in 2008 Confounding environmental issues - Sand mining - Heavy traffic of sea vessels Impacts - Loss of shelter and livelihood from typhoons - Land encroachment - Salt water intrusion during the dry season leads to a shortage of fresh water for domestic household and production uses

Table 4. Primary hazards and most vulnerable sectors.

Hazards	Batangas	Indonesia	Palawan	Vietnam
Primary CC hazards	Typhoon and flooding	Flooding and coastal flooding	Typhoon and flooding	Typhoon and salt water intrusion
Highly vulnerable sectors	Fisheries, tourism, and housing	Fisheries and housing	Fisheries and health	Agriculture (fisheries) and housing

Results from the household surveys confirm information obtained from the FGDs which indicated that the highest impact of climate hazards is on the earning capacity of coastal communities. Disruption of income-generating activities is inevitable since most of these communities are resource-dependent. Loss in income due to work disruption is almost twice the value of damages in assets including damage to houses. This is not surprising because these households are often very poor, thus the value of their assets is also comparatively very low.

Disruption in income streams and sources eventually rebound to a decline in consumption. Using the VEP framework and the

World Bank minimum consumption threshold of \$1.25 per capita per day, the study estimated the vulnerability of the households to climate change impacts. Mean vulnerability estimate for all households was highest for Palawan at 0.51, followed by Vietnam at 0.43, Batangas at 0.38 and Indonesia at 0.37. Mean VEP for those who are already considered highly vulnerable is highest for Indonesia at 0.92, followed by Vietnam at 0.91. Mean VEP estimates for the highly vulnerable group in Batangas and Palawan are 0.88 and 0.87, respectively (Annex 5).

In terms of incidence or percentage of households considered vulnerable, the highest was also found in Palawan (56%), followed

by Vietnam (46%), Batangas (42%) and then Indonesia (35%). However, the incidence of those who are considered highly vulnerable is highest for Vietnam (31%), with Palawan and Indonesia running second at 22%. Batangas had the lowest

incidence of highly vulnerable households at 15%. Figure 3 shows the distribution of household according to level of vulnerability across the study sites.

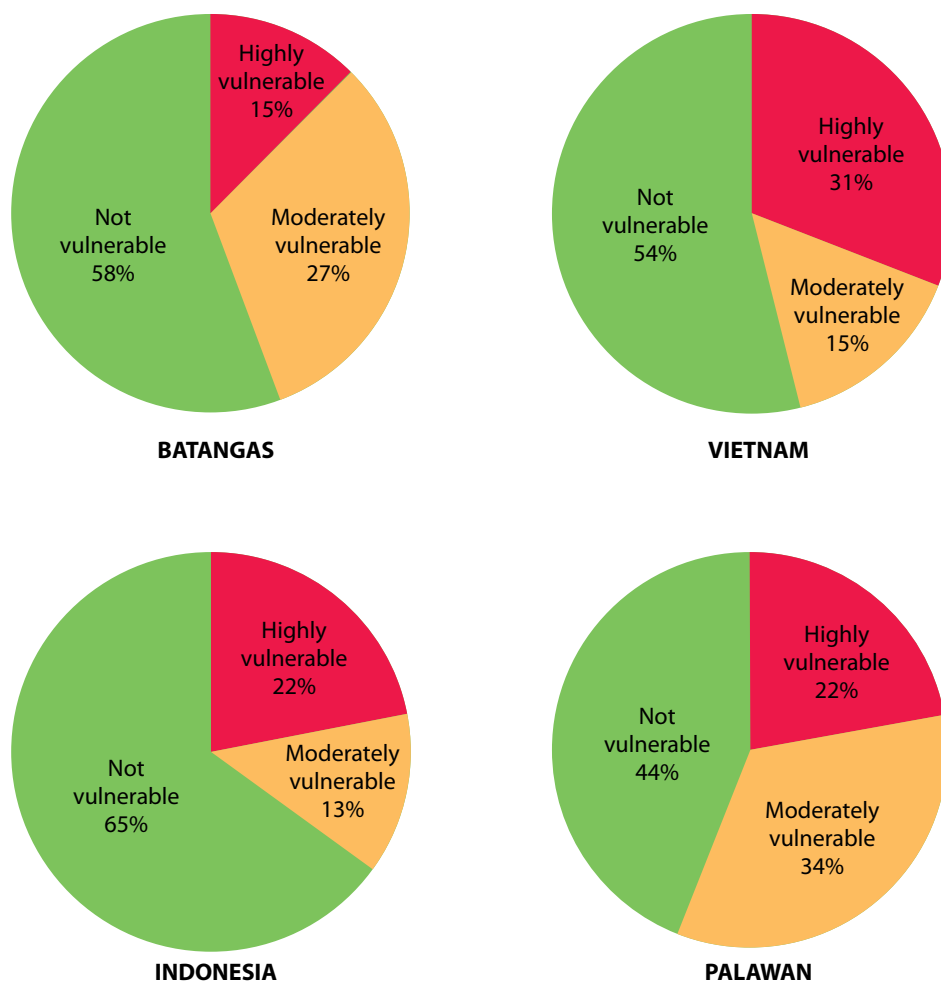


Figure 3. Distribution of households according to level of vulnerability.

One of the primary purposes of vulnerability assessment is to generate information that can aid in decision making. Hence, profiles of vulnerable households were established, and we need to describe their characteristics and analyze their profile. Such information can serve as a guide for governments, private organizations and the community themselves in strategizing how best to implement an adaptation program. Specifically, we looked at the primary occupation of the household heads, their perceptions about their knowledge and preparedness to deal with future climate change impacts, and the damages and impacts that they have experienced from past climate-related hazards and events. Looking at the role of gender also provided interesting insights.

In all sites except for Indonesia the majority of vulnerable households are headed by persons who are primarily occupied in the agriculture, fishery and forestry sectors (Table 5). Hence, it makes sense to implement interventions that target this particular

group. It is important to note that this sector is highly sensitive to external shocks, including those brought about by climate change. For instance, typhoon and flooding can destroy standing crops and fish pens. It can also prohibit fishermen and forest gatherers (who rely on their daily catch/collections to provide nourishment to their family) from going out to sea or to the forest.

One strategy could be livelihood diversification and income augmentation. Training and credit provision to support alternative livelihoods may be pursued towards this end. The possibility of providing insurance may also be explored. In Batangas and Indonesia, however, the heads of a significant proportion of vulnerable households are laborers, service-oriented trade and unskilled workers, or plant and machine operators. Hence, it is also beneficial to implement interventions that target this sector.

Table 5. Primary occupation of heads of vulnerable households (percentage distribution).

	Farmers, fishers, hunter/gatherers, foresters	Service-oriented workers, trade and related workers, plant and machine operators, laborers and unskilled workers	Officials, managers and business owners, professionals, technicians, clerks, and special occupations
Batangas	55	25	10
Palawan	73	13	4
Vietnam	81	13	0
Indonesia	6	49	0

Knowledge and information are crucial elements in ensuring that households are able to withstand or minimize the impacts of climate change. In Indonesia, Batangas and Vietnam the majority of the vulnerable households revealed that they have little or no knowledge about climate change and its impacts (Table 6). For

these sites, it may be necessary for climate change adaptation programs to include information-dissemination activities. For Palawan, on the other hand, the trend is quite different, with a significant proportion (38%) revealing that at the very least their knowledge about climate change is adequate.

Table 6. Level of knowledge of vulnerable households about climate change (percentage distribution).

	No information	A little bit of knowledge	Adequate knowledge	Fully knowledgeable
Batangas	47	40	11	2
Palawan	14	48	36	2
Vietnam	40	58	2	0
Indonesia	73	23	3	0

In Table 7 it is shown that a large proportion of the vulnerable households (63%) in Vietnam and Indonesia consider themselves unprepared for future climate change hazards. This proportion is smaller for Batangas and Palawan with 22 and 12%, respectively. The proportion of households claiming that they are at least

adequately prepared is highest for Palawan (48%), followed by Batangas (34%) and Indonesia (5%). In Vietnam, it is alarming that not one household claimed it was at least adequately prepared to address future climate change impacts. This highlights the need for government assistance in adaptation.

Table 7. Distribution of vulnerable households based on their preparedness to deal with future impacts of climate change (in percentage).

	Not prepared	Somewhat prepared	Adequately prepared	Fully prepared
Batangas	22	43	23	11
Palawan	12	39	35	13
Vietnam	63	37	0	0
Indonesia	63	31	4	1

Looking at the impact of past hazards on vulnerable households can also serve as a guide to the strategic formulation and targeting of adaptation programs. It is a means by which we can roughly assess the adaptation needs of the communities living in the study site. The incidence of these impacts among vulnerable households is summarized in Tables 8, 9 and 10. Major impact for vulnerable households in Batangas is income loss due to work stoppage, loss of fishing income, damage to houses, and gastrointestinal illnesses. Again this highlights the need to augment income sources of vulnerable households. This also means that healthcare provision may be necessary to address their needs.

Loss of income from agriculture production and aquaculture production also seems to be a major problem, affecting as high as 25% of vulnerable households. Strengthening house structures is a possible adaptation strategy for Vietnam, as well as the implementation of flood mitigating projects. Livelihood programs may also prove to be a strategic intervention. Also, since a significant proportion of vulnerable households are susceptible to saltwater intrusion impacts, particularly affecting agricultural production, introduction of relevant technologies, such as the planting of salt tolerant crops, may be pursued.

For Palawan, impacts seem to be quite minimal, affecting only a small percentage of the vulnerable households. Among these, gastrointestinal illness among household members had the highest incidence. Impacts in Vietnam are much more widespread, with more than half of the vulnerable households experiencing damage to their houses from typhoon and flooding, while 47% reported experiencing shortage in fresh water supply for their domestic household use.

In Indonesia, no household reported sustaining impacts from typhoon and floods, and saltwater intrusion. The most significant impacts that households reported are damage to house (affecting 9% of households) as well as household appliances (6%). Since the primary cause of these damages are erosion and sea level rise it might be reasonable to consider relocation of affected households away from the shoreline.

Table 8. Typhoon and flooding impacts among vulnerable households (incidence in %).

Typhoon and Flooding Impacts	Batangas	Palawan	Vietnam	Indonesia
Damage to house	11	1	54	0
Damage/loss of appliances	5	1	14	0
Loss of livestock	1	0	0	0
Damage to assets (boats, motorcycles)	1	0	6	0
Loss in agricultural production	0	1	15	0
Loss in fishing income	11	1	5	0
Loss in aquaculture production	0	1	15	0
Income loss due to work stoppage	13	2	2	0

Table 9. Erosion and sea level rise impacts among vulnerable households (incidence in %).

Erosion and Sea Level Rise Impacts	Batangas	Palawan	Vietnam	Indonesia
Damage to house	2	1	1	9
Damage/loss of appliances	1	1	0	6
Loss of livestock	2	0	0	0
Damage to assets (boats, motorcycles)	5	1	1	0
Loss in agricultural production	0	0	4	0
Loss in fishing income	10	2	0	0
Loss in aquaculture production	0	1	6	0
Income loss due to work stoppage	6	1	0	0

Table 10. Saltwater intrusion impacts (incidence in %).

Saltwater Intrusion Impacts	Batangas	Palawan	Vietnam	Indonesia
Loss in agricultural production	-	-	25	0
Household members got sick from typhoid	1	-	1	0
Household members got sick from diarrhea	4	2	1	0
Household members got sick from other gastrointestinal illnesses	8	4	2	0
Household experienced lack of fresh water for domestic uses	-	-	47	0

The role of gender still remains controversial. Some argue that women are more vulnerable since majority of the world's poor are women, and most women are largely dependent on livelihoods that rely heavily on the use of natural resources. The latter reason makes women more susceptible because natural resource intensive livelihoods are very sensitive to shocks. On the other hand, some contend that women play an important role in adaptation, which essentially reduces the household's vulnerability. Nonetheless, it is important that adaptation programs should be gender sensitive. Table 11 shows the distribution of vulnerable households based on gender of household head. For all sites, although majority of the vulnerable households are male-headed, a significant proportion (between 13 and 38%) are female-headed. In terms of incidence of vulnerability, it can be seen that it is higher for males in Vietnam, Batangas and Indonesia – 48, 43 and 42%, respectively. For Palawan, however, incidence is significantly higher for female-headed households at 74%, while male-headed households have a 55% vulnerability incidence (Table 12).

Table 11. Distribution of vulnerable households based on gender of household head (percentage share).

	Male	Female
Batangas	83	17
Palawan	88	12
Vietnam	87	13
Indonesia	63	38

Table 12. Incidence of vulnerability for male- and female-headed households (in percentage).

	Male	Female
Batangas	43	39
Palawan	55	74
Vietnam	48	35
Indonesia	42	27

3.4 Cost-effectiveness analysis of planned adaptation options

The planned adaptation strategies were selected through consultation with the residents, key individuals and officials of the community. After identifying the list of planned adaptation strategies in the study areas, the options were evaluated using cost-effectiveness analysis (CEA). Tables 18 to 21 present the CEAs conducted for each of the sites.

3.4.1 Vietnam

Two options were considered for cost effectiveness analysis, the construction of freshwater supply plant and the construction of a sea dyke system. The first option will ensure the supply of sufficient fresh water for agriculture, industry, tourism, services, and household domestic use within Thanh Phu, Cho Lach, Mo Cay Nam, and Mo Cay Bac. The sea dike system on the other hand, will prevent flooding caused by tides, typhoons, and sea level rise in favor of 10 communes in Thanh Phu district.

The initial investment for the Water Plant is VND249,567,795,979 (USD12,035,484) as summarized in Table 13. Apart from the initial

investment, there is an annual operating cost of USD44,560 from 2015 to 2019, and USD113,157 from 2020 to 2049.

Table 13. Initial investment for the water plant in Thanh Phu district.

Category	Expenses (VND)	Expenses (USD)
Construction	184,221,086,019	8,884,119
Machines and equipment	9,761,440,370	470,748
Project management	1,895,461,177	91,409
Project consultancy	5,907,569,190	284,894
Clear-the-ground compensation	3,270,250,000	157,709
Inflationary costs	42,864,132,393	2,067,136
Miscellaneous	1,647,856,829	79,468
Total investment	249,567,795,979	12,035,484

Source: DARD Ben Tre 2011.

The sea dike system, with a dimension of 52.4 km x 7.5 m x 4.0 m, will be constructed over a period of 6 years. This will require an initial investment of VND 2,999,704,000,000 (USD 144,661,651.23) (Table 4). The operating costs include maintenance and

miscellaneous costs, which will start by 2013. Replacement cost in 2030 is projected at VND302,150,000,000VND (USD14,571,277.01) (DARD Ben Tre 2010).

Table 14. Investment of the sea dike system.

Category	Expenses (VND)	Expenses (USD)
Construction	1,669,797,000,000	80,526,475.69
Clear-the-ground compensation	318,840,000,000	15,376,157.41
Project management	17,246,000,000	831,693.67
Project consultancy	121,908,000,000	5,879,050.93
Miscellaneous	61,773,000,000	2,979,021.99
Provision costs	810,140,000,000	39,069,251.54
Total investment	2,999,704,000,000	144,661,651.23

Source: DARD Ben Tre 2011.

The population of Thanh Phu district in 2010 was 121,902 while the average household size is 3.73. Population growth rate is assumed to be 1.16% per year. With this information, the total number of households until 2049 can be easily calculated. For the water plant, in the first four years of construction, the project will not generate any benefit. From 2015 to 2019 the number of benefited households is equal to 85% of the total number of households. From 2020 to 2049 the figure mounts to 90%. Such assumptions reflect the fact that a proportion of households will not take advantage of freshwater from the project because they are unable to cover the costs of investment for piped water connection. Also in the communities there are few households who are not affected by salt water intrusion and may be unwilling to participate.

Monetary benefit can be calculated by multiplying the amount of water consumed within Thanh Phu district with unit price. Unit price of freshwater is assumed to be constant, that is, VND 3,500/ m³. Here we assume that 95% of freshwater produced will be consumed. The rest (5%) is wasted along pipelines. From 2015 to 2019 monetary benefit would be VND5,780,512,500 (USD287,767) (DARD Ben Tre 2011). From 2020 to 2049 the amount would be VND8,448,825,000 (USD407,447).

For the sea dike the benefits were estimated based on the following assumptions. As of 2011, the total population in the project site is 66,504. It was assumed that the population will grow at a rate of 1.16% per year. The number of households benefiting from the sea dike first occurs in 2012 and keeps increasing until 2049 (DARD Ben Tre 2010). Monetary benefit can be measured by estimating the monetary value resulting from increased

productivity in agriculture. This value can be obtained from secondary data.

3.4.2 Batangas

Five adaptation options were subjected to CEA – the construction of a sea wall, mangrove reforestation, establishment of an early warning system, land zoning, and implementation of a livelihood program. The proposed sea wall will be 3 meters in height and 1 meter thick. It will have an underwater base that is 1.5 meters high and 3 meters thick. The proposed construction materials are a combination of concrete and boulders, stacked to form a wall. The mangrove reforestation would consist of propagules from the species already prevailing in the site to ensure that the rate of survival would be relatively high.

Through an effective early warning system the number of avoidable and unnecessary deaths and property damage could be reduced dramatically. In this study, this option also includes an effective response system involving evacuation and provision of temporary shelter. Because of budget constraints, the temporary shelters would be in schools and in public gymnasiums.

Land zoning through the Comprehensive Land Use Program (CLUP) is an important option to minimize the damage posed by typhoon and flooding. Through the CLUP development in lands that are flood-prone will be prohibited. Also, subdivision developers will be required to undertake flood-proofing measures as part of the strategy, while informal settlers living near the river banks will be relocated.

Experiences in other countries have shown that the ability to cope with increasing climatic hazards is highly dependent on the ability to diversify income sources (Truong 2007). For the livelihood program, barangay residents would be provided an opportunity to be trained in an off-shore, non-fishing source of livelihood. After the initial round of training they will be assisted in terms of management and financial aspects of the business that they will set-up. Access to credit would also be part of the package.

Based from the best estimates of key informants, composed of an officer from the Provincial Government Environment and Natural Resources Office (PGENRO), a civil engineer, an NGO official engaged in mangrove reforestation and officers from the Municipal Agriculture Office and Provincial Disaster Coordinating Council, the following assumptions about the cost and impacts of the options were made:

- Seawall construction: about PhP7.5M (USD174,054) for 1000 linear meters;
- Maintenance cost is PhP50,000 (USD1,160) annually.
- Mangrove reforestation, initial cost is PhP300,000 (USD6,962) with an annual maintenance and monitoring cost of PhP60,000 (USD1,392).
- Developing an integrated drainage and flood control system is PhP4M (USD92,829) spread over 2 years until its full completion.
- Maintenance cost of the drainage system is at PhP100,000 (USD2,321) annually.
- CLUP formulation and revision is PhP 3M (USD69,622) while PhP 100,000 (USD2,321) is provided for the annual monitoring and evaluation of the zoning ordinance.

- Livelihood project, an investment of PhP 5M (USD116,036) is assumed for the first two years, and an expected yearly monitoring and evaluation cost of PhP100,000 (USD2,321).
- Early warning system, an initial cost of PhP2M (USD46,414) in the first year, with an operations cost of PhP100,000 (USD 2,321) yearly thereafter.
- Annual cost for temporary shelter during calamities is PhP500,000 (USD11,604) which decreases by 10% annually starting at year 5 as a result of the assumed increasing effectiveness of the early warning system.
- Zoning implementation, PhP10M (USD232,072) for relocation, spread over the first five years.

It is assumed that the total number of households that will benefit from the projects is 500. There is no benefit for the seawall in the first year while the structure is being constructed. The benefit of having the protection from coastal erosion starts at the 5th year when mangrove propagules become fully matured trees and it is assumed to increase through time. As these mangrove propagules become full-grown and mature trees as time passes by their ability to stabilize the shore is predicted to increase. Predictions are based on a 60% rate of survival for the propagules.

3.4.3 Indonesia

Several adaptation options were considered in the study as summarized in Table 15.

Table 15. Adaptation options/strategies in Indonesia.

Site	Adaptation options
Rorotan	Continuation of the East Flood Canal Project
	River Dredging/Normalization
Marunda	Construction of Embankments
	Mangrove Planting
Kalibaru	Road Elevation and Establishment of Fresh Water Supply Facilities
	River Dredging/Normalization
Kamal Muara	River Dredging/Normalization
	Mangrove Planting
Muara Angke	Mangrove Planting
	Road Elevation

For Rorotan, the first option is the construction of the East Flood Canal. This project is expected to be able to resolve the flooding in Jakarta City, particularly the massive flooding occurring every five years. This huge canal spanning 23.5 km will be able to serve 13 Villages including Rorotan Village. Land acquisition comprises more than half of the total investment cost of USD269,058,300 while the construction of the canal costs USD236,199,160. Construction is expected to last 10 years accruing a total investment cost of USD505,257,460. The maintenance cost for the following years after the construction is USD 472,400 per year. Since this is a huge project the number of households that can be served is around 148,184 and covers 13 villages. It is assumed to last for at least 40 years.

The second proposition is the dredging of Sunter River crossing Rorotan Village covering a length of 3 km. The investment cost for every kilometer is USD751,120 in the first year, and the maintenance for drainage cleaning for the next 10 years costs USD168,160 per year.

For Marunda, the first option is a 3-meter high permanent embankment along its 8 km coastline. The investment cost for

this proposed strategy is USD2,802,690 in 2 years and the maintenance cost is USD22,240 per year. The second potential strategy is to plant mangroves regularly. The investment for providing 1000 mangrove seeds costs USD390. It is assumed that it would only serve a total population of this area which is 3,792 households.

For Kalibaru, the total investment cost to elevate roads for 330 meters is USD22,200 and the maintenance cost for road pavements is USD1,110. For the provision of fresh water, the investment cost is USD2,833,320 while maintenance is USD708,330 per year. This small intervention might only serve the 10,119 households of this village. The investment cost for the second option, dredging Cakung River along its 2 km length, is USD1,502,240, while maintenance it is USD336,320 per year. Dredging Cakung River will not only affect the habitants of Kalibaru Village but also the 13,911 households living in Marunda village.

In Kamal Muara, the initial investment cost to dredge the 3 km length of the Pesanggrahan River is USD2,253,360, while maintenance would be USD504,480 per year. Dredging this river

will serve residents of Kamal Muara village and surrounding villages including Kapuk Muara and Pluit. This means that a total of 20,891 households will benefit from this option. The second potential strategy is to plant 20 ha of mangroves which would cost USD23,540 for the mangrove seeds and about USD20 per person per day for labor.

For Muara Angke Sub-District there are two potential strategies – elevating roads and planting mangroves. The investment cost to elevate a 5 km road is USD336,320 with

maintenance cost of USD16,820 per year. This intervention serves not only the local habitants of this village but also the whole subdistrict, with the total number of households served reaching 49,792. The second potential strategy is to plant 17 ha of mangroves, which costs USD 20,010 for the mangrove seeds and about USD20 per person per day for labor.

3.4.4 Palawan

In Palawan, the adaptation options included in the analysis are summarized in Table 16.

Table 16. Adaptation options/strategies in Palawan.

Site	Objectives	Adaptation options
Babuyan	To protect the household from storm surges and loss of property, and minimize sand erosion	Breakwater construction
		Dike/levee construction
		Mangrove reforestation
	To prevent river overflow and minimize siltation that cause damages to coconut plantations and fishponds.	Riverbank rehabilitation using vetiver grass
		Riverbank rehabilitation using vetiver grass combined with mechanical method
		Dike construction
		River dredging
	To protect household from inland flooding.	Upland reforestation
		IEC/Establish early warning system and provision of temporary evacuation center
		Relocate affected households to safer place
Binduyan	To protect households from strong waves and storm surges	Breakwater construction
		Mangrove reforestation
		Seawall construction
		Relocation of affected households

In Babuyan, the construction of a breakwater is expected to benefit 200 households living in the coastal areas as well as a stretch of 6.3 km of coastline. It is assumed that one kilometer of shoreline will benefit 32 households (7.83 km shoreline with 251 HH residents). The dike on the other hand will be constructed on the mouth of the river and will benefit only 126 households. Mangrove reforestation is expected to provide progressive benefits. It was assumed that only around 10% of the expected household beneficiaries will benefit on the fifth year and the number will increase by 25 households every year for the next four years.

In riverbank rehabilitation, the overflow of the river and siltation are expected to be addressed. Using the Vetiver grass alone, eight ha of fishponds and coconut plantations will be protected from river overflow on the first year. On the second year, 24 ha will be protected and an increase of 20% is expected every year thereafter. The target reduction in erosion and siltation is at least 80% and the full benefit is expected to start on the 7th year. The impact of riverbank rehabilitation using the Vetiver grass combined with mechanical method is assumed to be greater because of the additional materials used to reinforce the capacity of the grass in holding the soil.

In the case of coral reefs, benefit will start on the 4th year. Dike construction along the mouth of the river will benefit a total of 107 ha of coconut plantations, fishponds and coral reefs combined. Riverbed clearing as an option to be done annually will likewise benefit a total of 91.5 ha of coconut plantations, fishponds and coral reefs. The operation will require almost 3 months to complete.

Finally, 126 household are believed to benefit from upland reforestation. Expected benefit will commence from the 6th year and will multiply at the rate of 25 households per year. Likewise, half of the total households are predicted to avoid any disaster

that comes to the community if a disaster warning system is installed. This option will go hand in hand with the establishment of temporary evacuation centers. A further option is to relocate the community. This relocation would take place in two batches. The first batch would comprise 125 households then after a year the last 126 households would follow.

For Babuyan, both the breakwater and seawall are expected to provide a constant protection to the households and the coastline. The breakwater is expected to provide 80% protection to the households living on the coastal area, because the breakwater will not cover the full length of the coastline. Aside from protecting the households, the degree of erosion is also expected to be minimized and about 90% (8.58 km) of the total coastal areas will be protected.

The cost assumptions for the planned adaptation options are presented in Table 17. There was no identified maintenance cost for the structures. It was given that – assuming the construction process followed strictly the standard for seawall, dike and breakwater – no cost will be incurred within the specified effective life of the structures under normal conditions. Mangroves planted during reforestation were computed to have 80% survival rate, therefore 20% of the seedlings planted would need replenishing the following year.

Various planned adaptation options, which communities and local governments can implement, were analyzed using cost effectiveness analysis (CEA). A consistent and common result across three sites is that ecosystem-based approaches are more cost-effective than hard infrastructure investments. This is true for the case of mangrove reforestation (whenever applicable) when compared with sea walls, embankments, and breakwaters. In Batangas, where livelihood diversification was considered for CEA, it was found that this intervention which can augment

the income-earning capacities of households is a cost-effective planned adaptation option.

As explained, the options considered for cost-effectiveness analysis were identified by the stakeholders, which include the local government. There seem to be a preponderance of protective measures (as seen in the table) when, in fact, the main

impact or risks from these hazards is really on the livelihoods of coastal-based communities. There is somewhat a disjoint in policy here. It is not to say that these initiatives are not needed. The results merely point to the fact that for coastal communities any public initiative should incorporate a livelihood diversification component.

Table 17. Cost assumptions for planned adaptation options.

Adaptation Options/Cost Items	Volume	Cost per unit (USD)	Total cost USD ('000)	Year cost incurred
Breakwater construction			298.68	
Construction cost	100	298.68	298.68	Y0
Dike construction			34.81	
Construction cost	1,000	34.81	34.81	Y0
Mangrove reforestation			5,819.67	
Planting material	50,000	0.30	15.08	Y0
Planting material	300	0.12	0.09	Y1
Labor	50,000		5804.5	
Relocation of affected HH			314.46	
Acquisition of land/devt	1	23,210	23.21	Y0
House construction	125	1,160.36	145.05	Y0
House construction	126	1,160.36	146.21	Y1
Riverbank rehab using Vetiver grass			9.28	
Planting materials	18,000	0.01	4.18	
Labor	90	0.20	0.42	Y0
Transport	1	2.00	0.05	
Replanting			4.64	
Riverbank rehab using Vetiver grass combined with mechanical method.			41.35	
Planting material	18,000	0.00023	4.18	Y0
Labor	90	0.005	0.42	Y0
Materials needed	1	23.21	23.21	Y0
Labor for landscaping	1	8.91	8.91	Y0
Replanting of Vetiver grass			4.64	
Dike/levee construction			66.14	
Construction cost	1000	34.81	34.81	Y0
Rehabilitation cost (90% of the construction cost)		31.33		
Clearing of riverbed			19.54	
Backhoe/dredger rent	320	34.81	11.14	Y0
Fuel	4,800	1.39	6.68	Y0
Oil/lubricants	1	1.16	1.16	Y0
Wages	40	13.92	0.56	Y0
Upland reforestation			749.09	
Seedlings (free)				
Trans. cost	5000	0.05	0.23	Y0
Replanting	1000	0.05	0.05	Y1
Replanting	200	0.05	0.01	Y2
Replanting	40	0.05	0.002	Y3
Labor cost	6240	0.12	748.8	
IEC/Establish disaster warning system and provision of temporary evacuation center			0.23	
Supplies and materials	1	0.23	0.23	Y0
Prep of temporary evacuation centers			1160.9	

Table 18. Cost effectiveness analysis (CEA) for Batangas.

Objectives	Planned adaptation strategies	CE ratio	Result
Protect the coastline from eroding	Construction of a sea wall	0.16M USD/linear km of erosion prevented	Mangrove reforestation is not only more cost effective, but also offers other co-benefits like additional sources of income, and preservation of marine biodiversity
	Mangrove reforestation	0.01M USD/linear km of erosion prevented	
Increase the number of households saved from typhoon/flooding (combination of objectives 2 & 3)	Zoning provisions according to revised and updated CLUP	0.07M USD/HH saved	Although the improvement of typhoon early warning systems with provision of emergency evacuation is the most cost effective, the construction of an integrated drainage and flood control system with livelihood diversification is highly acceptable among the stakeholders
	Improvement of typhoon early warning system and provision of emergency evacuation and shelter	0.04M USD/HH saved	
	Integrated drainage and flood control system and diversification of livelihood	0.10M USD/HH saved	

Table 19. CEA for Indonesia.

Site	Objectives	Planned adaptation strategies	CE ratio	Result
Rorotan	Reduce the no of HH affected by flooding	Constructing East Flood Canal	307M USD/HH	The cost effective option and suitable to be implemented in this area is dredging the Sunter river.
		Dredging the Sunter river	0.695M USD/HH	
Marunda	Reduce the no of HH affected by flooding and coastal flooding	Constructing Marunda permanent embankment	2.5M USD/HH	The cost effective potential solution is planting mangroves.
		Planting mangroves	13.37 USD/HH	
Kalibaru	Reduce the no of HH affected by flooding and coastal flooding and salt water intrusion	Elevating roads	2.64M USD/HH	The more cost effective solution is to dredge the Cakung river.
		Dredging the Cakung river	2.09M USD/HH	
Kamal Muara	Reduce the no of HH affected by flooding and coastal flooding	Dredging the Pesanggrahan river	2.09M USD/HH	The more cost-effective solution is to dredge the Pesanggrahan river. Note that a large portion of the cost for planting mangroves is the value of coastal land owned by private individuals or groups needed for this option.
		Planting mangroves	2.43M USD/HH	
Muara Angke	Reduce the no of HH affected by flooding and coastal flooding	Elevating roads	0.311M USD/HH	The more cost-effective solution is to elevate roads. Note that a large portion of the cost for planting mangroves is the value of coastal land owned by private individuals or groups needed for this option.
		Planting mangroves	2.07M USD/HH	

Table 20. CEA for Palawan.

Site	Objectives	Planned adaptation strategies	CE ratio	Result
Babuyan	To protect the household from storm surges and loss of property, and minimize sand erosion	Breakwater construction	0.276M USD/HH	Mangrove reforestation is cost effective in protecting the households and properties, and in minimizing sand erosion where mangrove has seen to thrive well
		Dike/levee construction	0.032M USD/HH	
		Mangrove reforestation	0.019M USD/HH	
	To prevent river overflow and minimize siltation that cause damages to coconut plantations and fishponds	Riverbank rehabilitation using Vetiver grass	0.004M USD/Ha	The discussion on the planned options and CE ratios focused on prioritizing Riverbed Dredging at the same time also undertake Riverbank Rehabilitation using Vetiver Grass alone
		Riverbank rehabilitation using Vetiver grass combined with mechanical method	0.034M USD/Ha	
		Dike construction	0.032M USD/Ha	
		River dredging	0.002M USD/Ha	
	To protect household from inland flooding.	Upland reforestation	926 USD/HH	The IEC is cost effective but success depends on the maturity of the residents to react accordingly
		IEC/Establish early warning system and provision of temporary evacuation center	120 USD/HH	
		Relocate affected households to safer place	2,234 USD/HH	
Binduyan	To protect households from strong waves and storm surges.	Breakwater Construction	0.277M USD/HH	Officials agreed to prioritize seawall construction but at the same time, pursue mangrove reforestation appropriate for the area
		Mangrove Reforestation	0.009M USD/HH	
		Seawall Construction	0.00089M USD/HH	
		Relocation of affected households	0.0012 USD/HH	

Table 21. CEA for Vietnam.

Objectives	Planned Adaptation Strategies	CE Ratio	Result
Prevent flooding caused by tides, typhoons, and sea level; Reduce impacts of salt water contamination	Building a sea dike	4,085 USD/HH	The freshwater plant seems more acceptable than the sea dike in terms of initial investment, annual operating cost, physical benefit and CE ratio. Priority should be given to the freshwater plant given that the government cannot afford the two projects at a time
Provide sufficient fresh water for family routines, agriculture, industry, tourism, services and miscellaneous activities	Building a Fresh Water Supplying Factory	183 USD/HH	

3.5 Determinants of choice of autonomous adaptation strategies

The results of the multivariate regression for the decision to adapt to multiple hazards are shown in Table 22. Likelihood ratio tests rejected the hypothesis that the correlation of error terms across the three probit equations is equal to zero. This confirms the validity of using a multivariate probit, which leads to more efficient estimates.

3.5.1 Adaptation to flooding and typhoons

From the table above one can see that the following factors significantly increase the likelihood of adapting to flooding: household size, percentage of fishing income to total income, the value of damages from worst flooding incidence, and the number of people whom the household can surely borrow from.

Bigger households tend to adapt more to flooding probably because they can meet the labor demands of frequent or recurring adaptation. Note that floods and typhoons, unlike coastal erosion and saltwater intrusion, are extreme events that occur regularly within a year. Often these events occur as many as 20 times in a year. The negative sign on the number of female household members supports this contention. Since men are

often more involved in preparation for typhoons and flooding, households with more females are less likely to be able to pursue adaptation strategies against flooding and typhoon.

In terms of site location, the Vietnamese respondents are more likely to adapt to flooding and typhoons compared with respondents in coastal communities in Batangas (the base location variable). On the other hand, people residing in the coastal communities in Palawan are less likely to adapt to flooding, since compared with Batangas this province is not in the common path of typhoons in the Philippines. A related variable is the value of damages from the worst flooding. Households who experienced and have vivid memories of large damages from the worst case of flooding will also be more likely to adapt.

Presence of mangroves in front of the house, on the other hand, decreases the likelihood of employing autonomous adaptation strategies. This seems to point to a “crowding out” effect of natural barriers systems. Mahmud and Barbier (2011) found the same result in their study of autonomous adaptation to a cyclone in Bangladesh.

Also evident in the table is the negative sign of the coefficient of the variable representing distance from creeks and rivers. It is often the case that excessive rains cause rivers and creeks to overflow, leading to flooding. Houses that are near these bodies of water are therefore more prone to the effects of flooding; the need to adapt is consequently more urgent.

This means that households rationally react to the degree of threat that they perceive. Another result that supports this is the

fact that pure fishermen or households that depend more on fishing are also more likely to use various adaptation strategies against flooding. Fishermen often live close to the shore, since it is easier to access the sea with their boats. One can conclude from the above that households respond rationally to the degree of threats. Households located in areas where risks are higher also have stronger compulsion to protect or insure themselves against loss or damages.

Table 22. Results of multivariate probit on adaptation to multiple hazards.

	Flooding	Coastal soil erosion/SLR	Saltwater intrusion
Age of HH head	0.002	0.001	0.015***
	-0.003	-0.004	-0.004
Years of schooling	0.002	0.000	0.067***
	-0.002	-0.003	-0.018
HH size	0.066**	0.061*	-0.061
	-0.031	-0.034	-0.041
Dependency ratio	0.000	0.000	0.000
	-0.001	-0.001	-0.001
Number of female	-0.102**	-0.055	0.189***
	-0.044	-0.051	-0.066
Palawan	-1.202***	-0.433***	-0.190
	-0.142	-0.161	-0.133
Vietnam	0.457***	0.755***	0.745***
	-0.146	-0.126	-0.183
Indonesia	16.827	-3.393	34.604***
	-12.843	-14.645	-12.863
Presence of mangrove	-0.004**	0.000	0.005
	-0.002	-0.003	-0.004
Distance from creek/rivers	-0.000***	-0.000**	0.000
	0.000	0.000	0.000
Type of roofing materials	0.052	-0.075*	0.058
	-0.034	-0.040	-0.041
Owns pigs	0.168	-0.036	0.233*
	-0.129	-0.148	-0.128
Income from gifts, relief, support, etc.	0.000	-0.000*	0.000
	0.000	0.000	0.000
% of fishing income in total income	0.008**	-0.010*	-0.047**
	-0.003	-0.006	-0.021
Value of Damages	0.000*	0.000	0.000
	0.000	0.000	0.000
# of people whom you can surely borrow	0.006***	0.005**	-0.004
	-0.002	-0.002	-0.008
Perception on climate change	-0.015	-0.020	-0.032
	-0.047	-0.052	-0.058
Presence of riverbank rehabilitation	0.003	0.003	-0.331***
	-0.002	-0.003	-0.115
Constant	-0.540**	-1.144***	-0.489
	-0.214	-0.252	-0.348

Observations 1203

Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

The social capital variable “number of people whom you can borrow from” also increases the likelihood of employing adaptive measures against flooding and typhoon. This factor measures the level of trust on the respondent. In some ways, trust increases the household’s capacity to autonomously adapt to these extreme events.

3.5.2 Adaptation to coastal soil erosion/sea level rise

As with the earlier results for adaptation to flooding, there are also site differences in the likelihood of adapting to coastal erosion and sea level rise. In particular, Palawan coastal communities are less likely to adapt to this threat relative to Batangas. On the other hand, respondents from Vietnam are more likely to adapt relative to Batangas coastal communities. Again, this likely captures the difference in the severity of the threat in these countries. Similarly, spatial factors also affect the decision to privately adapt to this bio-geophysical impact. We find that households or respondents farther away from riverbanks and streams are less likely to adapt. Likewise, household size and the social capital variable both increase the likelihood of autonomous adaptation in response to coastal erosion.

Regression results also show that respondents with roofing materials made of very light materials are also less likely to autonomously adapt. Perhaps what this captures is the wealth level of these households. Wealthier households, i.e. those who can afford more permanent roofing structures, are in a better position to meet the financial requirements of adaptation.

It is also interesting to see that income from gifts, relief and support operations also reduces the likelihood of adaptation against coastal erosion. Coastal erosion often accompanies severe typhoons, which often prompts disaster relief operations. This means that disaster and relief “dole outs”, which are common local government initiatives during calamities, can “crowd out” adaptive behavior.

3.5.3 Adaptation to saltwater intrusion

Finally, the last major hazard in the study areas is saltwater intrusion. Again, geographical differences are evident in the results. In Vietnam, this is a major problem, as cited in the Focus Group Discussions. Hence, as expected, households in these areas have higher probability of employing adaptive strategies. Ownership of pigs is also a positive determinant of adaptation.

Furthermore, saltwater intrusion is a permanent risk. This requires not recurring or repetitive adaptive strategies, but rather permanent strategies like having piped water connection. This requires financial capital – thus those with more liquid assets such as livestock are more likely to be in the position to adapt to saltwater intrusion.

Unlike the result for adaptation against flooding, the number of female household members increases the likelihood of adapting to saltwater intrusion. A common adaptation behavior against saltwater intrusion is to get water from other sources. This is a common household chore women perform, thus explaining the direct relationship between the number of female household members and probability of adaptation.

We again find a “crowding out” effect of planned adaptation strategies. This time we find that riverbank rehabilitation results into lower probability of adaptation against saltwater intrusion.

3.5.4 Insights from the multivariate probit results

The following insights can be gained from the results of the regression exercise:

- a. Geographical location matters. Obviously in areas or countries where a hazard is less of a threat, we can also expect less adaptation. Coastal communities still rationally insure and protect themselves against nature. Even within sites differences in say, distance from coastline and other bodies of water, lead to differences in autonomous behavior. Again this underscores the need for hazard mapping and communicating risks emanating from these hazard maps to coastal communities.
- b. The nature of the hazard matters and is somehow related to a gender dimension in adaptation. For something like the flooding and typhoons, which are recurring and often passing extreme events, household male labor is an essential component for implementing recurrent or repetitive adaptation strategies. On the other hand, permanent but creeping or slowly occurring hazards like saltwater intrusion, female labor is essential since adaptation takes the form of a common household chore.
- c. Government projects may crowd out autonomous strategies. Similar to other studies, we find natural protection such as mangroves and planned adaptation such riverbank rehabilitation as substitutes for self-protection and self-insurance. Likewise, income from disaster and relief operations can also lead to a reduction in the probability of adaptation to extreme events such as coastal erosion.
- d. Increasing trust in a community also leads to increased autonomous adaptation. This social variable can be a contributing factor to adaptation against coastal erosion and flooding. Extreme events that either recurring or permanent.
- e. Finally, in terms of methodology, there is gain in modeling adaptation options as joint decisions in the case of coastal communities.

4.0 Summary and conclusions

This study sought among other things to gain a better understanding of the risks associated with climate change and assess the adaptation strategies and policy options to address these risks more efficiently in coastal communities. This study team has attempted to provide a cross-country comparison and therefore a bigger picture on adaptation both at the public and private level. We intend to understand this within the unique context of multiple hazards that often confront households in coastal communities. The study covered the countries of Vietnam, Indonesia and the Philippines. Its focus was on assessing the impacts from three climate hazards besetting coastal communities, namely typhoon/flooding, coastal erosion and saltwater intrusion. It also analyzed planned adaptation options, which communities and local governments can implement, and also gauged the autonomous response of households to protect and insure themselves from these hazards.

It utilized a variety of methodologies to gain a clearer picture of the interrelated issues in four project sites in these three countries. Methodologies ranged from community-based approaches, such as community hazard mapping and focus group discussions (FGDs), to quantitative and econometric methods. These approaches provided information for further activities in the project. Specifically, the results of these community-based approaches were fed into a household survey, which was analyzed using various regression techniques.

The results show that indeed households in the coastal communities face a confluence of risks and often adapt simultaneously to these risks. These risks have most impacts on the livelihoods of households. Foregone income due to these risks is often twice as high as the value of damages from loss of assets including the house. Both the household survey and the FGDs lend evidence to this claim. We find this not surprising because households in these communities are often poor and the value of their assets is often low. These eventually have effects on their consumption.

VEP or vulnerability measures show that the mean vulnerability estimate for all households was highest for Palawan at 0.51. This means that, on average, there is a 51% probability that households in Palawan will fall below the minimum consumption threshold of USD1.25 per capita per day given shocks, including those that are climate-related. This is followed by Vietnam at 0.43, Batangas at 0.38, and Indonesia at 0.37. Accordingly, the incidence of vulnerability (or percentage of all households considered vulnerable) is highest in Palawan (56%), followed by Vietnam (46%), Batangas (42%) and then Indonesia (35%).

Various planned adaptation options, which communities and local governments can implement, were analyzed using cost effectiveness analysis (CEA). These options were identified through consultations with the community and local government officials. There seem to be a preponderance of protective measures when, in fact, the main impact or risks from these hazards is really on the livelihoods of coastal-based communities. A consistent and common result across three sites is that ecosystem-based approaches are more cost-effective than hard infrastructure investments. This is true for the case of mangrove reforestation (whenever this is applicable) when compared with sea walls, embankments, and breakwaters.

The study also found out that households, obviously, adapt or respond autonomously to all three hazards. In fact, the econometric model of joint decision cannot be rejected by the data. We find that perceptions about the future severity of climate change influence the decision to adapt. There are also geographical differences in adaptation patterns, reflecting that households react rationally to the degree of threats from these hazards. Unlike instances recorded elsewhere we do not find evidence that planned adaptation crowds out private or autonomous adaptation.

However, we find that external sources of funds and social capital are substitutes for self-insurance and self-protection. This points to a potential moral hazard problem in autonomous adaptation, which demands further investigation.

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Annexes

Annex 1: Initiatives and projects on climate change adaptation and disaster mitigation in Batangas.

Government-led initiatives	Community-based initiatives	Autonomous adaptation options	Available resources
• Organizing the Municipal Disaster Risk Management Council (MDRMC) • Financial assistance to boat men affected by typhoons (PhP1,000–2,000); • Establishment of the Municipal Tourism Office (MTO) • Enlarging and dredging of rivers to prevent flooding • Regular conduct of Information, Education and Communication (IEC) campaigns • Maintaining and Enhancing Marine Protected Areas (MPAs) and mangrove areas • “Billion of Trees Project”. Planting of forest tree species and fruit bearing trees in 400 hectares of upland, lowland and sea areas. In 2009, 6 hectares have been replanted	• Aquaculture activities as a source of livelihood (i.e. shrimp, red crab, bangus) • Fish processing • Mangrove planting • Regular collection of crown of thorns (COT) by the resort owners	• Relocation of houses • Planting and selling of mangrove seedlings • Temporary removal of light structures in beach areas upon the earliest sign of a low pressure area	• MDRMC has a budget amounting to 5% to 20% of the Municipal Development Fund; • Budget allocation of PhP300,000 for MPAs. • Soup kitchen in case of emergency and calamity; • 2-way radio (donated by First Philippine Conservation International) • UST Biological station at Brgy. Imelda • 5 Patrol boats, binocular, GPS, laptop, 2 cameras, projector and 6 life vests (donated by Conservation International)

Annex 2 : Initiatives and strategies on climate change adaptation and disaster mitigation in Indonesia.

Government-led initiatives and functions	Community-based initiatives and strategies	Other initiatives
Central Government • Develop policy guidance and coordination; • Institutional and implementation mechanisms of the strategic plan; • Assistance and technical support; • Investments in infrastructure and facilities to execute the strategy; • Support financing well-planned; • Increased capacity of authorities and relevant stakeholders; • Development of new research and technology transfer; • International and regional cooperation Provincial Government • Implement a strategy to formulate and adopt measures relating to watershed management • Develop policy and institutional framework needed to implement the environmental program • Identify environmental investment opportunities for public-private partnerships • Capacity building and institutional strengthening • Mobilize and empower stakeholders in implementing the program of action • Monitoring and evaluation system to measure the success of the strategy. County and Municipal Government • Mobilization of relevant parties to participate in the implementation of management programs; • Identify opportunities for economic growth and integrating the environmental aspects of the program in existing projects in Jakarta Bay; • Develop regulations with due regard to local wisdom in order to support the implementation of the strategy; • Capacity building and community empowerment apparatus watershed, coastal and marine Jakarta Bay. Provincial and District • Adopt a strategic plan as the basis for the legislative process of planning and development in the province and city districts • Facilitate the provision of local budgets to implement programs of watershed management in Jakarta Bay • Promote policies to integrate environmental protection policy in economic development • Facilitate the development of local regulations for watershed management in Jakarta Bay • Encourage institutional strengthening and river basin management	• Strengthen linkages between social, environmental, and cultural rights in watershed management • Ensuring the rights of local residents around Jakarta Bay is protected and conserved. • Become a partner government and other relevant agencies in the planning, implementation and monitoring of action plans for watershed management of Jakarta Bay; • Identify and develop investment opportunities in sustainable resource utilization in Jakarta Bay	Institutions of Higher Education and Research Institute • Provide technical expertise and scientific input to policy and decision-making process • Conduct appropriate research and studies to enhance information management systems and strengthen regional capacity in watershed management in Jakarta Bay Non-Governmental Organization • Formulate and implement environmental information and education programs • Organizing and mobilizing the population in implementing coastal resource management. • Promoting the rights of local populations and marginalized groups as well as community empowerment. • Fund sourcing to support environmental action programs.

Annex 3 : Initiatives and projects on climate change adaptation and disaster mitigation in Palawan.

Government-led initiatives	Community-based initiatives	Autonomous adaptation options	Available resources
• Ordinance Enacting the Code of Conduct for the Conservation, Protection and Restoration (CPR) of the Sources of Life of the City of Puerto Princesa • On-going flood control project and plans to put up breakwaters to prevent destruction of fishponds and as protection to the rising waters • Plan to reforest mangroves and put up a watch tower in the upland reforested area • Organization of the Barangay Disaster Risk Management Council (BDDRMC)	• Establishment and expansion of the fish sanctuary • Community-based early warning system (going from house to house) • Bio-engineering of river banks to prevent siltation and erosion	• Keeping the integrity of home lots facing the coastal area by using indigenous materials – like 3–4 inch wooden stakes, rocks and bamboo slats to contain soil and sand (riprap) • Resort owners use cement and rocks to control coastal erosion in their respective areas	• Each barangay have their own Barangay Disaster Risk Management Council (BDDRMC) and has calamity funds allocated per year • Non-government organizations engaged are mobilized during disasters

Annex 4. Initiatives and projects on climate change adaptation and disaster mitigation in Vietnam.

Government-led initiatives	Community-based initiatives	Autonomous adaptation options	Available resources
• Coastal zone management • Construction of concrete roads along the coast considering the rise of sea level. • Upgrading dikes along the sea and at the estuaries. • Construction of environmental warning system for aquaculture. • Preservation of mangrove forests and coastal wetlands. • Managing freshwater supplies for the development of livelihoods and economic activities. • Investment to fully complete the existing irrigation system. • Making extensive and efficient use of freshwater supplies. • Construction of dikes to prevent salt water intrusion. • Management of underground freshwater. • Growing forests to retain rain water, maintain moisture and reduce evaporation. • Limiting the impacts of climate change on agriculture • Plants and livestock switching in adaptation to salt water intrusion and increasing drought • Research for the invention of new seeds which can adapt to salt water intrusion and increasing drought. • Improving the ability of the climatic warning system in favor of agriculture. • Applying scientific research on agriculture in order to save fresh water, improve cultivation techniques, and reducing green house gases. • Adapting fisheries (capture fisheries and aquaculture) to the climate change • Importing or developing livestock which can adapt to water intrusion and high temperatures. • Increasing the depth of ponds to encounter with the faster evaporation due to high temperatures. • Conducting research to forecast the movement of fish in the ocean as well as changes in fishing grounds. • Shrimp-rice model is employed in areas where fresh water is contaminated by salt water. • Improving the awareness of communities of the climate change and its impacts. • Improving and widening medical care services for communities in adaptation to the climate change. • Upgrading existing sea walls in terms of height and width.	• Allocating areas for aquaculture and agriculture. • Preserving mangrove forests. • Constructing a fresh water-producing plant for agriculture, aquaculture and domestic needs. • Providing households with containers to harvest rain water. • Relocating people whose houses and properties are at risk due to erosion. • Constructing dikes. • Constructing a dam to prevent the intrusion of salt water into rivers.	• Rain water harvesting. • Switching from black tiger shrimp to vannamei which is more salt water tolerant. • Changing cultivation schedules to avoid salt water intrusion. • Using bags of sand to build dikes around farms or ponds to prevent the intrusion of salt water.	• Provincial Peoples Committees mobilize the contributions of international cooperation programs, capital contribution from the central and partly from local budgets. • Integrate and coordinate programs and projects related to climate change to attract more investment. • Funding for activities to implement the action plan in 2020 for the priority projects of the province of Ben Tre, allocated funds as follows: - Capital from foreign cooperation programs and support from central: 90%. - Local budgets/private sector: 10%. • Action plan

Annex 5. Mean Vulnerability as Expected Poverty (VEP) estimates, and number of households at different vulnerability levels.

	Vulnerability level	Number of HH	Mean VEP	Standard deviation
Batangas	Not vulnerable	172	0.11	0.14
	Moderately vulnerable	81	0.68	0.09
	Highly vulnerable	44	0.88	0.05
	<i>All Households</i>	<i>297</i>	<i>0.38</i>	<i>0.34</i>
Palawan	Not vulnerable	130	0.18	0.17
	Moderately vulnerable	101	0.69	0.07
	Highly vulnerable	67	0.87	0.05
	<i>All Households</i>	<i>298</i>	<i>0.51</i>	<i>0.32</i>
Vietnam	Not vulnerable	156	0.09	0.15
	Moderately vulnerable	44	0.67	0.08
	Highly vulnerable	90	0.91	0.05
	<i>All Households</i>	<i>290</i>	<i>0.43</i>	<i>0.39</i>
Indonesia	Not vulnerable	196	0.12	0.16
	Moderately vulnerable	39	0.66	0.09
	Highly vulnerable	65	0.92	0.07
	<i>All Households</i>	<i>300</i>	<i>0.37</i>	<i>0.37</i>



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This publication should be cited as: Perez, M.L., Sajise, A.J.U., Ramirez, P.J.B., Arias, J.K.B., Purnomo, A.H., Dipasupil, S.R., Regoniel, P.A., Nguyen, K.A.T., Zamora, G.J. (2013). Economic Analysis of Climate Change Adaptation Strategies in Selected Coastal Areas in Indonesia, Philippines and Vietnam. WorldFish, Penang, Malaysia. Project Report: 2013-32.

Design and layout: Eight Seconds Sdn Bhd.

Photo credits: Front cover, Robert S. Dipasupil; back cover, Patrick Regoniel.

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