Intra-household Impacts of Climate Hazards in Coastal Communities: A Cross-Country Perspective

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRA-HOUSEHOLD IMPACTS OF CLIMATE HAZARDS IN COASTAL COMMUNITIES: A CROSS-COUNTRY PERSPECTIVE

Asa Jose U. Sajise, Paul Joseph R. Ramirez, Glaiza J. Zamora,
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EXECUTIVE SUMMARY

This study is motivated by the increasing call for more gender-equitable participation and decision making in climate change adaptation. The study, therefore, revolves around the research question: *Does equity in adaptation decision making and involvement between the husband and wife increase the welfare and resilience of the household?* In the course of finding the answer to this question, the study also delved into the following questions: (1) What factors promote equitable adaptation decision making between the wife and husband? (2) What factors affect the labor/time allocation of husband and wife to adaptation activities?, (3) What is the average treatment effect (ATE) of equitable decision making on consumption expenditure (welfare) of the household?, and (4) Does equitable involvement and decision making in adaptation reduce the household's vulnerability to expected poverty (VEP) or increase their resilience?

Likewise, because most studies on gender and climate change have focused on agro-pastoral communities (i.e., crop cultivation) and because gender-disaggregated data are confined to African and South Asian locations, we also wanted to (possibly) provide new insights on Southeast Asia by collecting gender-disaggregated adaptation and socioeconomic data and by describing and documenting the following: (1) the role of men and women in decisions related to adaptation against various climate hazards in coastal communities, (2) various adaptation strategies employed by husband and/or wife for different climate-related hazards, and (3) intra-household and gendered impacts of climate-related hazards.

The research questions were answered through a mix of qualitative and quantitative methodologies. In particular, focus group discussions (FGDs) and key informant interviews (KIIs) were complimented by an econometric analysis of gender-disaggregated household survey data. The study sites included barangays/communes in coastal communities in Cambodia, Philippines, and Vietnam.

The results of the quantitative analysis showed that equitable decision making does lead to increases in the log of consumption expenditures. That is, it is welfare-increasing, possibly in the short run. On average, equitable decision making increased the log of per capita household expenditure by USD 1.07. The highest ATE, which is equal to USD 1.11, is found in the Vietnam study sites. However, the positive ATE or welfare impact is driven by the self-selection term because the coefficient of the treatment was found to be significant and negative, while interaction effects were insignificant. One possible interpretation for this result is that decision makers in the household opt to equitably decide on adaptation strategies because it is less costly or more beneficial to do so. They do so probably because the transaction or fixed costs of arriving at an agreement or equitable decision is lower for these households. This is apart from the impacts of such decision making on the welfare or resilience of the household. Possibly, those that employ equitable decision making in the adaptation sphere equitably decide on other decision spheres in the household as well.

Although extreme weather events like typhoons reduces the per capita consumption expenditure of households, regression results showed that this was dampened by the involvement

of the wife by implementing adaptation strategies. The mean number of hours that the wife spends on participating in adaptation activities reduces the impact of typhoons on household consumption expenditure or welfare. However, the same regression results showed that the wife's participation in adaptation matters regardless of whether this was or was not decided upon equitably by the husband and wife. In contrast, the mean number of hours spent by the husband on adaptation activities does not affect the log of consumption expenditures. We believe that this is so because the short-term benefits from the husband's involvement in adaptation activities is offset or traded off with the loss in income opportunities. Indeed, the survey data have shown that the loss in foregone income due to typhoons is larger for men than for women.

On the other hand, household vulnerability to extreme weather events, as measured by its VEP was reduced by only 2% under equitable decision-making regimes. The highest decline is for the Philippines, where this type of decision making reduces VEP by 3%. Although there are significant gains in terms of poverty reduction, this type of decision making is not enough to move households out of high vulnerability in the presence of shocks from extreme weather events. Two heads may still be better than one, but the resiliency improvements are quite modest. Improving household resiliency and moving households away from high VEP still require complementary public adaptation programs and investments.

Finally, the subsidiary objective of the study was to document intra-household impacts of climate change and the gender-specific adaptation strategies of households in coastal communities. The FGDs and KIIs done in the study documented information that is already common in literature. In particular, participation in and choice of adaptation strategies were found to be gender-differentiated and were tied with usual household responsibilities and innate capacity, but these ties are mediated by social and informational factors. Consequently, the gender-differentiated impacts were also tied up with these usual household responsibilities.

Overall, the study found that there are differentiated adaptation roles for men and women in the household. Although equitable decision making and participation increase welfare and reduce household vulnerability, these impacts are quite modest. These findings point to the conclusion that what the household is doing is probably close to optimal. Policies that aim to change decision making and participation within the household might not be something worth pondering on too much.

1.0 INTRODUCTION

Coastal and marine ecosystems are vital to most Southeast Asian countries, primarily because most of them depend on fish and other marine products to fuel their economy and feed their population. Furthermore, populations living in the coastal areas and who are dependent on this resource base are among the poorest in the region. Thus, it is not surprising that governments in this region have at least been concerned about the environmental problems confronting these ecosystems and the populations dependent on them.

Coastal ecosystems and communities are at even greater risk as most of the attendant effects of climate change (e.g., sea level rise, storm surges, and typhoons) often emanate from the sea. Unlike in the past when environmental externalities have been traced from the ridge to the reefs, with climate change, the problem is looked at from the reef to the ridge. These ecosystems and the populations dependent on them are placed in a very precarious position. Furthermore, unlike terrestrial ecosystems, coastal communities face a confluence of hazards such as flooding/typhoon, storm surges, coastal erosion/ sea level rise, and saltwater intrusion. When

these hazards impact communities simultaneously, intervention and adaptive behavior tend to be more complex. Thus, increasing the resiliency of coastal communities to climate change impacts is an urgent task for Southeast Asian countries. The only way to build such communities is to understand and eventually increase peoples' adaptive capacities and resiliency, both at the public (local government unit/community) and household levels.

Against the backdrop of this pressing concern, the WorldFish-Philippine Country Office (PCO) has been documenting and analyzing adaptive strategies against climate hazards in coastal communities in Southeast Asia for the past two years. Results of these studies have provided information critical in order to identify appropriate and cost-effective public/planned strategies, and to understand the determinants of autonomous or household adaptive behavior.

An interesting result that surfaced from previous studies of the WorldFish-PCO is the different roles that men and women play in adaptation. Earlier regression results showed that women play a more important role in adaptation against saltwater intrusion, and that the likelihood of adaptation against it increases with more women in the household. On the other hand, the presence of men in the household increases the likelihood of adaptation against flooding and typhoons. This result is, in fact, related to anecdotal fragments of the gender-differentiated impacts of climate-related hazards (Lambrou and Piana 2006; Lambrou and Nelson 2010; BRIDGE 2008). For instance, most of the migration is done by men in order to search of alternative labor income, and this has been a common adaptation measure against household-level shocks. In the presence of climate change, this means that women are often left at home. They bear the burden of increased workload because they now assume the role of the household head as well. This is not to overlook the fact that they also bear the brunt of cleanup work in the absence of men. Being left at home also increases the exposure of women to hazards. This is especially true in the cases of flooding and inundations. Another issue, which is alluded by the results of the earlier study, is the increase in the amount of time women spend in collecting clean water. At times, access to clean water is affected by climate hazards such as flooding and saltwater intrusion. Drudgery, together with its increased burden on women, has been one of the hallmarks of the debate and discussion on gender and climate change.

There are increasing acknowledged and documented differentiated impacts of climate hazards among individual members of the household. This is an important observation since most climate change studies have focused on the household as a unit of analysis. Impacts have been largely measured at the household level, and little attention has been given to whether individual household members are more at risk from climate hazards. Similarly, adaptive strategies have been looked at as a household activity and choice. These actions are often viewed as emanating from a consensus among household members. The idea that one member may be a dominant decision maker and that increased household resiliency can be achieved if there is equitable decision making—especially between husband and wife—has been given some attention in the literature; however, this has rarely been given empirical backing.

Indeed, the variable intra-household impacts of climate change have led to calls for greater equality in participation, both in decision making and involvement in adaptation, among members of the household. This has been especially true between men and women (or husband and wife). Gender equity in decision making has been thought as a way to identify and address these variable impacts. Equitable involvement is meant to ensure that adaptation measures benefit all those that implement them. If only one perspective is dominant, then some of the impacts of climate change might not be fully addressed. This, in turn, can have far-ranging effects on the household itself.

It has been acknowledged that gender equity within the household and at higher hierarchies is shaped by equality in access to information, in productive assets, and in prevailing norms and culture. This has led to advocacies for policies that could change the prevailing

distributions of assets (including information) as well as norms and customs that would allow different members of the household and society to equitably participate and contribute to increasing adaptation and resiliency.

Although the issue of gender has been a latecomer to the policy debate on climate change, there is now an increasing trend toward advocating (gender) equity and (gender) transformative policies. To date, evidence of the favorable outcomes of these advocacies has been largely driven by descriptive case studies and anecdotes. However, from an economic standpoint, the following question begs an answer: *Is moving from a more gender-equitable decision making and involvement in adaptation really welfare- and resiliency-enhancing for the household? Does it make economic sense to change household "sociology" to have more equitable decision making and involvement in adaptation activities?*

2.0 OBJECTIVES

This study covers three Southeast Asian countries identified to be vulnerable to climate change, namely, Cambodia, the Philippines, and Vietnam. It attempts to study systematically the intra-household and gender-related implications and issues of climate-related shocks or hazards. In particular, we are motivated by the following research question: *Does equity in adaptation decision making and involvement between the husband and wife increase the welfare of the household?* In pursuit of the answer to this main research question, we also ask the following ancillary questions:

1. What factors promote equitable adaptation decision making between the wife and husband in the household?
2. What factors affect the labor allocation of husband and wife to adaptation activities?
3. What is the average treatment effect (ATE) of equitable decision making on consumption expenditure of the household?
4. Does equitable involvement and decision making in adaptation reduce the household's vulnerability to expected poverty (VEP)?

Because most gender and climate change studies have focused on agro-pastoral (i.e., crop cultivation) communities, and because gender-disaggregated data are confined to African and South Asian locations, we also wanted to (possibly) provide new insights on Southeast Asia through collecting gender-disaggregated adaptation and socioeconomic data. This was done by documenting and describing the following:

1. Intra-household adaptation strategies in coastal communities in Southeast Asia, which include (a) describing the role of men and women in decisions related to adaptation against various climate hazards in coastal communities, and (b) describing and identifying various adaptation strategies employed by husband and/or wife for different climate-related hazards.
2. Intra-household and gendered impacts of climate-related hazards, which involve measuring (a) physical and monetary damages in terms of individual- and household-level assets and (b) impacts on unpaid household labor and leisure from climate-related hazards.

3.0 FRAMEWORK AND RESEARCH METHODOLOGY

3.1 Impacts, Hazards, and Adaptation: The Standard Framework

Figure 1 shows the common analytical framework for analyzing climate change impacts. The framework posits that risks/impacts are functions of the degree of the climate-related hazard, exposure of the household, and the adaptation strategies of households. The impacts of or risks from climate change emanate largely because of the attendant hazards associated with it. One aspect that is particular to coastal communities is that they face a confluence of hazards, including typhoons and flooding, coastal erosion and storm surges, and saltwater intrusion. These hazards, which will also be the focus of this study, have different implications because of their characteristics in terms of frequency and permanence of impacts. Typhoon and flooding are often extreme weather events that occur with uncertain regularity. The impacts may be passing—as is the case when flooding events do not inundate communities. Saltwater intrusion and coastal erosion, on the other hand, are slow and "creeping" events that occur slowly and gradually, yet their impacts on the communities are permanent.

Figure 1. Standard framework for climate change adaptation and impacts

Hazards or covariate risks have differential impacts on households in a community because of the different levels of exposure and the mitigating actions or adaptive strategies employed by households. Levels of exposure can differ because of factors such as location, as in cases where houses are located in danger zones or are located near sources of hazards. This can be classified as physical or geographic exposure. An indirect source of exposure is the degree to which a household is dependent on an income source that is affected directly by hazards. This is common for fishing communities that depend largely on the resource base for fishing. The impact of covariate risks, such as climate-related hazards, is larger for these households than to those with more diversified income sources. This can be termed as economic exposure.

Adaptation, on the other hand, reduces or mitigates the effects of hazards and exposure. Whereas hazards and exposure are exogenous to the household to some extent, adaptation options or strategies (or the lack thereof) are choices made by households and are endogenous. These are actions done either before (proactive adaptation) or after (coping mechanisms or reactive adaptation) a hazard. For instance, a household can diversify income prior to a climate-related event, thus, reducing its exposure level. On the other hand, a household can react to or "cope" with an event by diversifying or looking for alternative sources of income after the event. These can further be delineated between deciding on what adaptive strategies to take and the implementation action for these strategies. Household members may decide on a specific adaptation strategy, but its implementation may differ.

The impacts felt by the household are the net effects of hazards, exposure, and adaptation strategies. Often, the impacts are measured using household vulnerability approaches such as VEP or 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, Jalan, and Suryahadi 2002). However, as discussed earlier, the innovation in this study is that the impacts are measured both at the household and intra-household levels.

3.2 Impacts, Exposure, and Adaptation in an Intra-household Framework

The common framework presented earlier can be extended by introducing intra-household dynamics. The basic intra-household model—in particular, a collective household model—is illustrated by a labor supply in the presence of covariate shocks (Appendix Table 1). The basic intuition behind the model is that household members, particularly the household head and the spouse, have varying degrees of control over household resources. Therefore, each has a different degree of influence and participation in household decision making. The household member that has more control over the resources has a greater say in decision making. It deviates from the usual model of a unitary household, in which incomes from different members of the household are pooled and the household is representative of its members, thereby according the unit of analysis to the household.

The standard climate change framework can be modified to accommodate the assumption of a collective household (Figure 2). At the outset, this would mean that power dynamics within the household could influence outcomes. In particular, control of resources and bargaining power can lead to different outcomes for the household and, possibly, for individual members of the household. Husband and wife, for instance, may decide and implement different adaptation strategies. These internal dynamics and differences can lead to differential impacts or risks both at the household and intra-household levels. For instance, if women have control over household resources and assets, then her preferences will be more fully represented during decision-making activities within the household. This can mean lower economic exposure to covariate climatic risks such as, for instance, when women are more actively engaged in non-fishery income activities because they have more bargaining power and control over the use of their time. It can also mean better health outcomes for children if women are more in control of household expenditure, and their preference dictates higher expenditure on child immunization and health supplements (instead of on alcohol or tobacco, for example). In this case, household expenditure toward improved child health becomes an ex-ante or proactive adaptation in anticipation of health consequences of climate hazards.

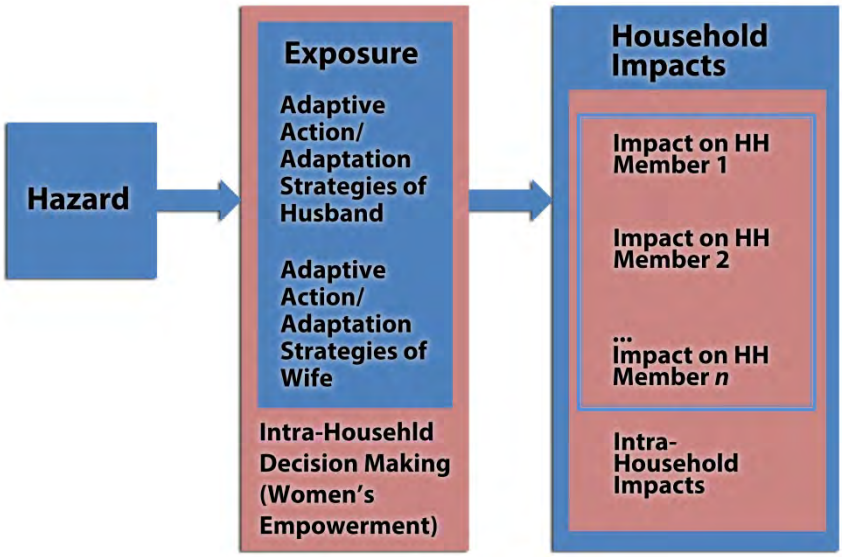

Figure 2. Climate change adaptation and impacts in an intra-household framework

The previous discussion points that one natural way to analyze climate within an intra-household framework is to incorporate dynamics of intra-household decision making and accounting for variables or factors that increase the bargaining position of individual household members, especially between husband and wife. In the context of climate change/hazard adaptation, this can be in the form of increasing the women's assets. These assets can be in the form of productive assets (or physical capital), such as more livelihood opportunities. It can be informational assets such as tailored trainings on disaster risk response to suit women's capabilities and concerns. Informational assets can also be in the form of highlighting aspects of the climate change problem that affect women's concerns. These, in turn, would affect outcomes or the level of risk both at the household level and among individual household members through their effect on the level of household and intra-household exposure and on the choice and participation of individual household members in adaptation activities.

3.3 Focus Group Discussions and Household Survey

To answer the research questions, the study employed a mix of qualitative and quantitative analysis. In particular, KIIs and community FGDs preceded the household surveys and quantitative analysis. The results of the preliminary qualitative studies supported and helped to identify the data to be gathered in the household survey.

The FGDs were conducted with members of various sectors of the community, such as the community officials and sectoral representatives from fishers/farmers, women, elderly, and youth groups. The toolkits used for community-based and participatory vulnerability and hazard assessments were based on field observations and modifications of currently existing participatory methods (Regmi et al. 2010; Reid et al. 2009). The toolkit developed for the project included modules for (1) historical and seasonal timeline analysis, (2) vulnerability matrices, (3) hazard mapping and physical vulnerability mapping, and (4) household and sectors at risk from bio-geophysical impacts.

Portions of the FGDs were administered separately to men and women participants in order to elicit disaggregated responses from the two groups. This was also done to encourage participation of women, who tend to be less participative and expressive of their thoughts in the presence of men. This varying degree of participation was observed in some of the study areas when facilitating the discussion for combined and separate groups as part of the whole FGD process. In general, the purposes of the FGDs were to

1. identify relevant issues related to climate change and its impacts;
2. determine adaptation activities and policies already being undertaken (i.e., autonomous adaptation);
3. produce a historical and seasonal (i.e., intra-year) account of climate hazards that have affected the residents of the various study sites;
4. delineate areas affected by these hazards; and
5. identify resources, population, and capital at risk to these hazards.

The FGDs also served as a venue to gather information that helped refine the household survey instrument that is being used by the regional/country teams. Results of the FGDs and other preliminary activities are found in Appendix Table 1 of this report.

As mentioned earlier, the inclusion of a gender or intra-household component in the FGDs was facilitated by separately administering the FGD modules to men and women participants.

Guide FGD questions were crafted to solicit most of the following information at the community level:

1. Gender-differentiated perception of risks and impacts of climate hazards
2. Role of women and men in the choice and implementation of adaptation strategies against the identified hazards, as well as community norms regarding the role of men and women during disasters
3. Typical labor allocation of household members in the communities and how this changes after a typhoon
4. Men's and women's perception of major decision activities
5. Relative awareness of men and women on climate change issues and adaptation choices

The household survey was administered to 1,500 households (500 households per country). The respondents were identified through stratified random sampling. First, coastal communities or those within 1 km from the coastline were identified. Through the participatory community-based hazard mapping described previously, these communities were delineated into hazard and non-hazard zones. The target number of respondents in each study site was distributed proportionally according to the fraction of the coastal population living in the identified hazard and non-hazard areas. The teams used the multipurpose household questionnaire designed to gather data, which, among other things, included the following:

1. Household demographic information;
2. Consumptive and non-consumptive expenditure of households;
3. Assets of husband and wife as well as their assets brought into marriage;
4. Income sources of individual household members;
5. Occurrence, damages, and impacts of flooding/typhoon, saltwater intrusion, and coastal erosion/storm surges;
6. Adaptive strategies implemented by husband and wife;
7. Participation of husband and wife in decision-making activities, including choice of adaptive strategies;
8. Time allocation of household members before and after an extreme weather event;
9. Incidence of disease and sickness and treatment expenditure after an extreme weather event; and
10. Awareness of husband and wife on climate change issues and adaptation choices.

Portions of the questionnaire were administered separately to the husband and wife.

3.4 Analytical Methods for Analyzing the Household Survey Data

This section discusses the analytical methods used to answer the research questions of the study. The main analysis dwelt on the impact of equitable adaptation decision making and involvement on the resiliency and welfare of the households. We measured the resiliency of the household by using the concept of VEP. However, we modified the derivation of the VEP measure to account for endogeneity. We first discuss the main regression, and then discuss the auxiliary regressions that were done to address the other objectives of the study.

3.4.1 Household welfare, VEP, and gender equity in adaptation decision making and involvement

Deriving the measure of vulnerability or resilience of the household against climate hazards begins with looking at the level of consumption expenditures for the household. In particular, we start by specifying the following consumption expenditure determination function:

$$\ln C = \beta' x + \beta_i x^i + \delta t + \gamma x^i t + \varepsilon \qquad \text{Equation (1)}$$

where:

- $\ln C$ = log of consumption expenditures,
- x = vector of exogenous variables,
- x^i = vector of interacted terms, and
- T = treatment variable, i.e., whether the wife mostly decides on what adaptation measures to implement or not.

The vector of exogenous determinants include, among others, (1) measures of the household's exposure to hazards, (2) the intensity of hazards, (3) household characteristics, (4) labor allocated to implementing adaptation strategies of the husband and wife, and (5) husband and wife's individual characteristics. The treatment variable in this case is whether there is equitable adaptation decision making between the wife and the husband or, in other words, whether the husband and the wife have an equal "voice" in the choice of adaptation strategies. Note that the labor allocated by the wife and the husband to adaptation strategies are potentially endogenous. Hence, we used the predicted value of the husband and wife's hours spent on implementing adaptation strategies. The predicted values came from an auxiliary regression in the form of a bivariate tobit. This regression will be discussed in the next section.

We derived the treatment variable from a modification of the concept of the women's empowerment index or WEI (Paris et al. 2010). For each adaptation strategy (a_k), for a specific hazard implemented by the households, we asked who decided on or chose (d_k) this adaptation strategy.; d_k is similar to a Likert's scale and has the following values:

$$d_k = \begin{cases} 1 = \text{Husband decides alone} \\ 2 = \text{Husband dominates the decision} \\ 3 = \text{Husband and wife make the joint decision} \\ 4 = \text{Wife dominates the decision} \\ 5 = \text{Wife decides alone} \end{cases}$$

We then took the *modal value* (d) for d_k for all the identified adaptation strategies for a particular hazard and used this to measure the "voice" of the husband or wife in adaptation decision making for a particular hazard. If the modal value d is equal to 3, then we set the treatment variable $t = 1$; otherwise, it was set $t = 0$. The modal value was used after trying alternative measures. We first used the WEI for what the literature has identified to be major and more policy-relevant adaptation strategies, such as evacuation, credit sourcing, and out-migration. However, there were only few households that used these strategies. This was not favorable for the econometric procedures that followed. Using subjective weights on the different adaptation options was also difficult because of the variety of adaptation strategies that the households employed. The interaction variables fall into the following categories:

1. Interaction between hazard/threat variable and predicted labor allocation to adaptation of husband and wife. This is intended to capture whether hours spent in adaptation dampens the hypothesized negative impact of hazards on consumption expenditure or welfare.

2. Interaction between the hazard/threat variable, predicted adaptation labor allocation, and the treatment. This is meant to capture whether the impact of hours spent in adaptation on the negative impact of hazards depends on who decided on what adaptation strategies to implement.

However, the treatment variable *t* is likely to be endogenous, and thus we also specified an equation for this endogenous treatment as follows:

$$\mathrm{t} = \begin{cases} 1, \text{ if } w\varphi + u > 0 \\ 2, \text{ otherwise} \end{cases} \qquad \text{Equation (2)}$$

where:

t	=	treatment variable,
w	=	vector of exogenous determinants, and
u	=	error term.

Here, *w* can be composed of variables that represent (1) measures of the household's exposure to hazards, (2) the intensity of hazards, (3) household characteristics, and (4) husband and wife's individual characteristics. In addition to these variables, we included over-identifying variables such as the wife's birth order in her family, the wife and husband's perception about the severity of future hazard events, and sources of early warning information on impending hazards.

Because there are interaction terms with the endogenous treatment variable, the coefficient of the treatment variable *t* no longer solely measures the ATE. In particular, the ATE for the sample analog can be derived as

$$\begin{aligned} \mathrm{ATE} &= E\lfloor \ln \mathrm{C} \mid \mathrm{t}=1, \mathrm{x}, \mathrm{x}^{\mathrm{i}} \rfloor - E\lfloor \ln \mathrm{C} \mid \mathrm{t}=0, \mathrm{x}, \mathrm{x}^{\mathrm{i}} \rfloor \\ &= \left(b\bar{x} + \bar{\delta} - \bar{\gamma}\bar{x}^{j} + \sigma_1 \rho \, \frac{\phi(\bar{w}\bar{\varphi})}{\Phi(\bar{w}\bar{\varphi})} \right) - \left(b\bar{x} - \sigma_1 \rho \, \frac{\phi(\bar{w}\bar{\varphi})}{1-\Phi(\bar{w}\bar{\varphi})} \right) \\ &= \bar{\delta} - b_i\bar{x}^{j} + \sigma_1 \rho \, \frac{\phi(\bar{w}\bar{\varphi})}{\Phi(\bar{w}\bar{\varphi})(1-\Phi(\bar{w}\bar{\varphi})} \end{aligned} \qquad \text{Equation (4)}$$

where:

$b, \bar{\gamma}, \bar{\delta}, \bar{\varphi}$	=	estimated coefficients,
$\bar{x}, \bar{x}^{j}, \bar{\mathrm{w}}$	=	appropriate regressors evaluated at their mean values,
ϕ	=	standard normal density,
Φ	=	standard normal cumulative density function,
σ_1	=	var (ε), and
ρ	=	cov(ε, u).

Thus, the ATE is derived from the estimated coefficient of the treatment variable, the mean of the interaction term between the treatment and other variables, and a term representing the sample selection correction. The ATE represents the impact of adaptation decision making and involvement on the household's welfare as measured by the log of consumption expenditure.

We used this ATE and the predicted log of consumption expenditure to calculate the measure of household vulnerability or VEP. In particular, for households where $t = 1$, the VEP was calculated using the following equation:

$$VEP_{t=1} = Pr(In\, C < In\, z \mid x, t) = \Phi\left(\frac{In\, z - E\left(In\, C \mid t=1, x, x^{j}\right) + ATE}{\hat{\sigma}_{\varepsilon}^{2}} \right) \qquad \text{Equation (5)}$$

where:

$\Phi(\bullet)$	=	cumulative density of the standard normal distribution; and
ln$z$	=	log of the minimum consumption level, below which a household would be called vulnerable.

The study used the World Bank minimum consumption threshold level of US$ 1.25 per capita per day. The analysis is based from the assumption that climate extremes or climate shocks, particularly typhoon, flood and drought will influence the probability that households' consumption will fall below a given minimum level (Deressa, Hassan, and Ringler 2009). $\hat{\sigma}_{\varepsilon}^2$, on the other hand is the estimated variance of the error term ε in the consumption determination function. Finally, $E(\ln \hat{C} \mid t = 1, x)$ is the mean of the predicted log of consumption expenditures when $t = 1$. This was defined earlier in the equation for the ATE. Similarly, the VEP when $t = 0$ is

$$VEP_{t=0} = \Pr(\ln C < \ln z \mid x, t) = \Phi\left(\frac{\ln z - E(\ln \hat{C} \mid t=0, x)}{\hat{\sigma}_{\varepsilon}^2}\right) \qquad \text{Equation (6)}$$

The impact of the treatment on household resiliency is simply the difference between the two VEP measures, i.e., $VEP_{t=1} - VEP_{t=0}$.

3.4.2 Auxiliary regression: Bivariate tobit of determinants of labor allocation to adaptation activities

As mentioned earlier, this section discusses the auxiliary regression that was done to complement the main analysis in the previous section. In particular, we used a bivariate tobit, which regresses the mean number of hours of the husband and wife against a set of determinants. This auxiliary regression is important for two reasons. First, we used the predicted mean labor allocation from this regression in the main econometric analysis to address the potential endogeneity in this variable. Second, important policy levers can also be gleaned from the results of this regression. These policy levers will be important should labor allocation to adaptation activities indeed dampen or counteract the negative impacts of climate hazards. The particular regression model to be estimated for the husband is given by the usual tobit specification:

$$Z_h = \beta_h X_h + \mu_h$$
$$Z_h \begin{cases} = L_h \text{ iff } \beta_h X_h + \mu_h > 0 \\ = 0 \text{ iff } \beta_h X_h + \mu_h \leq 0 \end{cases} \qquad \text{Equation (7)}$$

where :

Z_h = latent variable,
L_h = observed mean number of hours spent by the husband on adaptation activities, and
X_h = vector of covariates.

Similarly, for the wife's mean number of hours spent on adaptation activities, we have:

$$Z_w = \beta_w X_w + \mu_w$$
$$Z_w \begin{cases} = L_w \text{ iff } \beta_w X_w + \mu_w > 0 \\ = 0 \text{ iff } \beta_w X_w + \mu_w \leq 0 \end{cases} \qquad \text{Equation (8)}$$

where:

Z_w = latent variable,
L_w = observed mean number of hours spent by the wife on adaptation activities, and
X_w = vector of covariates.

The disturbances in both equations are assumed to be distributed with mean zero and variance covariance matrix, i.e, $(\mu_h , \mu_w) \sim N(O , \Sigma)$ where

$$\Sigma = \begin{bmatrix} \sigma_h & \sigma_{hw} \\ \sigma_{wh} & \sigma_w \end{bmatrix}, \text{ where } \sigma_{ii} = Var(\mu_i) \text{ for i = (h,w) and } \sigma_{ij} = \sigma_{ji} = Cov(\mu_i, \mu_j) \text{ for j=(h,w).} \qquad \text{Equation (9)}$$

We hypothesized that the structure of the regression model is akin to a seemingly unrelated regression model. This is because we hypothesized that the labor allocation decision for the wife and husband are correlated because they face the same risk. A likelihood test of whether $Cov(\mu_i , \mu_j) = 0$ or not will confirm this hypothesis. If the test cannot reject this hypothesis, then no gain in efficiency is achieved by joint estimation of the labor allocation equations.

Similar to the treatment equation in the main equation, we specified the regressors as falling under the following categories: (1) measures of the household's exposure to hazards, (2) the intensity of hazards, (3) household characteristics, and (4) husband and wife's individual characteristics. Similarly, we included over-identifying variables in both equations, such as the wife and husband's birth order in their respective families, their perception about the severity of future hazard events, and their sources of early warning information on impending hazards.

4.0 RESULTS OF PRELIMINARY PROJECT ACTIVITIES: SCOPING ACTIVITY AND SITE SELECTION

4.1 Scoping Activity and Site Selection

As a preliminary step in identifying climate change impacts, vulnerabilities, and adaptation strategies, the country/regional teams conducted a scoping activity to evaluate in detail the situation, problem, and other issues related to climate change hazards in their respective areas. Specifically, the teams verified which specific coastal barangays/communes are affected and are prone to climate-related hazards. The scoping activity was primarily intended to

1. rapidly assess and verify climate change impacts on the community;
2. identify and justify project sites that are affected by climate hazards;
3. identify sectors or communities that have economic activities or resources at risk;
4. assess the availability of, and, if possible, secure secondary data sources that would be relevant to future analysis;
5. understand the local context and institutions in the study site;
6. identify issues that may exacerbate the negative impacts of climate change;
7. produce a preliminary historical assessment of climate hazard occurrences in the project sites; and
8. get preliminary information on local initiatives (collective or individual) being done to address climate change impacts.

The site selection involved country/regional teams visiting the potential study sites to observe and document the coastal land and waterscape in order to validate or supplement the information collected from secondary and primary sources. Assessment derived from ocular inspection, in which photos were also taken to aid in the documentation, is qualitative in nature. The ocular inspection performed by the teams also involved taking note of structures/ infrastructure and natural and economic resources situated along the coastal zone, creating an inventory of economic activities, and documenting presence of coastal and fishing communities. Other significant details were obtained from historic and personal accounts of climate events in the target project sites. Based on this information, together with the data collected from secondary sources, specific sites were selected by the country/regional teams. Table 1 provides a summary of the specific barangays/communes chosen as study sites and the major climate change-related hazards for each based on the scoping activity.

Table 1. Summary of specific study sites, climate change hazards, and vulnerabilities

Study Sites	Cambodia	Philippines	Vietnam
Provinces/Regions	Kampot, Preah Sihanouk, and Kep provinces	Cental Visayas & Zamboanga Peninsula regions	Thai Binh and Nam Dinh provinces
Districts/Provinces	Tuek Chou, Prey Nob, and Damnak Chang Aeur districts	Bohol and Zamboanga del Norte provinces	Thai Thuy and Giao Thuy districts
Communes/Cities/ Municipalities	Preaek Tnaot, Tuek Thla, Angkaol, and Pong Teak communes	Municipalities of Anda, Bien Unido, Inabanga, Katipunan, Dapitan City, and Dipolog City	Thuy Truong, Thai Do, Giao Thien, and Giao Long communes
Identified Climate Change Hazards	Sea level rise, saltwater intrusion, storm surge, drought, landslide	Inland and coastal flooding, coastal erosion, storm surge, heavy rains, landslide	Sea level rise, extreme temperature, heavy rainfall, stronger typhoons, salinity intrusion
Vulnerable Sectors/ Economic Activities	Livelihood (agriculture and fisheries), housing, natural resources, and ecosystems (coral reef, sea grass, mangrove forest)	Livelihood (fisheries, salt-making), infrastructure, housing, ecotourism, natural resources, and ecosystems (coral reef, sea grass, mangrove, reef fish)	Livelihood (agriculture, fishery and livestock, salt-making), mangroves deforestation

4.1.1 Brief description of the sites and summary of findings from the scoping activities

Cambodia

Three coastal provinces, namely Preah Sihanouk province (where the key port is located), Kampot province (which borders Vietnam to the east), and Kep province were selected as study areas in Cambodia. According to the vulnerability map from the Ministry of Environment, coastal areas in Kampot province are the most vulnerable to climate change impacts, particularly to sea level rise (SLR).

1. Kampot province is located in Southwest Cambodia and has a 73-kilometer coastline that stretches from the border of Hatieng district, Vietnam to Koh Ses, Prey Nup district, and Sihanouk Ville. Kampot province is composed of eight districts with 92 communes and 477 villages, where around 4% of the total population resides. Preaek Tnaot commune in Tuek Chou district in Kampot province was selected as one of the study sites due to observed sea level rise, saltwater intrusion, and storm surge, which are major natural hazards in this commune. Sea level rise and saltwater intrusion happens every year, destroying several hectares of agricultural land of the coastal communities.
2. Preah Sihanouk province is located just over 200 km from Phnom Penh and borders Sre Ambel district, Koh Kong province on the north; Kampot district, Kampot province on the east; and the Gulf of Thailand on the south and west. Preah Sihanouk province has a total land area of 868 km^2 and consists of three districts, 23 communes, and 82 villages. The province is the largest coastal town in Cambodia, with the biggest seaport in the country. Tuek Thla commune in Prey Nob district was selected as a study area. Similar to Preaek Tnaot, the major natural hazards in Tuek Thla are sea level rise, saltwater intrusion,

and storm surge. Approximately 50 ha of agricultural land in this commune is destroyed every year by sea level rise and saltwater intrusion.

3. Kep province had an estimated population of 35,753 persons in 2008. The people of Kep live in two districts composed of five communes and 16 villages. The population density has slightly decreased from 98 to 96 persons per km^2 between 1998 and 2008. Mainly due to economic and social reasons, some 20% of the residents are in-migrants. Land use covers for Kep ranges from rocky outcrops found on the west of the city to mostly bamboo and secondary forests found in protected areas and along the border south of Krong Kep. To the east, land use comprises of degraded mangrove forest, shrubland, grass, and rocky outcrops. Two communes, namely, Angkaol and Pong Teak in Damnak Chang Aeur district, were chosen as the other study sites. People living in these areas are fishers; they are mostly affected by sea level rise, saltwater intrusion, storm surge, land slide, and drought. Sea level rise and saltwater intrusion are the most severe hazards in these communes.

Philippines

In the Philippines, six municipalities in two regions were selected as study areas, namely, Anda, Inabanga and Bien Unido in Bohol (Region 7) and Katipunan, Dapitan, and Dipolog in Zamboanga del Norte (Region 9).

1. Bohol, one of the four provinces in the Cental Visayas region, is the 10th largest island in the Philippines and has a land area of 4,117.3 km^2. The province is composed of one city and 47 municipalities and is separated from Mindanao by the Bohol Sea on the south and from the island of Leyte by the Canigao Channel on the east. The Camotes Sea on the north separates Bohol from the Camotes Islands, and the Bohol Strait separates it from Cebu. Agriculture is the main economic activity in the province, but the development of cottage industry has been noted because the island is the source of baskets being exported to other countries by Cebu-based exporters. Tourism is another major industry because of the island's natural wonders that makes it a major tourist destination in Central Visayas. Bohol is also considered the region's food basket because of its rice production. Fishing is also conducted along most offshore areas and fishpond developments in some municipalities.

   Preliminary investigation showed that the identified study areas have possible high risk of climate change impacts and a relatively high incidence of poverty. Being coastal municipalities in Bohol, most of the livelihoods across the three municipalities come from fishing and farming. Mat weaving is also common in both Bien Unido and Inabanga, whereas nipa thatch making is also done in Inabanga. In Anda, the major sources of income are farming (i.e., corn, rice, banana, coconut, and root crops as staple crops), fishing, and tourism-related. In the coastal barangays, some are engaged in small businesses (retail store), while others are employed by the government or in the private sector such as in a beach resort. The common major natural hazards among the selected sites are extreme weather events such as typhoons with heavy rains and storm surges, drought, and earthquake. Sea level rise/coastal erosion and saltwater intrusion were mentioned in some of the sites.

2. The coastal areas of Zamboanga del Norte province seat along Murcielagos Bay, Dipolog Bay, and Sindangan Bay. With a total coastal area of 1,057 ha, the province ranks 19th among the top 20 provinces in the country that is vulnerable to a one-meter sea level rise (GTZ-DENR 2010). Sea level rise is seen to inundate biodiversity-rich coastal habitats (e.g., mangroves and beach vegetation), to affect seagrass beds and mangroves, and to cause the intrusion of saline waters in groundwater, lakes, and rivers (GTZ-DENR 2010). Reports in the Zamboanga Peninsula Regional Development Plan 2011/2016 identified the region as highly susceptible to typhoons, storm surges, sea level rise, earthquakes,

tsunamis, and volcanic hazards; and to extreme weather conditions such as El Niño and La Niña. Climate change and climate variability adversely affect the biodiversity in the marine and coastal communities. The production output of the commercial fisheries sector in Zamboanga Peninsula dropped slightly by 4.96% in 2010 or 17,730.99 tonnes lower compared to the same period in 2009. The El Niño phenomenon affected the fishing industry, in which most of the pelagic species prefer deeper fishing ground due to the intense heat (NEDA-IX, 2010). Initial observation in the selected study areas showed frequent flooding, storm surge, and coastal erosion as the most common natural hazards faced by coastal communities affecting major livelihood activities, such as fishing, farming, solar salt-making, and eco-tourism activities.

Vietnam

The selected study areas are located in Northern Vietnam, namely, Thai Binh and Nam Dinh provinces. These provinces belong to the Red River Delta region, which is composed of 11 provinces, with a total area of 2,105 km^2. This region is known to be prone to the coastal impacts of extreme weather. During storms, high tides and waves cause landslides and damage to dikes, embankments, and culverts, which results in damage to several hectares of rice fields. Also, most of the huts in the clam-farming areas in the district were washed away when the high tides had caused water levels to reach a height of 2.65 m, the highest tides in the last 40 years.

1. Thai Thuy is a coastal district located in the northeast of Thai Binh province. With its 27-km coastline, the district has 47 communes, including six coastal communes, namely, Thuy Truong, Thuy Xuan, Thuy Hai, Thuy Truong, Thai Do, and Diem Dien. Although the geographical characteristics of Thai Thuy district are more favorable for agricultural production and transportation compared to the other districts and provinces in the region, the district is also more vulnerable to climate-related risks. The two selected coastal communes, Thuy Truong and Thai Do, belong to a part of the Northern Red River Delta, which is directly and more affected by impacts of typhoons, flooding associated with storm surges, high tide, salt water instrusion, and soil erosion. This is despite the fact that these communes also have a large area of mangrove forest outside the sea dike that somehow protects the ecosystem, dams, and dike; the mangrove forest also minimize climate-related disasters. The main livelihoods of the local residents in the two communes are crop cultivation, aquaculture farming, and fishing.
2. As a coastal area located in the low-lying Red River Delta, Giao Thuy district in Nam Dinh province is affected and exposed to the direct impacts of climate change such as sea level rise, extreme weather phenomena, temperature and rainfall pattern change, and salinity intrusion. It is reported that if sea level rises by 1 meter, then 93.4 km^2 (5.74 % of total area) of Nam Dinh province will be inundated. This is because sea level rise changes the patterns of sea currents and sedimentation in coastal areas. Additionally, the permanent inundation zone, lowland, and coastal natural systems such as mangroves and other wetlands, would be affected by the sea level rise and the associated changes in biophysical and chemical conditions. In this study, Giao Thien and Giao Xuan are two coastal communes that were selected in Giao Thuy district. The primary livelihoods of local residents in the two communes are crop cultivation and aquaculture farming.

5.0 RESULTS OF THE FOCUS GROUP DISCUSSIONS

5.1 Vulnerability Assessment and Impacts of Climate Hazards

To facilitate cross-country comparison of results by the end of the project, we initially developed materials based on the common methodology and standardized indicators that was planned to be used across sites. Although the project is a spinoff of two earlier climate change projects, the expansion of project objectives to incorporate the exploration of gender roles and decision making in adaptation to climate change and the documentation of intra-household impacts added another dimension that necessitated revisions and improvements on the initial FGD and survey instruments that had been developed in the past. These materials were then pretested during site visits in some communities in a couple of the study areas, and were subsequently refined. The "gendered" materials were then used in the FGDs of all the other study sites.

The FGDs mainly involved participatory mapping activities to illustrate detailed information on the village layout and infrastructure from the community residents themselves. These were vital to have a better understanding of the livelihood strategies and assets of the communities in the study area, their dependence on different resources, the climate changes they perceived, and their capacity to cope with these changes in order to assess their needs; and to gain information on the roles of different institutions in supporting them. In addition, hazard and physical vulnerability mapping was performed to identify the areas and resources at risk from climate hazards as perceived by the residents. Results from these activities validated the initial findings of the scoping activity.

Based on the FGDs, the common and predominant threats in all three countries are those related to sea-level rise and extreme weather events. Specifically for the study sites in the Philippines, the major sources of impacts are those emanating from extreme but irregular occurrences of typhoon and flooding. On the other hand, slowly creeping but permanent events such as saltwater intrusion and sea level rise characterize the main source of impacts in the study areas in Cambodia and Vietnam. Appendix Tables 2, 3, and 4 present summaries of climate change hazards experienced in each country and the general impacts on the properties, livelihoods and health of households. Despite the varying extent of hazards in the sites, it is important to note that the study will concentrate on the impacts brought about by the confluence of these hazards as it is difficult to separate or attribute a bio-geophysical impact to just a single source.

As defined by Fussel and Klein (2006), vulnerability is the risk of experiencing poverty or some other deprivation during some time interval. Vulnerability is commonly analyzed in a collective manner (i.e., with household as the unit of analysis). In this study, we hypothesized that the level of vulnerability actually varies across members of the household, depending on each individual's risk, exposure, sensitivity, and adaptive capacity to various climate hazards.
By conducting the vulnerability assessment separately for men's and women's groups as well as with representatives from the youth and elderly groups in the community, specific concerns and issues from each group surfaced with some indications of differences in intra-household perception, risk, exposure, and adaptive actions to climate change of the individual household members. Some of these initial observations, which were assessed together with the results of quantitative analysis, are as follows:

1. *Differences in perception of various hazards.* Results of the FGDs showed indications that women's groups, in general, assign a higher level of intensity on similar climate events experienced in the past than the men's groups do. This was evident in some communities in the Philippines where each group assessed major typhoon events differently during the conduct of the historical and seasonal timeline analysis. The cultural and social norm/belief

that men should be the stronger sex may have influenced their perception of hazards. Among others, this difference in perception may also be attributed to variations in physical characteristics, social and economic position, and access to information between men and women.

Stronger physical stature and well-being can be associated with a wider range of options/actions available that improves the adaptive capacity and reduces perception of helplessness. This is why in all three countries, men are always perceived to be less vulnerable to hazards relative to women (among those of working age). But in general, women, children, and the elderly are deemed to be the most vulnerable to climate change impacts, particularly in terms of susceptibility to sickness and lack of mobility to avoid hazards.

The absence or lack of information gives a greater feeling of uncertainty and fear that may result in higher intensity ratings, and women more commonly experience this uncertainty across sites. In the case of Cambodia, for instance, men ranked typhoons/windstorms lower relative to other major hazards in the area, whereas women placed it at the top of the list. Note that the men's ranking was based on the information that local people prepared themselves better for windstorms relative to other hazards. This may mean that women are not aware of the climate change measures planned/executed at the community level. Moreover, the "unpredictability" of windstorms is always mentioned by the women's groups but were not mentioned by any of the men's groups, and this may have added to the uncertainty of the former. Aside from the women's possible lack of involvement in climate-related activities, there are other circumstances that can lead to this. In Vietnam, for instance, some women lack information because they were just brought into the community by the men through marriage and are unfamiliar with the history of hazards and the climate situation in the area. These situations just show that information impacts how hazards are perceived by various groups; it is critical in measuring vulnerabilities and decisions on both autonomous and planned adaptation.

2. *Risk and exposure in prioritization of various hazards*. In addition to perceptions, other important elements in prioritizing hazards as part of the vulnerability assessment exercise are (a) the exposure to hazards of men and women based on their roles and responsibilities in the household and (b) the risk and impacts from the hazards they faced in performing their roles. Across the three countries, hazards that cause impacts related to reproductive and domestic roles (e.g., coastal erosion and saltwater intrusion) are mostly prioritized by women's groups. On the other hand, the big waves experienced by the men during fishing or fish farming are usually the hazards that they find relevant and important.

   The varying levels of exposure to various climate hazards were reflected in the recall and prioritization of hazards that each group perceived to have the greatest risk to and impact on them. In some study areas in the Philippines, women's groups remembered more instances of coastal erosion and flooding; these were more relevant to them since they mostly stay at home. Meanwhile, men recalled more typhoon occurrences as these prevented them from engaging in fishing activities. In another community, big waves and storm surges are also the hazards commonly mentioned by the men's groups but are rarely mentioned by women's groups. In general, priority hazards chosen by men and women are those closely related to the hazards that they experience most often, those with greater risks to and impacts on their roles, and those they perceive to have the greatest intensity based on information they possess.

3. *Household roles and varying impacts of climate hazards.* Based on the results of the FGDs, the vulnerability and impacts experienced by men, women, children, and elderly vary due to differing extent of exposures that each group has to the hazards. This difference can be attributed to the nature of the roles that each plays in the household. In almost all of the study sites, these roles and gender relations are highly influenced by existing social and

cultural norms. For instance, men are often the head of household, while the women are homemakers who take overall responsibility for the reproductive and domestic work involved in managing the household. In some of the study sites in Cambodia, this domestic role also includes securing clear water for drinking and cooking purposes, the source of which is located around 5 km away during the dry season and in times of disaster. This makes the burden on women greater than on men in times of disaster. In some households in the Philippines, it is the women who must take the lead in the protection or evacuation of the family as men are usually out of the house working or is a member of the rescue group in their community. The situation is tougher in the study areas in Vietnam, where women are found to be generally more vulnerable in both the productive and reproductive spheres due to the multiple roles they play as caregivers, home keepers, and even breadwinners for the household. In fact, women in Vietnam engage more regularly in agricultural tasks, particularly in planting and harvesting. With these roles, they become prone to skin diseases as they soak in water to clean up both the houses and fields after storms and floods. This tedious role of women also lowers their mobility and may have an effect on their ability to access information. Information such as status and changes in the climate and environment in their community and beyond could have increased their adaptive capacity. The excessive burden on women may also have an implication on their possible involvements in climate change-related activities and may hamper the information on what the community is planning or doing in response to climate hazards. In general, women in the study sites are mostly affected by hazards associated with the creeping and permanent events they face every day, which are further exacerbated in times of disaster and extreme weather events.

There are, however, differences in vulnerability within and among women. In Vietnam, widows are found to be relatively more vulnerable to climate hazards because they assume the role of both husband and man. Furthermore, since women are not allowed to hold land titles, they do not own land. The burden of assuming two household roles and the lack of access to physical assets make this category of women more vulnerable. On the other hand, in Cambodia, women in mid- to large-sized households are less prone to drudgery because of the increased demand for household labor after an extreme weather event. This is because there are more household members sharing the increased load in household tasks. These two cases show that there are also confounding factors that temper or exacerbate the impacts of climate hazards on women.

On the other hand, men are also vulnerable due to the risky and hazardous working environment they are engaged in every day as part of their productive role as the breadwinner in most households in the study sites. In the case of some of the sites where land for cultivation is not available and the major (or only) source of income is fishing or fish farming, men are found to be more vulnerable to extreme weather events such as typhoons, storm surges, and flooding, particularly those who still need to catch fish/tend to their cages even during the course of a disaster. In addition, the role of men in the community also involves community protection and rescue, and this places them in a hazardous position. Their involvement in these tasks is also the reason why men are usually more informed than women in terms of plans and programs related to climate change adaptation and disaster preparedness. In fact, it was mentioned in some communities in Vietnam that men are better in identifying coping/adaptation strategies because they have had more opportunities involving administrative work in their commune. In both counts, the health impacts are more probable during and after the hazards. In general, the risks men face are intensified in times of disaster and extreme weather events and when the stakes are bigger and often involve major injuries or even death.

5.2 Qualitative Assessment of Autonomous Adaptation

The researchers were able to document a wide variety of autonomous adaptation in the study sites. This ranges from protective strategies such as mangrove reforestation and reinforcing sea dikes to managed retreats such as evacuation and relocation. Appendix Table 5 presents the household adaptation strategies and practices of each country in response to the various climate hazards they face.

To have a better understanding of the intra-household adaptive behavior of coastal households in the selected sites, the specific roles of each member of the household were also viewed separately. This disaggregation aimed to explore and identify emerging issues in the intra-household study of adaptation decision making and action. To elicit this, the discussions with the focus groups included gathering information on how regular household roles are disrupted by climate hazards and how the burden is further reinforced in times of disaster. In all three countries, there is minor distinction in the roles of children across gender and just a few differences in the roles of elderly men and women, specifically noticeable in Cambodia. In general, men focus more on heavy tasks that require brute strength and force whereas the women are assigned many lighter duties. The children and the elderly have minor involvement in adaptive strategies. Appendix Tables 6, 7, and 8 enumerate the detailed roles of each group in response to major climate hazards.

Based on the results of the qualitative assessment, there are some distinct and shared roles in the adaptive strategies for various members of the household. Based on the results, there are indications that the roles of each household member in implementing adaptive strategies are highly associated with the innate and acquired adaptive capacity of each member, their existing roles in the household, and social and cultural norms. Some of these initial observations, which were validated after the survey via some quantitative methods, are as follows:

1. The innate characteristics involve physical and biological features that make each member more suitable to particular adaptive tasks. In all three countries, it is common for men of working age to do heavy tasks that involve lifting and carrying, among others, while women of working age are responsible for most light activities such as preparing belongings, cleaning the house, and taking care of the sick. As presented in the tables, the children and the elderly mostly play support roles because of their age-associated physical vulnerability. However, note that although men primarily lead physical adaptation actions, the decision to perform the task may still involve women. This was demonstrated in the case of some households in the Philippines, where it was explicitly mentioned that the women decided to tie the roofs of their houses in response to an approaching typhoon and to elevate the house to address flooding. In Vietnam, women also help reinforce collapsed dikes along with their husbands.
2. Acquired adaptive capacity involves those abilities developed through trainings, experiences, asset ownerships, and social relations, among others. The initial finding was that men are more involved in climate-related and disaster preparedness activities as members of a rescue team, and this equips them with greater information and capacity to respond and adapt. Literature also showed that the experience of men as part of their productive role, particularly fishing, makes them better swimmers compared to women who usually do not develop this skill since it is not that important in their reproductive and domestic roles. This gives men greater capacity to adapt to flooding as compared to women. The available adaptation strategies also depend on the size and status of networks of men and/or women. In the case of some sites in the Philippines, it is usually the role of the men to source out credit. This may be attributed to his larger network as a result of being the one who is more mobile and active in the community given his roles of being a breadwinner and rescue member. The women, on the other hand, are the ones usually lining up during relief operations, which may be rooted in the usual

perception/culture that it is "unmanly" for the men to receive relief or aid. This is the kind of impact cultural norms have on the distribution of roles related to adaptive strategies in some of the study areas. Assets ownership, on the other hand, also determines the scope and how effective household members are in specific adaptation strategies. In Vietnam, land titles are held under the husband's name. Thus, men are able to borrow larger amounts. Women do have access to credit but they can borrow only small amounts because of the lack of collateral. Thus, in the realm of credit, men usually are more effective because they own assets.

3. The existing roles in the household (even without climate change hazards) also define the adaptive strategies practiced by each member. In one of the selected districts in Vietnam, more than 80% of men are engaged in aquaculture; they are mostly responsible for fish farming tasks like early harvesting and pond reinforcement and repair during typhoons. In the case of Cambodia, it seems that women (both the working and the elderly) have the major role in livestock rearing, and thus are responsible for protecting them at times of disaster. This makes them more vulnerable to climate hazards given that they need to tend to this in addition to their responsibility to evacuate the whole family. This is also true for protecting crops. In most of the study sites, the task is shared among men and women, with the latter doing more in the case of Cambodia and Vietnam.

   In Cambodia, men and women always work together to reinforce their rice field dike to ensure that their rice production is not destroyed by saltwater. In addition to dike reinforcement, women are always involved in all productive works (e.g., rice cultivation) to make sure that their rice crop is harvested before the seawater intrudes. In addition to livestock rearing, they also take some tasks that are traditionally associated with women roles like planting, weeding, harvesting, and breeding. Aside from engaging in agricultural activities, women also handle several other tasks such as clothes washing, food preparation for their children and other family members, taking care of sick members, and cleaning. This is especially the case for women in smaller households.

   In Vietnam, the women are also responsible for preparing the financial sources to implement the adaptive strategy of the household against hazards. Women of working age are responsible for almost all crop farming activities including paddy production. It seems that women work harder to adapt to saltwater intrusion in paddy fields. They are also responsible for clearing the fields and using lime to reduce salt before planting. Moreover, women play a key role in collecting water for domestic consumption in the dry season.

6.0 RESULTS OF THE HOUSEHOLD SURVEY

6.1 Household-Level Damages to Property and Livelihood

The results of the household survey identified the impacts and estimated the damages brought about by primary hazards, as experienced in different degrees across the three countries. In the whole sample, we found that the dominant threats are typhoon and saltwater intrusion, affecting 86% and 50% of the respondents, respectively (Table 2).

Table 2. Percentage distribution of hazard-affected households, by country and whole sample

Hazards	Cambodia n = 506	Vietnam n = 487	Philippines n = 600	Whole Sample N = 1,593
% affected by flood	9	61	37	35
% affected by typhoon	92	100	70	86
% affected by coastal erosion/ SLR	1	17	1	6
% affected by saltwater intrusion	59	100	2	50

Although typhoon is a dominant hazard across all countries, more respondents in Cambodia (92% of Cambodian respondents) and Vietnam (100% of Vietnamese respondents) identified it as a primary hazard. This result may be attributed to the increasing frequency of typhoon occurrence as well as the greater uncertainty of typhoon path and magnitude in recent years. Most of the households are also located near water reservoirs and river tributaries, making them susceptible to flooding, especially during strong and sustained typhoons. For saltwater intrusion, Vietnam is most affected with 100% of the respondents indicating that they have felt the effects of saltwater intrusion. However, unlike responses to extreme and catastrophic events like typhoon and flooding, we will see later on that adaptation to this slow-setting hazard is not as common. The hazard that has least effect on households is coastal erosion/SLR.

In Vietnam, the most common impact of typhoons and flooding, as reported by 86.8% of respondents, is damage to or loss of one's house. It is followed by loss in agricultural production, which 83% of interviewed respondents experienced. However, damages to households significantly vary across communes; some areas take a more proactive approach to prepare for potential typhoon/ flooding events, while some are more reactive in terms of adaptation. The largest amount of loss is related to aquaculture livelihood at an average of USD 1,119 for the 46% who experienced destruction of ponds/pond implements and loss of fish stock due to water overflow (see Table 3). This is not unusual considering the huge investment in aquaculture production; thus, losses can range from USD 100 to USD 20,000 for fish farmers engaged in sea bass and on-shore clam farming, among others.

Table 3. Mean value of household-level damages (in USD) from typhoons and flooding*

Damage/Loss	Vietnam n = 487	Philippines n = 420	Whole Sample N = 907
Damage/Loss to house	324	41	250
Loss in agricultural production	240	62	236
Loss in fishing income	498	28	133
Loss in aquaculture production	1,119	11	1,114
Others	699	22	634

Note: *All values for damages are USD per latest incidence of hazard.

In the case of the Philippines, damage or loss to houses is also the most commonly experienced impact of typhoon/flooding, affecting 25.5% of respondents. It is followed by loss in fishing income, which is experienced by 24.3% of respondents. This finding points to a cross-country trend among households to value and identify their material properties and major sources of livelihood as impact items. As shown in Table 3, approximately 86% (USD 142) of the total mean damage from typhoon/flooding is accounted for by these impact items. Unlike in Vietnam, loss from aquaculture was not that significant in the Philippines because household respondents are mostly caretakers rather than owners of ponds, pens, and cages of milkfish, tilapia, shrimps, or oysters in the coastal areas. Another identified damage pertains to loss in income from not being able to glean and make nipa thatch in the event of hazards, among others.

In Vietnam, saltwater intrusion is a significant hazard—all respondent households reported being affected by it. As presented in Table 4, an average loss in agricultural income of USD 150 from 48% of respondents was estimated; this is generally due to reduced rice yield of up to 30% for affected farms. Among the health risks associated with saltwater intrusion, kidney problems were identified to have caused the greatest mean value of damage at USD 218. Across the three countries, lack of freshwater for drinking and household activities (e.g., cleaning and washing clothes) was perceived to be the common impact of saltwater intrusion (and also has impact on time allocation when looking for alternative water sources).

Table 4. Mean value of household-level damages (in USD) from saltwater intrusion*

Damage/ Loss	Vietnam n = 487	Philippines n = 12
Loss in agricultural production	150	–
Death/ Loss of livestock	139	–
Household members with kidney problems	218	–
Lack of freshwater for daily tasks	87	3
Others	171	–

Note: *All values for damages are USD per latest incidence of hazard.

Damages from coastal erosion/SLR were found to be uncommon and sporadic but can still be significant (see Table 5). Results show that the unexpected impacts usually include damage to houses, boats, and ponds. However, this is experienced by very few household respondents in both the Philippines (4%) and Vietnam (0.4%). In comparison to the impacts caused by typhoon/flooding, both the extent and range of impacts are relatively limited for this hazard. A possible explanation may be the difference in the nature of the hazard; i.e., coastal erosion/SLR is more creeping and long-term, and is therefore perceived as having less impact compared to extreme and regular events such as typhoons. In general, this gradual nature allows households to anticipate and prepare for possible impacts of coastal erosion/SLR and avoid potential damages.

Table 5. Mean value of household-level damages (in USD) from coastal erosion/sea level rise*

Damage/Loss	Vietnam n = 83	Philippines n = 4
Damage /Loss to house	167	53
Damage/Loss to appliances (Stereos, TV, cellphones, furniture, etc.)	–	7
Loss in fishing income	–	19
Loss in aquaculture production	3,474	–
Income loss due to work stoppage	–	17
Others	–	6

Note: *All values for damages are USD per latest incidence of hazard.

6.2 Gender-Differentiated Asset and Income Impacts from Extreme Weather Events

Gender-differentiated impacts are greatly associated with asset ownership and roles, and responsibilities of men and women within the household. Across countries, men are generally more involved in productive activities, and thus husbands (21%) experience more income loss than the wives (7%) at times of extreme weather events. As husbands are mostly engaged in fishing activities, typhoons prevent them from catching fish and, in some cases, even damage their fishing boats and gear, thus adding up to an average loss of USD 156 in income due to work stoppage (Table 6).

Table 6. Income and asset losses (in USD) on wife and husband due to extreme weather events*

Damage/ Loss	Vietnam	Philippines	Whole Sample
Wife's income loss from other sources due to work stoppage	302	17	123
Husband's income loss from other sources due to work stoppage	250	35	156
Damage to wife-owned appliances (TV, stereos, cellphone, etc.)	–	50	50
Damage to wife-owned livestock	–	14	14
Damage to husband-owned appliances (TV, stereos, cellphone, etc.)	–	57	57
Damage to husband-owned livestock	–	13	13

Note: *All values for damages are USD per latest incidence of hazard.

This has a direct effect on the income earned by some wives who usually take care of selling the fish caught by their husbands and other fishers within the community. Estimates show that wives experience an average income loss of USD 123 caused by both absence of fish to sell and the need to shift to usual household responsibilities (e.g., cleaning the house) during typhoon/flooding events. Prioritizing household responsibilities seems to provide an explanation as to why wives in Vietnam posted a higher opportunity cost than husbands did in response to extreme weather events. (This is also related to the difference in time allocated for some household activities, which will be discussed in the succeeding paragraphs).

The gender-disaggregated data was able to capture and highlight the differences in assets owned or commonly used by either the husband or wife within a household, at least in the Philippines. Although the estimated mean values for the losses do not differ much, there were distinct items valued by the respondents. In the case of loss to (backyard) livestock, most wives account losses from swine, which they feed as part of the daily household chores. The husbands generally claim losses from poultry (including those from fighting cocks), which they personally take care of. In Vietnam, there were no reported gender-specific damages to assets as there was no clear-cut delineation in the specific asset ownership between husbands and wives.

Aside from losses in income and assets, the time allocated for productive activities and leisure is definitely affected before, during, and after the occurrence of extreme weather events. As discussed earlier, loss in income is clearly magnified by time reallocation if it takes time away from productive activities. This is where the analysis of gender-differentiated impacts on time is important because the varying roles of men and women in the household may shift at times of extreme weather events which, in turn, may cascade to other activities. Moreover, the decision to reallocate time among household members may also be based on gender-differentiated characteristics, as it requires diverse sets of skills and capacities to pursue certain adaptation strategies.

Tables 7, 8, and 9 summarize the mean number of hours spent on unpaid household/reproductive activities and leisure time before and after an extreme weather event in the Philippines, Vietnam, and Cambodia, respectively. Time spent by women on reproductive activities, in absolute terms, expectedly far exceeds that of men both during regular days (96% more time spent) and after extreme weather events (113%) for respondents in the Philippines.

Table 7. Mean number of hours spent on unpaid household activities and leisure time before and after an extreme weather event in the Philippines

Activities	Men		Diff	Women		Diff
	Normal Days	After Extreme Weather Event		Normal Days	After Extreme Weather Event	
	(Hours)	(Hours)		(Hours)	(Hours)	
Cleaning house	0.46	0.89	0.43*	0.90	1.34	0.45*
Cleaning house's surroundings	0.55	1.10	0.55*	0.90	1.39	0.49*
Washing clothes	0.66	0.75	0.10*	1.94	2.17	0.23*
Cooking	0.39	0.45	0.06*	0.60	0.65	0.05*
Fetching water	0.24	0.26	0.02	0.17	0.20	0.03
Taking care of children	1.25	1.06	–0.19*	3.55	2.77	–0.78*
Feeding pets/house animals	0.19	0.18	–0.01	0.12	0.11	–0.01
Watching TV/listening to radio	1.33	1.23	–0.11	1.45	1.28	–0.18*
Personal hygiene	0.29	0.28	–0.01	0.37	0.33	–0.03
Sleeping	7.32	5.06	–2.25*	7.69	5.51	–2.19*

Note: * means that the difference is significant at 1% level.

Table 8. Mean number of hours spent on unpaid household activities and leisure time before and after an extreme weather event in Vietnam

ACTIVITIES	Men		Diff	Women		Diff
	Normal Days	After Extreme Weather Event		Normal Days	After Extreme Weather Event	
	(Hours)	(Hours)		(Hours)	(Hours)	
Cleaning house	0.47	2.11	1.64*	0.78	2.52	1.74*
Cleaning house's surroundings	0.62	3.12	2.50*	1.10	3.62	2.52*
Washing clothes	0.22	0.30	0.08*	0.68	0.93	0.25*
Cooking	0.42	0.34	–0.08*	1.15	1.11	–0.05
Fetching water	0.01	0.01	–0.00	0.02	0.02	–0.00
Taking care of children	0.24	0.25	0.01	0.57	0.53	–0.04
Feeding pets/house animals	0.45	0.45	0.00	0.73	0.74	0.01
Watching TV/listening to radio	2.91	1.88	–1.02*	2.10	1.37	–0.73*
Personal hygiene	0.56	0.57	0.01*	0.59	0.62	0.03*
Sleeping	6.83	6.27	–0.56*	7.23	6.48	–0.75*

Note: * means that the difference is significant at 1% level.

Table 9. Mean number of hours spent on unpaid household activities and leisure time before and after an extreme weather event in Cambodia

Activities	Men		Diff	Women		Diff
	Normal Days	After Extreme Weather Event		Normal Days	After Extreme Weather Event	
	(Hours)	(Hours)		(Hours)	(Hours)	
Cleaning house	0.63	1.35	0.72*	0.66	1.74	1.08*
Cleaning house's surroundings	0.81	1.70	0.89*	0.83	2.11	1.27*
Washing clothes	0.66	0.84	0.17*	0.96	1.07	0.12*
Cooking	0.65	0.70	0.05*	0.84	0.90	0.05*
Fetching water	0.59	0.67	0.08**	0.61	0.76	0.15*
Taking care of children	2.53	3.28	0.74*	5.64	5.76	0.12
Feeding pets/house animals	0.20	0.22	0.02	0.25	0.25	–0.00
Watching TV/listening to radio	1.52	1.40	–0.12*	1.38	1.14	–0.24*
Personal hygiene	0.26	0.27	0.01*	0.34	0.33	–0.01
Sleeping	7.01	6.11	–0.90*	6.97	5.96	–1.00*

Note: * means that the difference is significant at 1% level.

Similarly, in Vietnam, wives spend more time on unpaid household activities during regular days (115%) and after extreme weather events (40%) compared to their husbands. In general, for the whole sample, women's time spent on household chores surpass that of men. In some of the categories, the increase in time spent on these activities by the wife is twice as high than that of their husbands (Table 10). For instance, fetching water increased by 0.03 hours for men; for women, it increased by 0.06 hours. Time spent by the wife on childcare decreased, on average, by 8%. However, the husband usually fills in the slack. For the whole sample, the husband's time spent on childcare increased, on average, by 12%. At the same time, while time spent on household chores increased significantly, leisure time decreased significantly after weather extreme weather events. Most notable is in the Philippines, where the additional time spent on cleaning clothes, the house, and its surroundings after an extreme weather event is taken from time spent on sleeping on normal days. Estimates show that more than 30% (2.25 hours) of the regular sleeping time of husbands are reallocated while the figure is around 28% (2.19 hours) for wives.

An interesting difference is the significant amount of time that Vietnamese husbands reallocated for household chores after extreme weather events. This seems to link with the significant role of wives in productive activities; husbands also share time for reproductive tasks until the household has returned to its normal routine. Another interesting cross-country difference is that extreme weather events indicate an increase in the total time spent on reproductive activities and leisure in the case of Vietnam but not that in the Philippines. This additional time spent mainly on cleaning the surroundings is possibly taken away from time spent on productive activities. This may partly account for the relatively higher income loss from work stoppage of both men and women in Vietnam (Table 6). Furthermore, compared to Cambodia, husbands in the Philippines do not complement their wives in childcare. The decline in the wife's time spent on childcare is met with a similar decline in the husband's time spent on this activity. On the other hand, unlike in the Philippines and Cambodia, complementation in time spent on cooking was not observed in Vietnam. On average, the husband's time allocation for cooking declined by 0.08 hours.

Table 10. Mean number of hours spent on unpaid household activities and leisure time before and after an extreme weather event, whole sample

Activities	Men		Diff	Women		Diff
	Normal Days	After Extreme Weather Event		Normal Days	After Extreme Weather Event	
	(Hours)	(Hours)		(Hours)	(Hours)	
Cleaning house	0.52	1.41	0.89*	0.78	1.83	1.04*
Cleaning house's surroundings	0.65	1.91	1.25*	0.94	2.30	1.36*
Washing clothes	0.52	0.64	0.11*	1.24	1.44	0.20*
Cooking	0.48	0.49	0.01	0.85	0.87	0.21
Fetching water	0.28	0.31	0.03**	0.26	0.32	0.06*
Taking care of children	1.35	1.52	0.17*	3.30	3.03	–0.27*
Feeding house animals	0.27	0.28	0.00	0.35	0.35	–0.00
Watching TV/listening to radio	1.88	1.48	–0.39*	1.63	1.25	–0.37*
Personal hygiene	0.36	0.36	0.00	0.42	0.42	–0.01
Sleeping	7.07	5.76	–1.30*	7.32	5.95	–1.37*

Note: * means that the difference is significant at 1% level.

In terms of unpaid labor and leisure, we can say that there are two possible effects, namely, magnification and complementation. Magnification happens because extreme weather events increase the time spent on "traditional" household gender roles. The common trend in all countries is that the time additionally spent to respond to extreme weather events is almost equally shared between men and women. This also somehow supports the earlier hypothesis that adaptation strategies practiced by households to respond to extreme weather events require time and innate physical capacities and skills developed over time by both men and women. However, the increased burden in absolute terms is higher in women, on the average. However, in relative terms, the increase in time spent by the husband on these activities is higher except for fetching of water. Complementation, on the other hand, is also observed especially in the areas of childcare and cooking. In these activities, we can see husbands assuming roles that are traditionally associated with women or the wife.

6.3 Intra-household Participation in Adaptation and Women Empowerment in Adaptation Decision Making

In general, the intra-household adaptation participation rate depended on the adaptive capacity of individual household members and how impactful the hazard was to them and the household. Table 11 shows that around 90% of adult men and women aged 25–65 equally participate in adaptation activities that address both typhoon/flooding and saltwater intrusion—the top two hazards affecting households in Vietnam. Despite age, elderly men still have a high participation rate at 87%, while the figure for elderly women is at 58%. In the climate risk context, the elderly, particularly those living with their children, almost stay in for the housework. This complements the result of the FGDs where adults are mainly involved in adaptation but with significant support from the elderly. In general, men are in charge of heavy tasks (e.g., reinforcing houses and ponds) while women are responsible for moving animals, belongings, assets, and cleaning afterwards. The results also reflect minimal adaptation participation rates across all age cohorts for minor hazards such as coastal erosion and storm surges, which may be due to their relatively small impact on households and respondents in Vietnam.

Table 11. Adaptation participation rates (in %) within each age and gender cohort in Vietnam

Gender and Age Group	Typhoon/ Flooding	Storm Surge	Coastal Erosion	Saltwater Intrusion
Male				
25–65 years old	90	14	1	89
>65 years old	87	3	1	88
Female				
19–24 years old	4	0	0	4
25–65 years old	91	13	1	90
>65 years old	58	3	0	58

In the case of the Philippines, adaptation participation rate against typhoon/flooding is more spread out across age cohorts although adult men (52.82%) and women (48.32%) still contribute the most (Table 12). Male and female young adults (10–24 years old) have participation rates of 11.28% and 10.48%, respectively. Their involvement in adaptation includes information dissemination on risk reduction and management, specific roles in household activities, and evacuation in the event of a typhoon/flooding. Similar to the case of Vietnam, men and women respondents in the Philippines almost equally share responsibilities in adaptation and exhibit low participation rates in addressing hazards with marginal impact. It is mostly adult males participating in adaptation against typhoon/flooding. There are also signs that participation starts at an earlier age compared to the respondent households in Vietnam. This is seen for coastal erosion and typhoon and flooding, where it can be observed that children aged 0–6 are already participating in adaptation activities regardless of gender.

Table 12. Adaptation participation rates (in %) within each age and gender cohort in Philippines

Gender and Age Group	Typhoon/ Flooding	Storm Surge	Coastal Erosion	Saltwater Intrusion
Male				
7–18 years old	0.35	0	0.00	0.00
19–24 years old	11.28	0	1.00	0.40
25–65 years old	52.82	3	9.00	1.00
> 65 years old	40.00	4	6.00	0.00
Female				
0–6 years old	0.00	0	0.30	0.00
7–18 years old	1.00	0	0.20	0.00
19–24 years old	10.48	0	0.00	0.00
25–65 years old	48.32	3	7.00	1.00
> 65 years old	39.00	3	6.00	2.00

In the Cambodia study site, participation rate is highest for typhoon and flooding in both men and women (Table 13). Participation rate is highest in the age brackets 25–65 and above 65. Similar to the Philippines, we can already observe the youngest cohorts for both genders already participating in adaptation activities against all hazards. Participation rates in the youngest cohort are similar in both genders. Finally, the common trends in the individual countries are reflected on the whole sample. Participation rates are higher in older cohorts and participation is highest in typhoon/flooding (Table 14). In addition, men have relatively higher participation rates for all cohorts.

Table 13. Adaptation participation rates (in %) within each age and gender cohort in Cambodia

Gender and Age Group	Typhoon/ Flooding	Storm Surge	Coastal Erosion	Saltwater Intrusion
Male				
7–18 years old	0.5	0.5	0.5	0.5
19–24 years old	17.0	8.0	8.0	11.0
25–65 years old	82.0	46.0	24.0	37.0
>65 years old	72.0	49.0	28.0	41.0
Female				
7–18 years old	0.5	0.5	0.5	0.5
19–24 years old	28.0	17.0	10.0	14.0
25–65 years old	81.0	44.0	24.0	35.0
>65 years old	50.0	38.0	15.0	35.0

Table 14. Adaptation participation rates (in %) within each age and gender cohort, whole sample

Gender and Age Group	Typhoon/ Flooding	Storm Surge	Coastal Erosion	Saltwater Intrusion
Male				
7–18 Years Old	0.3	0.2	0.2	0.2
19–24 Years Old	13	3	4	4
25–65 Years Old	73	20	12	38
>65 Years Old	69	12	8	49
Female				
0–6 Years Old	0	0	0.1	0
7–18 Years Old	0.4	0.2	0.2	0.2
19–24 Years Old	18	8	5	7
25–65 Years Old	72	19	11	39
>65 Years Old	51	8	4	35

In Vietnam, men and women in around 98% of the respondent households make decisions on adaptation strategies to address typhoon/flooding and saltwater intrusion. On the other hand, only around 56% of men and women in the Philippine households decide on adaptation strategies to typhoon/flooding (Table 15). In terms of adaptation choices and decision making, the results are more diverse across countries. Table 16 presents the degree of women empowerment in household decision making as represented by the women empowerment index (WEI) for household respondents in Vietnam. Although men and women in households jointly undertake adaptation against typhoon/flooding and saltwater intrusion, results show that the husband generally dominates decision making on what adaptation measures to implement. This result holds for all hazards. The only aspect of adaptation where women have a significant "voice" in decision making is on reactive adaptation strategies against flooding/typhoon. About 48% of the affected Vietnamese household respondents indicate that the decision to implement reactive adaptation strategies is solely the wife's decision.

Table 15. Participation of main household decision makers in adaptation in Vietnam (%)

Hazard	Man Decision Maker (Vietnam)	Woman Decision Maker (Vietnam)
Proactive adaptation against typhoon/flooding	95	95
Reactive adaptation against typhoon/flooding	99	96
Storm surge	13	7
Coastal erosion	1	1
Saltwater intrusion	98	97

Table 16. Distribution of modal value for WEI in Vietnam (%)

WEI	Proactive Adaptation against Typhoon/ Flooding	Reactive Adaptation against Typhoon/ Flooding	Storm Surge	Coastal Erosion	Saltwater Intrusion
Husband decides alone (WEI = 1)	86.0	48.0	95.0	100.0	76.0
Husband consults wife but husband decides (WEI = 2)	0.4	1.0	0.0	0.0	2.0
Husband and wife jointly decide (WEI = 3)	8.0	18.0	5.0	0.0	19.0
Husband consults wife but wife decides (WEI = 4)	0.2	4.0	0.0	0.0	0.4
Wife decides alone (WEI = 5)	5.0	28.0	0.0	0.0	3.0

Note: WEI = women empowerment index

The dynamics of participation and decision making in adaptation for the Philippines are shown in Tables 17 and 18. In the Philippines, there seems to be balanced participation in adaptation against all hazards. We can observe the same distribution of participation for all hazards in both male and female decision makers. Again, the highest participation for both men and women are in reactive decision making or coping after a flooding or typhoon.

Table 17. Participation of main household decision makers in adaptation in the Philippines (%)

Hazard	Man Decision Maker	Woman Decision Maker
Proactive adaptation against typhoon/flooding	38.0	31.0
Reactive adaptation against typhoon/flooding	45.0	45.0
Storm surge	2.5	2.7
Coastal erosion	11.0	10.0
Saltwater intrusion	1.0	0.5

When it comes to the extent of the "voice" of women in adaptation decision making, we see from Table 18 that there is balanced decision making. We say this because the distribution is concentrated on WEI being equal to 3; that is, both husband and wife decide on which adaptation strategy to implement. The only adaptation area where men seem to dominate the decision making process is on proactive adaptation against typhoon and flooding.

Table 18. Distribution of modal value for WEI in the Philippines (%)

WEI	Proactive Adaptation against Typhoon/ Flooding	Reactive Adaptation against Typhoon/ Flooding	Storm Surge	Coastal Erosion	Saltwater Intrusion
Husband decides alone (WEI = 1)	46	11	6	18	0
Husband consults wife but husband decides (WEI = 2)	1	4	0	15	20
Husband and wife jointly decide (WEI = 3)	48	75	94	51	60
Husband consults wife but wife decides (WEI = 4)	0	1	0	2	0
Wife decides alone (WEI = 5)	6	9	0	14	20

In Cambodia, the trend in participation is almost similar to that in the Philippines (Table 19) except for reactive adaptation against extreme weather events, in which women have a higher participation rate than men. Similar to the participation rate for the whole sample, participation of both male and female decision makers is highest in adaptation against extreme weather events.

Table 19. Participation of main household decision makers in adaptation in Cambodia (%)

Hazard	Man Decision Maker	Woman Decision Maker
Proactive adaptation against typhoon/flooding	62	61
Reactive adaptation against typhoon/flooding	63	75
Storm surge	33	33
Coastal erosion	15	19
Saltwater intrusion	27	26

In terms of the extent of the "voice" of women in adaptation, we can see that unlike in Vietnam, there is also balanced decision making in Cambodia (see Table 20). Again, in all hazards, the distribution is concentrated at WEI = 3, i.e., the husband and wife jointly decide on which adaptation strategies to implement.

In the whole sample, the trend in participation rates is closer to that of Cambodia and the Philippines. That is, there is a similar participation rate in men and women decision makers in all hazards. Participation rates are most prominent in typhoon and flooding, while women have higher participation rates in reactive adaptation against extreme weather events.

Table 22 shows the strength of the women's "voice" in decision making in the whole sample. We can observe that men generally dominate decision making in proactive adaptation against extreme weather events and adaptation against saltwater intrusion. The dominance of men in proactive adaptation against extreme weather events is largely driven by the data from the Philippine and Vietnamese respondents. One can cross-reference this from Table 15 and 16. For saltwater intrusion, it is driven by the Vietnamese data. Note that as seen earlier, most adaptation against saltwater intrusion was observed only for the Vietnamese study sites. For adaptation against other hazards, we can see that there is a balance between men's and women's "voices."

Table 20. Distribution of modal value for the women empowerment index in Cambodia (%)

WEI	Proactive Adaptation against Typhoon/ Flooding	Reactive Adaptation against Typhoon/ Flooding	Storm Surge	Coastal Erosion	Saltwater Intrusion
Husband decides alone (WEI = 1)	25	13	10	25	12
Husband consults wife but husband decides (WEI = 2)	8	4	16	1	4
Husband and wife jointly decide (WEI = 3)	63	66	66	74	67
Husband consults wife but wife decides (WEI = 4)	2	2	6	0	8
Wife decides alone (WEI = 5)	2	14	2	0	9

Table 21. Participation of main household decision makers in adaptation, whole sample (%)

Hazard	Man Decision Maker	Woman Decision Maker
Proactive adaptation against typhoon/flooding	63	60
Reactive adaptation against typhoon/flooding	66	71
Storm surge	15	14
Coastal erosion	9	10
Saltwater intrusion	39	38

Table 22. Distribution of modal value for WEI, whole sample (%)

WEI	Proactive Adaptation against Typhoon/ Flooding	Reactive Adaptation against Typhoon/ Flooding	Storm Surge	Coastal Erosion	Saltwater Intrusion
Husband decides alone (WEI = 1)	58	28	31	25	61
Husband consults wife but husband decides (WEI = 2)	3	3	11	7	3
Husband and wife jointly decide (WEI = 3)	34	47	52	61	29
Husband consults wife but wife decides (WEI = 4)	1	3	4	1	2
Wife decides alone (WEI = 5)	4	19	2	6	4

6.4 Quantitative Analysis of Household Survey Data

In the succeeding sections, we analyze the relationships between equitable adaptation decision making and involvement in actual adaptation and household outcomes through a series of quantitative analysis. In particular, we want to see what determines equitable participation in adaptation decision making and time allocation to adaptation activities, and relate this to consumption expenditure and resiliency of the household against extreme weather events. We decided to focus the analysis on adaptation against extreme weather events, particularly to typhoons, because we have more observations on adaptation and impacts for this climate-related hazard.

6.4.1 Determinants of labor/time allocation to adaptation to extreme weather events

We first discuss the determinants of husband's and wife's labor or time allocation to adaptation strategies. This is an auxiliary regression to complement the main econometric analysis of the study. However, this regression in itself offers insights on the intra-household dynamics of adaptation decision making. In particular, it also shows what affects the labor-leisure choices of the husband and wife during extreme weather events. Table 23 shows the results of the bivariate tobit on adaptation time allocation decision. First, the error terms in the labor allocation equations for the wife and husband are significantly correlated; hence, it is appropriate to run the tobit regression as a system of labor allocation equations. In the table, there are common variables that affect the actual participation of the husband and wife in adaptation activities. The mean number of hours spent in implementing proactive or coping/ reactive adaptation strategies is higher for both husband and wife when the household is engaged in both fishing and farming. A similar effect can be observed in households that own livestock. Households usually protect their livelihoods and livestock during extreme weather events, and thus this eats up a lot of time. Similarly, distance from mangroves and the physical position of mangroves relative to the respondent's houses affect both husband and wife's labor allocation in the same manner. The labor allocation to adaptive activities of both husband and wife is higher if they are near coastlines with mangrove patches. Again, the exposure to threats increases the need for adaptation perhaps because damages are higher as well.

Table 23. Multivariate regression on the determinants of wife and husband's mean labor allocation to adaptation activities against extreme weather events

Mean Number of Hours Wife Spent in Adaptation Activities	Coefficient	Mean Number of Hours Husband Spent in Adaptation Activities	Coefficient
HH has piped water connection	–0.1230**	% female HH members	–0.00221*
	(0.0613)		(0.00129)
Roof of house made of permanent materials	–0.1230*	Dependency ratio	0.05190*
	(0.0698)		(0.02890)
HH has tenure on lot	–0.0954*	HH has piped water connection	–0.11800**
	(0.0498)		(0.04770)
Husband received typhoon early warning from LGUs	0.1330**	Roof of house made of permanent materials	–0.12400**
	(0.0650)		(0.05890)
Wife received typhoon early warning from LGUs	0.1950***	HH owns livestock	0.15300***
	(0.0581)		(0.04000)
HH owns livestock	0.1970***	Wife received typhoon early warning from media	–0.10200*
	(0.0496)		(0.05700)
Number of years wife spent in school	–0.0143*	Husband received typhoon early warning from LGUs	0.20200***
	(0.0083)		(0.05060)
HH engaged in fishing and farming	0.2530***	Wife received typhoon early warning from LGUs	0.14000**
	(0.0913)		(0.05520)
HH engaged in fishing	0.2480*	HH engaged in fishing and farming	0.18500**
	(0.1380)		(0.07700)
Husband received disaster preparedness training	0.2580**	Dummy variable for Cambodia	–0.36000**
	(0.1260)		(0.10900)
Dummy variable for Cambodia	–0.4040***	Dummy variable for Philippines	–1.26100***
	(0.1360)		(0.14600)
Dummy variable for Philippines	–1.5990***	HH near mangrove area	0.11200**
	(0.1820)		(0.04960)
HH near mangrove area	0.2430***		
	(0.0673)		
Constant	0.6580**		
	(0.2690)		

Note: ***, **, and * pertain to values that are significant at the 1%, 5%, and 10% levels, respectively.

The characteristic of the household abode also affects labor allocation of both husband and wife. Their time spent on adaptive activities decline if they have tenure in their lot, permanent roofing material, and piped water connection. These variables can be treated as indicators of the household's wealth as well as the sturdiness of their houses. This means that these households have higher adaptive capacity both in terms of the resilience of their house and perhaps also in terms of their capacity to withstand potential property damages. Receipt of public warning from local government units (LGUs) also increases both the husband and wife's adaptation labor. This corroborates the findings of the FGDs and KIIs that information, even in the form of early warnings, increases the adaptive activity of households. Finally, study site dummy variables also significantly lower labor allocation of both husband and wife. In particular, the hours that both husband and wife spent on adaptation activities are lower in Cambodia and the Philippines than that in Vietnam.

There were also variables found to affect only either the labor allocation of the husband or the wife. Household's involvement in fishing, for instance, only affects the wife's allocation of adaptation labor. There are also "cross effects" in the sense that in households whose husbands have undergone disaster training, the mean number of hours that the wife spent on adaptation is higher. An increase in the husband's knowledge of disaster management may lead him to be more in charge of adaptation decisions, including directing or redirecting the wife's labor allocation during periods of extreme weather events. It can also mean that disaster preparedness information is often shared within the household. This is strengthened by the fact that the wife's own receipt of disaster training does not have an effect on her labor participation. This is largely due to the low percentage of wives who have had disaster training. In the sample, only about 4% of wives have attended disaster training, while the figure for husbands is about 8%.

On the other hand, a variable that was found to affect only the husband's labor participation in adaptation is the ratio of female household members. This variable has a negative effect on the husband's labor allocation on adaptation. In contrast, the husband's age and the dependency ratio both increase the time that the husband spends on adaptation activities. This may imply that older husbands tend to assume more responsibility in the household compared to younger husbands. This is supported by the qualitative results in which older male household members were shown to assume most of the adaptation activities. Higher dependency ratio, on the other hand, means that there are fewer "working hands" in the household. Hence, the burden of most of the adaptation work would likely fall on the husband. This is also supported by the descriptive discussions of the household survey data and the results of the FGDs. Both discussions have shown that younger household members and older household members participate less in adaptation compared to working-age male and female household members.

6.4.2 Impacts of intra-household decision making and labor allocated to adaptation on household welfare and vulnerability to expected poverty

In this section, we look at the main objective of the study, which is to find out whether equality in adaptation decision making affects the household's VEP. In other words, does the manner by which a household arrives at adaptation decisions have consequences on their household's resiliency and welfare? As outlined in the methodology, we first discuss the determinants of "egalitarian" adaptation decision making within the household or having an equal "voice" in adaptation decision making between the husband and wife.

Determinants of equitable adaptation decision making

The results of the probit regression on the probability of having equal adaptation decision making are shown in Table 24. Among the factors that increase the likelihood of equality in adaptation decision making are the husband's and wife's access to other sources of income, the number of years the wife has spent in school, the age of the husband, the frequency of typhoons, husband's age, and the receipt of the early warning by the husband from his social network. We turn to discuss the implications of each of these variables.

Table 24. Probit regression on the determinants of equitable adaptation decision making in the household

Variable	Coefficient
Female household head	–0.5090000***
	(0.1500000)
Household owns livestock	–0.2190000**
	(0.0989000)
Wife received income from other sources	0.1460000*
	(0.0833000)
Husband received income from other sources	0.1560000*
	(0.0824000)
HH engaged in both farming and fishing	0.2730000
	(0.1570000)
Age of husband	0.0267000*
	(0.0126000)
Number of years wife is in school	0.0320000*
	(0.0159000)
Number of typhoons	0.0208000*
	(0.0081000)
Number of typhoons x HH was affected by typhoon	–0.0041000**
	(0.0072000)
Number of wife's relatives holding political position	–0.0379000*
	(0.0223000)
Dummy variable for Cambodia	2.4980000***
	(0.2400000)
Dummy variable for Philippines	2.2380000***
	(0.2840000)
Distance of house to river/creek/stream	–0.0001020*
	(0.0000575)
Husband received typhoon early warning from his social network	0.2000000**
	(0.0858000)
Mills Ratio #1	0.1430000***
	(0.0487000)
Mills Ratio #2	0.1490000***
	(0.0495000)
Constant	–3.6100000***
	(0.5590000)

Note: (1) ***, **, and * pertain to values that are significant at the 1%, 5%, and 10% levels, respectively. (2) Values in parentheses are standard errors.

The access of either the husband or wife to other sources of income increases the likelihood of equality in adaptation decision making. This means that the economic position of the husband and wife within the household gives them more "voice" in the household. The variety of income sources also increases the probability of egalitarian decision making. Some demographic characteristics of the household also increase the likelihood of equal decision making. In particular, households with older husbands and more educated wives are more likely to decide jointly on adaptation strategies or activities. Older male members, as discussed earlier, tend to assume more responsibility in adaptation activities. On the other hand, women's education, much like economic position, gives more "voice" to women. They may also have more knowledge relevant to decision making. If one accepts a non-unitary view of decision making in the household, then this also means that similar to economic position, knowledge increases the bargaining position of the wife within the household. The increased frequency of typhoons also increases the likelihood of equality. This seems to point to the fact that increasing household exposure to risk also calls for more inputs into decisions within the household. Another possible reason is that there are more shared experiences and interaction for husband and wife with respect to decision making. Finally, receipt of early warning from social networks of the husband also leads to higher likelihood of equality in decision making.

In contrast, households far from the river are less likely to have equality in adaptation decision making. This means that households less exposed to threats from typhoons also have less incentive to solicit more decision inputs from all household members. This complements our earlier finding that exposure to risk calls for more decision inputs. Female-headed households, on the other hand, skews decision making to just the wife. One interesting variable is the political connections of the wife, which reduce the likelihood of equal decision making. The number of the wife's relatives holding political positions may skew decision making in favor of the wife. Note that this is one of the instrumental variables or over-identifying variables for the endogenous treatment regression or IV regression.

Time allocated to adaptation, equality in decision making, and other factors affecting household (per capita) consumption expenditure and resiliency

Prior to computing the household resiliency indicator, we first need to identify the determinants of the household consumption expenditure. This is captured by the second stage of the endogenous treatment or IV regression (Table 25). One may look at the significant factors or variables as determinants of the household's poverty levels as well. That is, that significant variables positively associated with per capita household expenditure can also be interpreted as variables that may help alleviate household poverty levels.

In Table 25, we see that there are site differences in per capita consumption expenditure. Households in Cambodia and the Philippines have higher household per capita expenditure than the coastal households in Vietnam. As expected, we observe that the proxy for household wealth, such as the house having permanent roofing materials, is positively associated with increases in the log of per capita household consumption expenditure. In contrast, female-headed households, household size, and dependency ratio are all associated with lower household consumption expenditure. The households being headed by the wife and its associated negative effects on consumption expenditure seem to allude that women may have less earning capacity than men in coastal areas. Perhaps this is due to limited work opportunities for women in these areas and being tied up with their traditional roles, i.e., working mainly at home. Note that earlier, we found that the wife's loss of income due to work stoppage or lost income opportunities is lower than that of the husband. This is strengthened by the positive relationship between the wife's years in school and per capita consumption expenditure.

Table 25. Endogenous treatment regression results for the determinants of the log of consumption expenditures

Variable	Coefficient
Female HH head	–0.16600**
	(0.07770)
Household size	–0.05970***
	(0.01240)
Dependency ratio	–0.05220*
	(0.03170)
Roof of house made of permanent material	0.14500**
	(0.06580)
Number of years wife is in school	0.03020***
	(0.00807)
Dummy variable for Cambodia	0.76400***
	(0.16000)
Dummy variable for Philippines	0.85300***
	(0.19000)
Number of typhoons	0.00900**
	(0.00412)
Number of typhoons x HH was affected by typhoon	–0.00879**
	(0.00395)
No. of typhoons x HH was affected by typhoon x Predicted mean no. of hours that wife spent on adaptation activities	0.00943*
	(0.00535)
Equitable adaptation decision making	–0.68600***
	(0.07070)
Constant	–0.94000***
	(0.28500)

Notes: (1) ***, **, and * pertain to values that are significant at the 1%, 5%, and 10% levels, respectively. (2) Values in parentheses are standard errors.

Earning capacity or income in the household is also highly related to the number of working members vis-à-vis the dependency ratio. Lower household per capita consumption expenditure is therefore associated with higher dependency ratios. Household size, meanwhile, is related to the number of mouths to feed, which naturally extends to lower per capita household consumption expenditure. Livestock ownership also tends to be associated with lower per capita expenditure. This may mean that maintaining livestock competes with household resources, thereby the observed association with lower per capita consumption expenditure. Households would still tend to keep livestock despite its effect on per capita consumption expenditure because of their "insurance" role. They invest in livestock primarily as insurance and buffer in the presence of the uncertainty of downside shocks.

We now turn to significant factors that relate to the interest of this study. In Table 25, we can further see the impact of adaptation and hazards on household per capita consumption expenditure. Surprisingly, we note that the frequency of typhoons is associated with increased per capita consumption expenditure. However, this is dampened by the negative coefficient on the interaction term between typhoon frequency and the household experiencing adverse typhoon impacts. Thus, in general, affected households would still have lower per capita consumption expenditure. This means that households tend to fall more into poverty due to extreme weather events. The associated increase in per capita consumption expenditure may be related to the pouring of relief goods and services after typhoon events. The side stories collected from the KIIs and FGDs provide anecdotal evidence that the number of meals during a calamity actually increases because of the feeding programs in evacuation

centers and the financial support given in the advent of extreme weather events. The results seem to point that these are beneficial only for those that are not affected by typhoons.

Another interesting insight from the second-stage regression results is that adaptation does reduce the impact of extreme weather events. This is embodied in the positive and significant coefficient of the interaction term between households being affected by typhoons and the predicted number of hours that the wife spends on adaptation activities. This predicted time allocation was derived from the earlier multivariate tobit regression on the determinants of time allocation by the wife and husband on adaptation activities against typhoon damages. What this result shows is that the negative impacts of typhoons are alleviated or reduced by the participation of women in actual adaptation activities. The regression results also show that who decides on their participation does not matter. This is represented by the insignificant coefficient of the interaction terms between the predicted time allocation of the wife, equal decision making (the predicted dummy treatment variable), and dummy variable for the household being affected by frequent typhoons. What matters most, in this case, is the actual adaptation action of the wife.

This result is also related to what is becoming increasingly common in the adaptation literature: the observable fact that the impact of climate-related hazards on women is the increased drudgery of housework brought about by extreme weather events and, possibly, inequality in adaptation decision making in the household. What our results show is that this drudgery may be optimal because it increases the welfare of the household. It actually dampens the poverty-increasing effect of extreme weather events. The wife, as may have been alluded to in previous regressions, has fewer work opportunities outside the home. This means that the opportunity cost of their time spent on house work is lower. Thus, it is more rational for the household to engage women more in reactive adaptation and/or coping activities after extreme weather events.

We also note that the husband's time allocation and the interaction terms associated with it are all insignificant. One possible explanation for this is that husbands or men in the household tend to have more work opportunities outside of the house, and thus have more income-earning capacity. Indeed, we have seen that the loss—in terms of foregone income opportunities—is higher for the husbands; at the same time, the incremental increase in their involvement in house work after a typhoon is higher for the husbands than that of the wives. Thus, tying up the husband in adaptation activities may lead to lost opportunity for work, which may negate any welfare gains that adaptation may have created. Possibly, there will be a trade-off between the short-term gains from self-protection and the loss in income-earning opportunities.

Finally, we see that the treatment variable (equal "voice" in adaptation decision making) has a significantly negative coefficient. This means that egalitarian decision making does not really increase the household's welfare. Instead, we find that, assuming all else remains constant, households that equally decide on adaptation activities have USD 0.54 lower per capita consumption expenditure relative to those that do not. However, note that this is not the average treatment effect (ATE) of "equal" decision making. As shown in the methodology, the coefficient of the treatment variable is not the treatment effect in the presence of sample selection and interaction terms. We now turn to discuss the appropriate ATE.

Using the results of the previous regressions, we can calculate the treatment effects associated with equal "voice" in adaptation decision making. In Table 26, we see that the ATE of the whole sample is positive and highly significant. This means that on average, equitable decision making increases the log of per capita household expenditure by USD 1.07. For the individual study sites, the ATEs are also positive and highly significant.

Table 26. ATE on per capita expenditure

Country	Average Treatment Effects (per capita expenditure, USD)
Cambodia	1.03***
Philippines	1.08***
Vietnam	1.11***
Whole sample	1.07***

Notes: (1) ***, **, and * pertain to values that are significant at the 1%, 5%, and 10% levels, respectively.
(2) ATE = average treatment effects

The highest ATE is found in the Vietnam study sites. On average, equal participation in adaptation decision making increases the log of per capita expenditure by USD 1.11. This may be because as seen in the descriptive analysis of the data, husbands largely dominate Vietnamese adaptation decision making; in the Philippines and Cambodia, there is already relatively equal participation by husbands and wives in decision making during extreme weather events. This is further supported by earlier regression findings. Thus, we expect that the marginal gains from moving to an egalitarian system of decision making would be smaller in these study sites since potential gains have already been factored in. Note that a positive ATE is observed despite the treatment variable having a negative coefficient and all the interaction terms associated with it turned out to be insignificant. Thus, we can conclude that the ATE is driven largely by the selection correction term in the ATE.

With the ATE in hand, we can now relate decision making in the household to a measure of potential household resiliency. In particular, we used the computed ATE and the predicted log of per capita expenditure from the second-stage regression to compute the household's VEP. The results of this calculation show that on average, households in all study sites have high VEP (Table 27). Vietnamese coastal households, in particular, are reported to be 100% vulnerable to expected poverty. On the other hand, coastal households in the Philippines have the lowest mean VEP. These households only have a 93% probability of falling below a per capita consumption of USD 1.25. Incorporating the calculated ATE in the derivation of the VEP gives us the counterfactual VEP or the VEP that could have been achieved had the households allowed for equitable adaptation decision making. Looking at the last column of Table 27, we see that in the whole sample and in the individual country study sites, the treatment significantly reduces the mean VEP. On average, equitable adaptation decision making reduces household VEP by 2%. The highest decline is in the Philippines, where this type of decision making reduces VEP by 3%. Although there are significant gains in terms of poverty reduction, this type of decision making is not enough to move households out of the high-vulnerability range in the presence of shocks from extreme weather events. Two heads may still be better than one but the resiliency improvements are quite modest.

Table 27. Mean VEP under different adaptation decision making regimes

Country	VEP (a)	VEP under Equitable Adaptation Decision Making (b)	Difference (b) – (a)
Cambodia	0.96	0.95	–0.01***
Philippines	0.93	0.90	–0.03***
Vietnam	1.00	0.98	–0.02***
Whole Sample	0.96	0.94	–0.02***

Notes: (1) ***, **, and * pertain to values that are significant at the 1%, 5%, and 10% levels, respectively.
(2) VEP = vulnerability to expected poverty

7.0 CONCLUSIONS AND RECOMMENDATIONS

The underlying or main research question around which this study revolved is: *Does equity in adaptation decision making and involvement between the husband and wife increase the welfare of the household?* Common threads in gender literature and climate change adaptation motivated this research question. There are increasing calls and policy initiatives to increase women's capacity to participate in adaptation decision making (i.e., increase their "voice" in adaptation planning) and adaptation activities in particular. Recent policy advocacy has also called for transformative policies that may affect norms. We reviewed these calls for equitable participation in adaptation decision making and implementation, and looked at whether moving toward this direction would enhance the welfare of the household. Apart from this, we also documented adaptation strategies implemented in coastal communities, as well as intra-household impacts of various climate hazards in selected coastal areas in Vietnam, the Philippines, and Cambodia. This activity was motivated by the lack or dearth of gender-disaggregated data on climate change adaptation in coastal communities.

To answer these questions, a mix of qualitative and quantitative methods were employed. In particular, information gathered via three distinct but interrelated methods were used, namely, FGDs with community members, qualitative or descriptive analysis of a 1,600-respondent household survey, and a series of quantitative (econometric) analysis of the household survey data. The FGDs and household survey involved collecting information from women and men separately. Included in the information collected are (1) the adaptation activities they have been involved in, (2) the hours spent on these activities, and (3) who decides on which adaptation strategies to implement. We used a slightly modified women's empowerment index (WEI) to capture the equitability in adaptation decision making. The use of an endogenous treatment effects regression (or instrumental variables regression) to facilitate the computation of the average treatment effects (ATE) of equitable adaptation decision making on the log of consumption expenditures, which is our measure of household welfare. This regression was supplemented by a bivariate tobit regression that identified factors influencing labor or hours spent by the wife and husband in adaptation activities. The ATEs were then used to compute the measure of resiliency or vulnerability, which is the vulnerability to expected poverty (VEP).

Results of the quantitative analysis showed that equitable decision making does lead to increases in the log of consumption expenditures. That is, it is welfare-increasing, possibly in the short run. On average, equitable decision making increased the log of per capita household expenditure by USD 1.07. The Vietnam study sites posted the highest ATE, which is equal to USD 1.11.

The positive ATE, however, is driven by the self-selection term because the coefficient of the treatment was found to be significant and negative, while interaction effects were insignificant. One possible interpretation for this result is that decision makers in the household opt to equitably decide on adaptation strategies because it is less costly or more beneficial to do so. They do so probably because the transaction or fixed costs of arriving at an agreement or equitable decision is lower for these households. This is apart from the impacts of such decision making on the welfare or resilience of the household. Possibly, those that find equitable decision making in the adaptation sphere may probably equitably decide on other decision spheres in the household as well.

Although it may sound that equitable decision making in adaptation is an innate characteristic of a household, there are policy levers that may increase the likelihood of equitable decision making. Notable among them is the access of the wife and husband to other work and income sources. These variables may equalize the bargaining power of the wife and husband in

decision making by increasing their economic power within the household. Another variable that significantly increases the likelihood of this type of adaptation decision making is the wife's educational attainment. More educated wives can have more useful inputs in adaptation decision making. We can consider these variables as those that lower the fixed costs of arriving at agreements in adaptation strategies within the households. Thus, programs that aim to increase access to other work or livelihoods opportunities for both the husband and wife can lead to more equitable adaptation decision making.

The next piece of the study looked at whether equitable decision making increases the resiliency of the household. Here, we used the VEP as a measure of the household's resiliency. The VEP was calculated using the ATEs that had been derived in the previous regressions. We found that on average, equitable adaptation decision making reduces the vulnerability of households to expected poverty by only 2%. The highest decline is in the Philippines, where this type of decision making reduces VEP by 3%. Although there are significant gains in terms of poverty reduction, this type of decision making is not enough to move households out of the high-vulnerability range in the presence of shocks from extreme weather events. Two heads may still be better than one, but the resiliency improvements are quite modest. Improving household resiliency and moving households away from high VEP still require complementary public adaptation programs and investments.

The study also found that being affected by typhoons reduces household per capita consumption expenditures. This, however, is dampened by the positive effect of the mean number of hours that the wife spends on participating in adaptation activities. That is, the wife's involvement in implementing adaptation strategies increases the welfare of households by negating the adverse effects of typhoons. The interaction of this variable with the treatment, however, is insignificant. This means that what matters is the wife's participation in adaptation regardless of whether this was decided upon equitably or not by the husband and wife.

Among the relevant policy levers to increase the time that the wife spends on adaptation activities is the provision of early warning through the local government as this information is vital to her adaptive response. This corroborates the results of the FGD that information increases the adaptive capacity of women in the household. The other policy lever is the disaster response training of the husband, which was also found to increase the time the wife spends on adaptation activities. This shows that information and, possibly, skills in disaster response is shared within the household; increasing the husband's information does not necessarily mean that the wife is left behind. These variables that reduce the wife's mean number of adaptation hours also provide insights on who to target for disaster training. Since variables are related to the wealth of the household (i.e., piped water connection and permanent roof materials), disaster training programs should then aim for wider participation from relatively poorer households. Currently, these disaster training programs mostly target local government officials, since it is assumed that they lead disaster response in the community.

In contrast, the regression results show that the mean number of hours spent by the husband on adaptation activities does not affect the log of consumption expenditures. We believe that this is because the short-term benefits from the husband's involvement in adaptation activities are offset by the loss in income opportunities. Indeed, the survey data have shown that the loss in foregone income due to typhoons is larger for men than for the women. The variables that reduce the mean number of hours spent by the husband on adaptation activities can offer clues on how to reduce this trade-off. Notable among these variables is whether the roof is made of permanent materials or not. This represents the resiliency or sturdiness of the house. The household survey revealed that one of the major damages of typhoons is the damage to the house, which the husband then spends much time reconstructing.

Finally, the subsidiary objective of the study was to document intra-household impacts of climate change and the gender-specific adaptation strategies of households in coastal communities. This was borne out of the observation that most studies looking at gender-disaggregated data has been confined to terrestrial agriculture in Africa and South Asia. FGDs and KIIs documented information that are already common in the literature. Qualitative analysis from the household survey and the FGDs, on the other hand, showed that participation in adaptation strategies are gender-differentiated and are tied with household and productive roles and innate capacity, but that these ties are mediated by social and informational factors. Both the household survey data and the FGDs showed that innate physical and biological features (or innate adaptive capacity) affect the role and participation of husband and wife in self-insurance activities. Men tend to do the physically demanding activities (e.g., lifting boats and other heavy objects to safety), while women are mostly responsible for packing clothes and preparing food prior to evacuation. Survey data revealed that adaptation rates across demographic cohorts within the household is highest in working-age men and women and second-highest in the elderly. This shows that working and able-bodied members of the household participate more in adaptation. Elderly members, on the other hand, take on support roles.

Division of labor in the productive spheres is also very much tied with the individual adaptation choice. For instance, FGDs in Vietnam revealed that since men are more responsible for aquaculture while women are in charge of agriculture, women play a bigger role in adaptation strategies during flooding because it affects rice cultivation. On the other hand, during typhoon and storm surges, men are more concerned with protecting the household's aquaculture livelihood.

FGD results seem to point out that access to assets is a factor associated with how effective a member can be in using specific adaptation or coping strategies. If women do not own land titles, then she would not be able to borrow large amounts of money. Therefore, women would be ineffective in using credit as a coping strategy. Similarly, if a household member has less information regarding climate change because he/she stays only at home, then he/ she would have a short menu of adaptation options. Consequently, this also affects the way they perceive their vulnerability. Thus, the link between "inherited" and natural roles/abilities and adaptation strategies is often mediated by social and informational variables.

Qualitative results also lend support to the existence of gender and age related intra-household differences in impacts of climate-related hazards in coastal communities. The FGDs or the qualitative analysis have shown that there are differences in impacts and vulnerabilities among members of a household. These impacts and vulnerabilities are eventually tied with their productive and household roles, as well as their access to productive and financial assets. For instance, if a male member of the household is traditionally into fishing, then this exposes him to injury or loss of income if there are strong waves and typhoons. If a female member is involved in agriculture, then she is exposed to skin diseases when attempting to salvage damaged crops during flooding. Likewise, participation in and choice of adaptation strategies are found to be gender-differentiated and are also tied with household and productive roles and innate capacity of men and women (i.e., physical endowments), but these ties are mediated by social and informational factors (i.e., institutional, informational, and social endowments).

Overall, the study found that there are differentiated adaptation roles for men and women in the household. Although equitable decision making and participation increases welfare and reduces household vulnerability, the impacts are quite modest. All these point to the conclusion that what the household is doing is probably close to optimal. Policies that aim to change decision making and participation within the household might not be something worth pondering upon too much but that public policies in support of increasing the knowledge of men and women on disaster management and response and providing early warning should be continued.

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APPENDICES

Appendix Table 1. Variable categorization

Variable	Variable Category
% female members	Sociodemographic control
HH size	Sociodemographic control
Dependency ratio	Sociodemographic control
Roof made of permanent materials	Proxy for HH adaptive capacity
HH has piped water	Proxy for HH adaptive capacity
Modal number of typhoon that affected the village	Hazard threat level
No. of typhoon x HH affected by latest typhoon	Hazard threat level
No. of wife's relatives who hold political positions	Proxy for bargaining power
No. of husband's relatives who hold political positions	Proxy for bargaining power
HH has tenure over lot	Proxy for HH adaptive capacity
Husband perceives typhoon/flooding will be worse in the future	Information/Bargaining power proxy
Wife perceives typhoon/flooding will be worse in the future	Information/Bargaining power proxy
Wife receives income from other sources	Proxy for bargaining power
Husband receives income from other sources	Proxy for bargaining power
Wife spent more years in school than husband	Proxy for bargaining power
Wife is the eldest among her siblings	Proxy for bargaining power
Wife is the eldest and has lower birth order than husband	Proxy for bargaining power
Age of wife	Sociodemographic control
Square of age of wife	Sociodemographic control
HH owns livestock	Sociodemographic control
Husband receives typhoon warning from TV/radio	Information/Adaptive capacity proxy
Wife receives typhoon warning from TV/radio	Information/Adaptive capacity proxy
Husband receives typhoon warning from his social network	Information/Adaptive capacity proxy
Wife receives typhoon warning from her social network	Information/Adaptive capacity proxy
Husband receives typhoon warning from LGUs	Information/Adaptive capacity proxy
Wife receives typhoon warning from LGUs	Information/Adaptive capacity proxy
HH engaged in both farming and fishing	Sociodemographic control
HH engaged in fishing	Sociodemographic control
Wife receive disaster training	Information proxy
Husband received disaster training	Information proxy
Cambodia dummy	Locational control
Philippine dummy	Locational control
Dummy variable for presence of mangrove near and in front of the house	Proxy for hazard exposure
Distance of dwelling from river	Proxy for hazard exposure
Age of husband	Sociodemographic control
Main decision maker is the husband	Sociodemographic control
Square of husband's age	Sociodemographic control

Appendix Table 2. Impacts on households of major climate-related hazards in selected sites in Cambodia

Damages	Typhoon/ Wind Storm	Flooding	Sea Level Rise/ Coastal Erosion	Saltwater Intrusion
Property	• Damage to house and fishing facilities	• Damage to house and other properties • Loss of fishing facilities	• Fruit trees die because of salinity • Damage to agricultural land	• Soil and water salinity
Livelihood	• Damage to rice fields • Loss in income from fishing • Loss in income from livestock rearing • Damage to fruit trees	• Damage to rice fields • Damage to fruit trees • Loss in income from fishing • Livestock died	• Damage to agricultural land • Damage to salt farm • Damage to rice crop • Loss in income from fishing due to protection of rice crop and family members • Loss of off-farm income	• Cost to buy clean drinking water • Spend more time to collect clean water • Damage to rice crop
Health	• Common diseases: headache, sore throat, colds, and fever • Injury to some people • Loss of human life	• Water-borne disease • Lack of fresh water	• Some health problems related to fresh water shortage	• Some health problems related to fresh water shortage

Appendix Table 3. Impacts on households from major climate-related hazards in selected sites in the Philippines

Damages	Typhoon/Wind Storm (and Storm Surge)	Flooding	Sea Level Rise/ Coastal Erosion	Saltwater Intrusion
Property	• Damage to houses and other properties • Damage to infrastructure (dikes, bridges, ports, and commercial establishments)	• Damaged houses and other properties • Damage to infrastructures (dikes, sea wall, ports, aqua farms, bridges, schools, and offices) • Loss of livestock	• Eroded land in some areas • Damage to houses • Damaged agricultural land	• Water salinity
Livelihood	• Damage to rice and corn fields • Loss in income due to early harvest of farmed fish • Loss in income from fishing and gleaning • Loss in income from dried fish and hard-boiled fertilized duck processing • Loss in income from livestock rearing • Damage to coconut and fruit trees • Damage to fish cages • Loss in income from other sources	• Damage to backyard vegetable garden • Damage to rice and corn fields • Damage to fruit trees • Loss in income from fish farming and gleaning • Livestock death • Loss in income due to work stoppage • Loss in income from dried fish and hard boiled fertilized duck processing	• Loss of land area for dried fish processing and raft making	• Spend more time and extra travel cost to collect clean water • Damage to coconut trees
Health	• Cough, fever, colds, and skin diseases caught mostly by children • Injury to some people • Sickness of children and elderly	• Skin diseases common after flooding • Cough, fever, and colds caught mostly by children	• Some health problems related to undrinkable water in some areas	• Some health problems related to undrinkable water in some areas

Appendix Table 4. Impacts on households from major climate-related hazards in selected sites in Vietnam

Damages	Typhoon/Wind Storm (and Storm Surge)	Flooding	Sea Level Rise/ Coastal Erosion	Saltwater Intrusion
Property	• Damage to houses, and aquaculture and fishing facilities • Damage to water gates, fish pond, dikes, tents, and houses on fish ponds and marine culture area	• Damage to houses and fishing facilities	• Damage to houses and facilities	• Soil and water salinity • Damage to sanitary accessories • Cost of rain water storage and collection
Livelihood	• Damage to crops and aquaculture • Loss in income from fishing • Loss in income from livestock rearing	• Damage to crops and aquaculture (change in pH) • Loss in income from livestock rearing	• Loss in agriculture • Aquaculture-based livelihoods are affected by salinity and erosion • Loss in income from salt making	• Loss in income from agricultural activities • Decrease in rice yield (switching to aquaculture) • Affects rice seedling preparation
Health	• Loss of human life	• Common diseases are headache, sore throat and colds, and fever mostly by children and elderly	• The effect is unclear in the short-term	• Some health problems related to kidney and stomach

Appendix Table 5. Autonomous adaptation strategies by households

Hazards	Cambodia	Philippines	Vietnam
Typhoon/Wind storm (and storm surge)	• Reinforce and repair house • Reinforce and repair school • Change the roof from light materials to permanent materials • Tie the roof of their house • Cut and trim trees near the house • Move family members to safer place • Move livestock and household items to safer place • Migrate to city, involvement in non-farm activities • Fishing delay • Repair fishing boat • Inform other people • Move household appliances to a safer place	• Early harvest of milkfish in ponds • Family intact and all members accounted for • Packed clothing and underwear • Pray • Transfer hogs and swine • Prepared flashlights, candle • Packed rice, canned goods, noodles, instant food, water • Family members stayed at home • Monitor typhoon updates from TV, radio, internet, and community announcements • Households evacuate to nearby barangays	• Reinforce and repair house • Build permanent houses • Build barrier around the house (made of iron, steel, and brick) • Prepare means of evacuation (torch, radio, and life-jacket) • Prepare sand bags for keeping the roof and breeding facilities • Prepare iron bars for keeping the doors • Cut and trim trees near the house • Move family members to safer place • Move livestock and household items to safer place • Change crop patterns and adjust crop calendar
Typhoon/Wind storm (and storm surge)	• Early harvesting rice crop • Rice plants have been fallen by farmers using bamboo stick to protect paddy grains	• Move fishing equipment to a safer place • Packed relief goods, clothing • Warn other neighbor • Cemented footing • Families along the creek look for drift wood and nuts • Elevate appliances • Place used wheels on roofing or tied roofing • After hazards, find where and from whom to borrow money for food, schooling of children • Private sea wall constructed by some residents • Elevating boats, nets, and their other assets	• Early harvesting of crops and aquaculture • Diversify agricultural production (grow many types of crops) • Migrate to city, involvement in non-farm activities • Buy and store food, drinking water and other necessary goods • Change farming practices

Appendix Table 5 continued

Hazards	Cambodia	Philippines	Vietnam
Flooding	• Build permanent houses • Buy drinking water and other necessary goods • Change farming practices • Move fishing boat to a safer place • Move family members to safer place • Move livestock and household items to safer place • Migrate to city, involvement in non-farm activities • Replant rice crop and fruit tree	• Gleaning after big waves with shells washed to shore • Stand along river and creek to pick up drift coconuts and wood • Private sea wall constructed • During night time, men lighted torched to gather shrimps and crabs along rivers and shores • Look for drifted coconut along rivers even crabs • Prepare flashlights, candle, rice, canned goods, noodles • Family members stayed at home • Keep dried firewood • Monitor from radio, TV	• Build permanent houses • Build barrier around the house (by iron, steel, and brick) • Buy and store food, drinking water and other necessary goods • Prepare a mean of evacuation (torch, radio, life-jacket) • Upgrade permanent ponds for aquaculture nursery • Move family members to safer place • Move livestock and household items to safer place • Migrate to city, involvement in non-farm activities • Change farming practices
Flooding		• Carrying their chicken, rooster, wild duck • Pushing their motorcycles • Carry children and old and sick household members • Alternative livelihood from collected coconut shell, mangrove, mud clam • Pack canned goods, clothing, and flashlight for evacuation • Each household shouts to the neighborhood for warning • Observe rise in water level • Cleaning of church, covered court, brgy. hall • Elevate houses and their fishing paraphernalia	

Appendix Table 5 continued

Hazards	Cambodia	Philippines	Vietnam
Sea level rise/Coastal erosion	• Change farming practices • Change crop patterns and adjust crop calendar • Early harvesting of rice crop • Change variety of rice crop • Change rice cultivation to salt farm • Change to new rice variety that is more resilient to salinity • Borrow money from loan agents to feed their family and buy rice seed • Borrow money from village bank • Borrow rice seed from neighbor • Migrate to city, involvement in non-farm activities • Reinforce and repair rice field dike • Reinforce and repair sea dike • Retain rainwater in rice field to reduce level of salinity • Buy medicine to treat their skin disease • Move livestock to safer or higher place • Restore mangrove forest • Move household appliances to a safer place • Build concrete wall to their house or rice field • Plant mangrove trees	• Private sea wall constructed by some residents • Piled sacks of sand by some residents • Report to the municipality the situation	• Move to safer places • Migrate to city, involvement in non-farm activities • Cooperate with other households to improve the dike by sand bags and trees

Appendix Table 5 continued

Hazards	Cambodia	Philippines	Vietnam
Saltwater intrusion	• Buy drinking water • Build rainwater storage tank or jar • Dig more groundwater wells • Collect clean water from a pond far away from their house • Collect water from private dug well • Connect to private pipe water • Restore fresh water pond	• Drive motorbikes to fetch water from deep well in nearby barangay • Filter and boil water to drink • Those who could not afford water connections buy water from neighbors	• Change farming practices • Change crop patterns and adjust crop calendar • Migrate to city, involvement in non-farm activities • Switch to new varieties and salt tolerant crops • Restore the land using lime and phosphorus for paddy fields • Construct water filter system for domestic consumption water • Prevent freshwater fish from saltwater by lining the edge of ponds with concrete and nylon use

Appendix Table 6. Roles of household members in adaptive strategies in Cambodia, by gender and age

Hazard	Children (0–15)	Working Age (16–59)		Elderly (60 and above)	
	Boys/Girls	Men	Women	Men	Women
Saltwater intrusion	• Help in collecting clean water (girls more often than boys)	• Construct rainwater storage tank or jar • Collect clean water	• Collect clean water from a pond located far away from house (more often than men)		
Typhoon/ Wind storm (and storm surge)	• Clean and wash house and belongings (girls more often than boys) • Help in productive tasks, e.g., collecting fallen branches	• Move family members to a safer place • Move livestock and belongings to safer place • Reinforce and repair house • Take care of belongings and family members • Go to rice field to protect rice grain • Construct or buy concrete pillars to change wooden pillars	• Move livestock and belongings to safer place (more often than men) • Prepare food for family members • Clean house and wash belongings • Take care of sick people and family members • Recovery from damages and losses • Go to rice field to fall down rice plants to protect rice grain (more often than men)	• Move family members to a safer place • Move belongings to a safer place • Reinforce and repair house • Take care of belongings and family members	• Move livestock and belongings to safer place • Prepare food for family members • Clean house and wash belongings • Take care of sick people and family members
Sea level rise/ Coastal (and creek bank) erosion	• Help their parents in reinforcing and repair rice field dike (boys)	• Reinforce and repair rice field dike • Move belongings to a safer place	• Reinforce and repair rice field dike • Prepare reserve food	• Reinforce and repair rice field dike • Move belongings to a safer place	• Help prepare reserve food • Move belongings to a safer place

Appendix Table 6 continued

Hazard	Children (0–15)	Working Age (16–59)		Elderly (60 and above)	
	Boys/Girls	Men	Women	Men	Women
Sea level rise/ Coastal (and creek bank) erosion	• Help their mother in preparing reserved foods (girls) • Help parents in moving small belongings to a safer place	• Reinforce and repair rice field dike after hazard to retain rainwater in rice field to reduce salinity • Buy medicine for family members who have skill problem • Early harvest • Collect salt in salt farm for generating for money • Build concrete embankment • Plant and restore mangrove forest	• Move belongings to a safer place • Reinforce and repair rice field dike after hazard to retain rainwater in rice field to reduce salinity • Clean house and wash belongings • Buy medicine for family members who have skill problem (more often than men) • Early harvest • Collect salt in salt farm for generating for money • Plant and restore mangrove forest	• Reinforce and repair rice field dike after hazard to retain rainwater in rice field to reduce salinity • Build concrete embankment	• Reinforce and repair rice field dike
Flooding	• Help parents in reinforcing and repair rice field dike (boys) • Help mother in preparing reserved foods (girls)	• Construct or buy concrete pillars to change wooden pillars • Build or rebuild chicken coop higher than before	• Move livestock and belongings to safer places • Prepare food • Evacuate family members to a safer place	• Build or rebuild chicken coop higher than before • Evacuate family members to a safer place • Take care of belongings and family members	• Move livestock and belongings to safer places • Prepare food • Evacuate family members to a safer place

Appendix Table 6 continued

Hazard	Children (0–15)	Working Age (16–59)		Elderly (60 and above)	
	Boys/Girls	Men	Women	Men	Women
Flooding	• Help parents in moving small belongings to a safer place	• Evacuate family members to a safer place • Take care of belongings and family members • Reinforce and repair house • Move livestock and belongings to safer places	• Clean house and wash belongings • Take care of sick people and family members • Recovery from damages and losses • Collect drinking water	• Reinforce and repair house • Move belongings to safer places	• Clean house and wash belongings • Take care of sick people and family members • Recovery from damages and losses • Collect drinking water

Appendix Table 7. Roles of household members in adaptive strategies in the Philippines, by gender and age

Hazard	Children (0–15)	Working Age (16–59)		Elderly (60 and above)
	Boys/Girls	Men	Women	Men/Women
Flooding		• Lead prayers in the family • Prepare flashlights and batteries • Prepare and pack rice, canned goods, noodles, clothing • Monitor flooding updates • Help others as members of rescue group in the province • Find means to borrow money • Still decide to fish even after flooding for income • Prepare clothing and canned goods	• Early harvest of milkfish from fishpond • Prepare rice, canned goods, noodles, clothing • Look for drift wood and even crabs • Monitor updates from radio, TV • Elevate appliances • Place used wheels on roofing • Keep dried firewood • Stand along water ways for coconuts and drift wood • Wait for relief assistance	• Lead prayers in the family

Appendix Table 7 continued

Hazard	Children (0–15)	Working Age (16–59)		Elderly (60 and above)
	Boys/Girls	Men	Women	Men/Women
Typhoon/Wind storm (and Storm surge)	• Pack bags in case of evacuation • Lift and transfer pump boat (boys) • Repair houses using nails from LGU (boys)	• Lead prayers in the family • Transfer hogs and swine • Look for shrimps and crabs for consumption during night time • Prepare the flashlight • Pack rice, canned goods , noodles • Monitor typhoon update • Decide on packing bags in case of evacuation • Decide to make concrete footing of house posts • Encouraged other men on concreting base of house posts • Planted mangroves • Help others as members of rescue group in the province • Still decide to fish even after typhoon for income • Carry the roosters and other domesticated animals • Carry their sick household members • Monitor height of waves based on elevation of houses	• Prepare and pack rice, canned goods, clothing • Harvest more quantity of shells after strong waves • Stand along river/water ways and gather drifted coconuts, woods even crabs after typhoon • Wait for relief assistance • Decided on tying roofing	• Lead prayers in the family • Transfer hogs and swine
Sea level rise/ Coastal erosion			• Decide on construction of private sea wall	

Appendix Table 8. Roles of household members in adaptive strategies in Vietnam, by gender and age

Hazard	Children (0–15)	Working Age (16–59)		Elderly (60 and above)
	Boys/Girls	Men	Women	Men/Women
Typhoon/ Wind storm (and storm surge)	• Help in productive tasks, e.g., collecting of fallen branches (girls more often than boys) • Evacuate	• Do heavy tasks such as re-ploughing, pond repairs • Reinforce and repair the house and breeding facilities and fishing ponds • Move fishing facilities to safer places • Present in the field to take care fishing facilities and ponds • Prepare for evacuation • Construct and improve fish ponds	• Clean, wash, and take care of belongings and sick people • Prepare food and belongings for evacuation • Assist men in reinforcing and repairing the house • Prepare finance for coping with typhoon • Recover production after typhoon • Diversify livelihood	• Take care of belongings and people (men) • Clean wash, take care of sick people (women) • Evacuate
Flooding	• Help in collection of belongings	• Collect belongings • Move belongings to safer places • Construct and improve fish ponds, reinforce and repair the house and breeding facilities	• Prepare reserve food, • Collect and move belongings to safer places • Clean the pond and recovery from damages and losses • Early harvest	• Collect belongings
Saltwater intrusion		• Use lime, phosphorus fertilizer to reduce level of salinity • Construct water container to reserve rain water for domestic use	• Use lime, phosphorus fertilizer to reduce level of salinity (more often than men) • Find out the new varieties that can withstand salinity better • Present in paddy field to collect fresh water to clear salt when the commune opens upstream water • Ask for and buy water from other households	• Use lime, phosphorus fertilizer to reduce level of salinity (women more often than men)

Appendix Table 8 continued

Hazard	Children (0–15)	Working Age (16 – 59)		Elderly (60 and above)
	Boys/Girls	Men	Women	Men/ Women
Sea level rise/ Coastal erosion		• Move belongings to safer places • New income-generating activities in new places • Upgrade the ponds and net around edge of fish ponds	• Move belongings to safer places • New income generating activities in new places • Early harvest	• Move belongings to safer places

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