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# Impacts of and Adaptation to Extreme Weather Events: An Intra-household Perspective

Jaimie Kim B. Arias, Jefferson A. Arapoc, and Hanny John P. Mediodia

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Front cover photo: Ajuy, Iloilo. Photo by Kevin John Lino

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January, 2016

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We dedicate this work to the victims and survivors of typhoon Yolanda.

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# IMPACTS OF AND ADAPTATION TO EXTREME WEATHER EVENTS: AN INTRA-HOUSEHOLD PERSPECTIVE

Jaimie Kim B. Arias, Jefferson A. Arapoc, Hanny John P. Mediodia

## EXECUTIVE SUMMARY

This study documented and analyzed the experiences of households and their individual members during two extreme weather events in the Philippines in 2013. The first weather event took the form of heavy monsoon rain (local name: Habagat) and the subsequent widespread flooding in August 2013; this event affected households in Bacoor, Cavite. The second weather event was typhoon Haiyan (local name: Yolanda), which affected coastal households in Ajuy, Iloilo.

Results showed that warnings, experience of flooding, and community adaptation activities were significant determinants of household adaptation in Bacoor. The results also showed that undergoing disaster risk reduction and management training, engaging in community adaptation, and receiving information from local government increased the likelihood of households in Ajuy undertaking preparations in advance of the weather event. The losses in Bacoor were about a third of household income. The welfare losses from typhoon Yolanda were estimated to be six times that of the household income in Ajuy; households in Ajuy with mangrove cover experienced less damages to their property by as much as PHP 7,641. Policy implications were derived from the results of the analysis.

## 1.0 INTRODUCTION

### 1.1 Background and Rationale

The Philippines is one of the most vulnerable countries to extreme weather- and climate-related hazards. Every year, the Philippines experiences around 20 tropical storms, making it the most storm-prone country in the world. It is also at risk of flood disasters, with 65 events of this type recorded over the last 10 years (CRED 2009).

In 2013, the country faced several extreme weather phenomena, including the devastation of a super typhoon and the onset of unusually heavy monsoon rains. Because of climate change, coupled with continuous environmental and natural resource degradation, similar disasters are expected to become more frequent and more intense in the future.

In order to overcome the potential economic and social impacts of these extreme events, the country needs to build its overall resilience. This involves strengthening the different institutions in the country, including its smallest unit—the household. A crucial first step in this endeavor is studying how households are affected by extreme weather events and how they prepare for and respond to such events. This information can help identify policy interventions that can potentially enhance a household's ability to adapt, and therefore reduce its vulnerability to weather disasters.

Although a number of studies have examined the impacts of floods and typhoons at a household level, few have looked at the impacts on a household's individual members. This study undertook this more in-depth analysis. It dissected the impacts of extreme weather events on different demographic groups within a household and examined the roles and participation of different sex and age groups in household adaptation activities.

The importance of looking at the marginalized sectors of society when studying climate change and its impacts was highlighted by the Intergovernmental Panel on Climate Change (IPCC 2007). It stated that those who stand to be severely affected by climate change impacts are the marginalized sectors such as women and the young. Furthermore, these groups are the ones least capable of adapting to the impacts of climate change. Viewing climate change through demographic and gender lenses can bring about a richer understanding of its impacts, which can then be transformed into more effective and sustainable intervention strategies.

Against this backdrop, this research examined two case studies: one of extreme rainfall and subsequent flooding, and one of an extreme typhoon. The municipality of Bacoor in the province of Cavite, Philippines experienced extreme rainfall and flooding during the heavy monsoon rains of 2013 (local name: *Habagat*) and so is the location of our first case study. Ajuy, Iloilo was one of the areas affected by typhoon Haiyan (local name: Yolanda), one of the most powerful typhoons ever recorded, and so is the location of our second case study.

Bacoor is prone to floods due to its proximity to Manila de Bay and because it serves as the catchment basin for the nearby municipalities of Imus and Dasmariñas, Cavite. During the southwestern Habagat, which regularly occurs from June to September every year, flooding usually occurs in the low-lying parts of the city. In August 2013, an unusually heavy monsoon rain was intensified by typhoon Maring (international name: Trami), which brought 475.4 millimeters (mm) of rainfall within a 24-hour period. This volume of rainfall was greater than the average expected rainfall in Bacoor for the entire month. As a result, about 90% of the whole municipality was inundated; this affected 17,000 families and displaced 2,000 households.

A super typhoon with the strength of Yolanda had never happened in the Philippines. Ajuy was selected as one of the study sites because it is a municipality that rarely experiences strong typhoons, and yet it was in the path of the strongest typhoon that has ever occurred in the country. Moreover, Ajuy is a municipality where areas of mangrove still exist. Due to pressure from human activity, natural resources such as mangroves are constantly under threat. Finding empirical evidence to demonstrate the protection benefits of mangroves against coastal hazards can pave the way for policies that would encourage the protection and rehabilitation of this dwindling resource. With this objective in mind, this study also evaluated the significance of mangroves in increasing the resilience of households against extreme weather events.

Through these case studies, lessons related to disaster risk reduction and management (DRRM) in the Philippines can be derived. In particular, insights were gained by looking at how households and their individual members respond to and are affected by extreme weather events. These, in turn, were used to identify policies that can help households become more resilient against future climate change-related hazards.

## 1.2 Research Objectives and Research Questions

The general objective of the research project was to analyze the household and intra-household impacts of extreme weather events and to determine the significant factors that affect a household's decision to undertake adaptation activities. Specifically, this study aimed to

1. describe the adaptation actions undertaken by households and to determine the factors that significantly affect the choice of adaptation activities;
2. identify, quantify, and monetize (whenever possible) the household and intra-household impacts of an extreme flood and an extreme typhoon;
3. assess whether men and women have different preferences for DRRM interventions, and whether they have specialized roles in household adaptation activities;
4. determine whether the presence of mangroves reduced the damage suffered by households during typhoon Yolanda; and
5. draw policy implications based on the findings of the study.

The research aimed to answer the following questions:

1. What are the significant factors that affect a household's decision to undertake adaptation activities in preparation for extreme weather events?
2. How is a household (and its different members) affected by extreme weather events such as a typhoon or flooding?
3. Are the preferences of women for DRRM intervention different from those of men?
4. Are there specialized roles for various demographic groups within various adaptation activities?
5. Did the households in Ajuy who were protected by mangroves sustain less damage than those who were not protected by mangroves?

# 2.0 FRAMEWORK AND METHODOLOGY

## 2.1 Conceptual Framework

The overarching framework of analysis is presented in Figure 1. The diagram shows that extreme events such as flooding and typhoons can adversely impact households through various channels: damage to property, damage to livelihoods, loss of income, impacts on health, impacts on education, and displacement. Because of the differences in vulnerabilities, different members of a household may have different susceptibilities to these impacts. However, such impacts may be reduced if the household has built up its resiliency. Resiliency, however, depends on the choice of adaptation actions. A household and its members can also contribute to community adaptation (for instance, a community may undertake evacuation drills and information dissemination activities), which in turn can further enhance the autonomous adaptation of the household. Lastly, government interventions can either encourage (if complementary) or discourage (if substitute) autonomous adaptation.

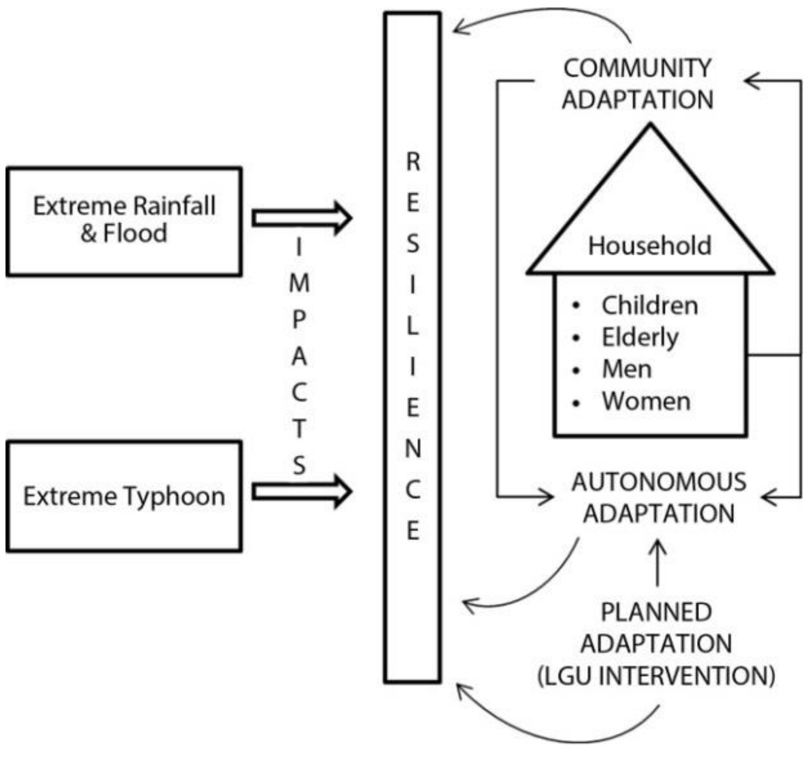


**Figure 1.** Conceptual framework

## 2.2 Analytical Procedure

### 2.2.1 Adaptation actions undertaken by households and factors affecting the choice of adaptation activities

To analyze household adaptation behavior in Ajuy, the multivariate probit regression model was used. Multivariate probit is used to account for the interrelatedness of household adaptation choices. It estimates an *m*-equation discrete choice model, with each equation representing a possible adaptation strategy. The model starts with the following indirect utility equation:

$$V_m^* = \beta'_m X_m + \varepsilon_m \qquad \text{(Equation 1)}$$

where:

| | | |
|---|---|---|
| $V_m^*$ | = | latent (indirect) utility obtained from choosing adaptation strategy *m*, |
| $\beta'_m$ | = | coefficients, and |
| $X_m$ | = | matrix of factors affecting utility. |

A household will choose adaptation strategy *m* if it receives positive utility from it, given by

$$y_m = 1\left[V_m^* > 0\right] \qquad \text{(Equation 2)}$$

where:

| | | |
|---|---|---|
| $y_m$ | = | latent (indirect) utility obtained from choosing adaptation strategy *m*. |

Hence, the probability of observing a household choosing strategy *m* can be written as

$$\Pr\left[y_m = 1\right] = \Pr\left[\beta'_m X_m + \varepsilon_m > 0\right] \qquad \text{(Equation 3)}$$

where:

| | | |
|---|---|---|
| $y_m$ | = | latent (indirect) utility obtained from choosing adaptation strategy *m* and |
| $X_m$ | = | matrix of factors affecting utility. |

Observing a combination of strategies, in which two strategies are adopted and all the other possibilities are not, can be expressed as

$$\begin{aligned} &\Pr\left[y_1 = 1, y_2 = 1, y_3 = 0 = \ldots y_m\right] \\ &= \Pr\left[\beta'_1 X_1 + \varepsilon_1 > 0, \beta'_2 X_2 + \varepsilon_2 > 0, \beta'_3 X_3 + \varepsilon_3 < 0 \ldots, \beta'_m X_m + \varepsilon_m < 0\right] \qquad \text{(Equation 4)} \\ &= Pr\left[\varepsilon_1 > -\beta'_1 X_1, \varepsilon_2 > -\beta'_2 X_2, \varepsilon_2 < -\beta'_3 X_3 \ldots, \varepsilon_m < -\beta'_m X_m\right]. \end{aligned}$$

Assuming that the error terms are jointly normal, the specification will lead to a multivariate normal model, which can be estimated using simulated maximum likelihood. In the estimation, we used the Stata program developed by Capellari and Jenkins (Cappellari 2003).

In the Bacoor study site, we implemented a probit regression. The dependent variable was a binary choice equal to 1 if the household undertook preparations for Habagat and 0 if otherwise. Using the random utility framework, the individual was assumed to face the following utility function given two choices: to undertake adaptation actions (1); or not to undertake adaptation actions (0).

$$\begin{aligned} u_1 &= Z_{i1}\gamma + X_i\beta_1 + U_{1i} \qquad \text{(Equation 5)} \\ u_0 &= Z_{i0}\gamma + X_i\beta_0 + U_{0i} \end{aligned}$$

where:

| | | |
|---|---|---|
| $Z_{i1}$ | = | choice and subject specific attributes and |
| $X_i$ | = | subject specific characteristics. |

The respondent chooses to undertake preparations if $u_1 > u_0$. Assuming that $U_{1i}$ and $U_{0i}$ are normally distributed, then $U_{1i} - U_{0i}$ is normally distributed, and the expression below can be evaluated. This can be computed using the maximum likelihood framework through Stata.

$$P(U_{1i} > U_{0i}) = \mathrm{P}\left[U_{1i} - U_{0i} > -\gamma(Z_{i1} - Z_{i0}) - X_i(\beta_1 - \beta_0)\right]. \qquad \text{(Equation 6)}$$

### 2.2.2 Impacts of extreme flooding and typhoons on households and intra-household

The impacts that were documented in this study included both generic (affects the whole household) and specific (specific to the members of the household) property, livelihood, income, health, education, and displacement impacts. For health and education, an intra-household perspective was undertaken, i.e., differences in vulnerabilities between male and female and among the different age groups were examined. The measures/indicators as well as the valuation methods used are summarized in Table 1.

To determine whether certain age groups or gender groups are more susceptible or vulnerable to the impacts of extreme weather events, we computed the incidence rates as follows:

$$I_{ij} = {}^{A_{ij}}\!/_{P_j} \qquad \text{(Equation 7)}$$

where:

$I_{ij}$ = incidence rate of demographic group *j* for impact *I*;
$A_{ij}$ = number of individuals from demographic group *j* affected by impact *I*;
$P_j$ = total subpopulation of demographic group *j*; and
$j$ = men, women, children (0–14), teens and adults (15–64), and elderly (65 and above).

We conducted an unpaired t-test to determine whether mean lost school days and mean work loss days were statistically different between the males and the females.

**Table 1.** Summary of methods used in the analysis of impacts

| Impact | Measures/Indicators | Valuation Method |
|---|---|---|
| Damage to property | Damage/loss of house<br>Damage/loss of belongings (household appliances, clothes, furniture, electronic devices)<br>Damage/loss of vehicles | Cost of repairs (if salvageable)<br>Replacement cost (if non-salvageable) |
| Impact on livelihoods | Damage/loss of fishing boats<br>Damage/loss of farm equipment/machinery | Cost of repairs (if salvageable)<br>Replacement cost (if non-salvageable) |
| Loss of income | Work loss days<br>Loss of income<br>Damage/loss of fish/livestock<br>Damage/loss of crops | Average daily income or wage rate<br>Reported income losses |
| Impacts on health | Dengue fever<br>Diarrhea<br>Injuries<br>Skin infections<br>Leptospirosis | Cost of illness (hospitalization and medication cost, foregone income due to work-loss days is already captured in income losses) |
| Education | Lost school days due to absences | |
| Other impacts | Displacement (evacuation) | |

### 2.2.3 Preferences of men and women regarding DRRM interventions and roles of men and women in household adaptation activities

The study documented the adaptation actions undertaken by households, and identified which household members executed these activities. Frequency distribution tables and proportions and percentages were used to determine whether there were predominant gender roles in various adaptation and preparation activities.

To determine differences in opinion between male and female gender groups toward different government interventions and programs, an open-ended question was asked requesting respondents to name the top three government interventions they would prefer to help them become more resilient to future extreme typhoons (for Ajuy) or flooding (for Bacoor). The responses were tabulated and ranked based on the percentage of respondents that had identified the intervention. The ranking was disaggregated according to gender in order to determine if there were differences in preferences between the male and female respondents.

### 2.2.4 Effectiveness of mangroves in reducing damage to households during typhoon Yolanda

To determine whether mangroves significantly reduced the damage faced by households during typhoon Yolanda, ordinary least squares (OLS) and weighted least squares (WLS) were estimated. WLS was used to address the presence of heteroskedasticity. The explanatory variables used in the regression were the presence of mangrove cover, adaptation expenditure, value of assets, distance to the coastline, and other variables reflecting household economic and social characteristics (e.g., household size, house size, type of house, and household income).

## 2.3 Data Collection Method

The data used in the study was collected through a survey of 770 households. The head of each household, either male or female, was interviewed for the survey. The sample size was computed and the actual sampling procedure was undertaken with the aid of an online tool, Research Randomizer. The sample size for Ajuy was 370. Since the primary research problem in Ajuy was determining whether mangroves offer protection benefits, only coastal communities were included in the sampling frame. The 370 household respondents were proportionally distributed based on the estimated total number of households in the community (Table 2). In selecting the households, systematic sampling was employed. The sampling interval used was 2 (i.e., every second household was interviewed).

**Table 2.** Distribution of sample household respondents (Ajuy)

| Village | Coastal Household Population* | Number of Respondents |
|---|---|---|
| Culasi | 500 | 177 |
| Barrido | 200 | 70 |
| Malayuan | 86 | 30 |
| Pili | 100 | 35 |
| Mangorocoro | 50 | 18 |
| Pantalan Nabaye | 111 | 40 |
| **Total** | **1,047** | **370** |

Note: *Researchers' own estimates

The sample size for Bacoor was 400 (Table 3). The sampling procedure used in Bacoor followed the guidelines developed by the World Food Programme for Vulnerability Analysis (WFP 2004). Specifically, a two-stage random sampling technique was employed. In the first stage, the *barangay* (village) was selected. In the second stage, the household respondents were randomly drawn. The random sampling of the barangay was weighted based on population. Each of the barangays selected were then assigned an equal number of samples. This sampling methodology allowed us to draw inference for the whole City of Bacoor.

**Table 3.** Distribution of sample household respondents (Bacoor)

| Village | Household Population | Number of Respondents |
|---|---|---|
| San Nicolas I | 866 | 40 |
| Talaba II | 1,140 | 40 |
| Zapote V | 2,785 | 40 |
| Habay I | 10,088 | 40 |
| P.F. Espiritu IV | 2,824 | 40 |
| Niog II | 345 | 40 |
| Real II | 2,369 | 40 |
| Salinas I | 4,182 | 40 |
| Mabolo III | 408 | 40 |
| Ligas I | 795 | 40 |
| **Total** | **25,802** | **400** |

## 2.4 Description of the Study Sites

Figure 2 locates the study sites in the Philippines. Bacoor, Cavite, is in Luzon near the country's capital of Manila; while Ajuy, Iloilo, is in the Visayas. The brown dots represent the location of the household respondents in Bacoor; the yellow dots represent the location of the household respondents in Ajuy.

Bacoor is a first-class city[1], which serves as a link between Metro Manila and the province of Cavite. It is bounded on the east by Las Piñas City and Muntinlupa City, on the south by Dasmariñas City, on the west by Kawit and Imus, and on the north by Manila de Bay. The majority of its total land area of 52.4 square kilometers ($km^2$) was previously agricultural land, which has been converted into subdivisions. Residents of the area are predominantly people that work in the nearby metropolitan areas of Makati and Metro Manila. Bacoor City is politically subdivided into 73 barangays with two legislative districts: Bacoor West and Bacoor East. Some of its coastal barangays lie below sea level, which makes them susceptible to flooding. Two major rivers traverse the area: Zapote River and Bacoor River (Bacoor City Government, n.d.).

The economy of Bacoor has rapidly shifted from being agriculture- and fishery-based into being a residential and commercial urban center. Trade, banking, and the service sectors are currently the biggest income contributors to the city. As of 2010, the total population was about 520,000 and the average density was 8,420 people per $km^2$. In the hazard maps developed by the local government, 42 barangays are moderately to highly susceptible to flooding, while five barangays are susceptible to storm surges as high as 1 meter (m) (Bacoor City Government, n.d.).

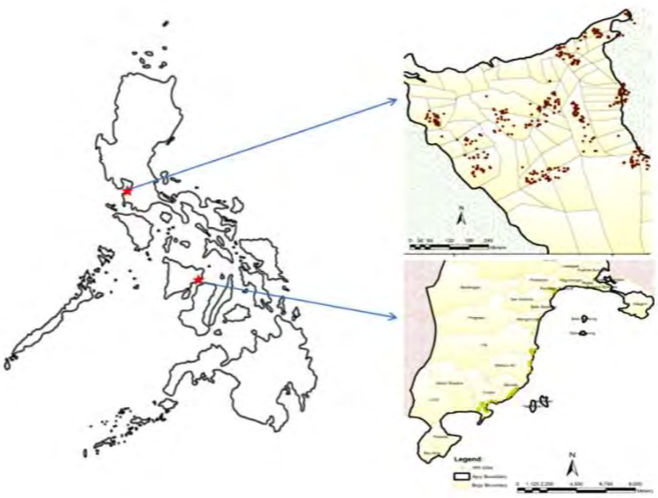

**Figure 2.** Map of the Philippines showing the location of the study sites

[1] A city with an average annual income of PHP 400 million (USD 8.9 million) or more

Bacoor is prone to floods because of its proximity to Manila de Bay and because some areas are low-lying. The climate is classified as tropical, with distinct wet and dry seasons. The dry season runs from late December to April, while the wet season is longer, extending over the months of May to early December. The southwest monsoon or Habagat usually occurs from June to September and can cause flooding in low-lying areas.

The extreme flooding in Bacoor in August 2013 was brought about by a strong monsoon, which was intensified by typhoon Maring. During this monsoon, the recorded rainfall over a 24-hour period reached 475.4 mm, which was greater than the average expected rainfall for the entire month. As a result, about 90% of the whole municipality was inundated, affecting 17,000 families and displacing 2,000 households. There were also three cases of drowning reported, two of which were caused by a breach in a Spanish-era irrigation dam (NDRRMC 2013).

Ajuy, on the other hand, is a second-class municipality[2] from the province of Iloilo in the Visayas. Its location is 87 kilometers (km) north of Iloilo City, which is the provincial capital. Covering a total area of 152.3 km$^2$, the municipality has 34 barangays, 18 of which are classified as island or coastal barangays. The total length of its shoreline is 75.83 km, and its surface water spans 250 km$^2$. The economy is predominantly based on agriculture and aquaculture, with all its barangays classified as being rural. As of 2010, the estimated population was 47,248 (NSCB, n.d.).

Ajuy was selected as a study site for an extreme typhoon because of the following: (1) it was one of the municipalities affected by typhoon Yolanda; (2) mangroves still exist along the coastal areas (Sinfuego 2013); and (3) it is susceptible to 1–4 m storm surges (NAMRIA, n.d.). In addition, for ethical reasons, we chose an area where communities are already on the road to full recovery from typhoon Yolanda.

Typhoon Yolanda is one of the most powerful typhoons ever recorded worldwide, and it is the most catastrophic typhoon the Philippines has experienced. It is the epitome of an extreme weather event, with a landfall wind speed of about 234 kilometers per hour (kph), which caused high storm surges. The typhoon caused widespread coastal floods and storm surges in provinces along the central Philippines as it made landfall on 8 November, 2013, traversing Samar, Leyte, Cebu, Iloilo, Capiz, Aklan, Antique, and Palawan.

# 3.0 RESULTS AND DISCUSSION

## 3.1 Description of the Household Respondents and Assessment of Their Vulnerability

Different households faced with the same threat and hazard may experience different degrees of impacts because of the differences in their characteristics and their ownership of assets and resources. To assess the context in which the households included in this study are susceptible to the impacts of extreme flooding and extreme typhoons, some indicators and variables that would indicate a household's vulnerability and adaptive capacity were first identified. The discussion that follows focuses first on the characteristics of the households, and then goes on to a more in-depth analysis that compares the resources and opportunities available to men and women within households.

On average, households in Ajuy had five members, with a male to female ratio of about one to one. Forty percent of Ajuy households were young (<15 years old) or elderly (>64 years old). This indicates that in a household, there are potentially more productive members or income earners than dependents. However, majority (58%) of the households in the study site lived on a monthly income of less than PHP 5,000 (USD 114). The mean household income of PHP 6,958 per month indicates that, on average, households live below the World Bank standard of USD 1.25 per capita per month. The primary livelihoods of the households in Ajuy may explain the reason for their low income. Being a coastal community, majority of the households (37%) were dependent on the fishery sector. Similar to other fishing communities found in the rest of the country, households in Ajuy were already facing the problem of dwindling marine resources, which can

[2] A city with an average annual income of PHP 45 million (USD 1 million) or more but less than PHP 55 million (USD 1.2 million)

contribute to their low earnings. When coupled with extreme weather, their already meager conditions can be exacerbated because of their heavy dependence on natural resources.

At the Bacoor study site, the average household size was also five, with 33% of household members being of dependent age. The proportion of female household members was about 46%. Similar to Ajuy, the lower proportion of household members of dependent age (<15 and >64) may imply that more members will be able to potentially contribute financially or physically to support the needs of the household. The average household income of PHP 19,773 per month was significantly higher than that in Ajuy, which may indicate some financial capacity to undertake adaptation. However, a substantial percentage of households (27%) still lived in extreme poverty, earning less than PHP 5,000 per month. Being an urban area, the majority (79%) of the households that were sampled in Bacoor primarily depended on employment in the commercial and services sectors, while only 3% were dependent on agriculture and fisheries.

The importance of incorporating gender and demographic perspectives to disaster and climate change studies comes from the observation that women, the young, and the elderly are more vulnerable and have lower adaptive capacities because they have less access to and command over resources, and therefore have less bargaining power in the household. Toward this end, the profiles of the various demographic groups were analyzed as a backdrop for understanding the economic opportunities available to them. In this analysis, we used the socioeconomic profile of all the members of the respondent households included in the survey. From the 770 household respondents, we were able to compile data from 2,073 individuals in Bacoor and 1,826 individuals in Ajuy (Table 4).

The distribution of the different demographic groups was more or less similar in the two study sites. The proportion of women was slightly higher than that of the men, and the majority of household members (63% in Bacoor and 59% in Ajuy) belonged to the 15–64 age group. About one-third were young (<15 years old) and about 6%–7% belonged in the elderly age group (Figure 3).

**Table 4.** Number of individual members from respondent households, by gender, by age

| Gender/ Age Group | Bacoor | | | | Ajuy | | | |
|---|---|---|---|---|---|---|---|---|
| | <15 | 15–64 | >64 | Total | <15 | 15–63 | >64 | Total |
| Male | 297 | 641 | 57 | 995 | 294 | 524 | 47 | 865 |
| Female | 329 | 674 | 75 | 1,078 | 338 | 545 | 78 | 961 |
| **Total** | **626** | **1,315** | **132** | **2,073** | **632** | **1,069** | **125** | **1,826** |

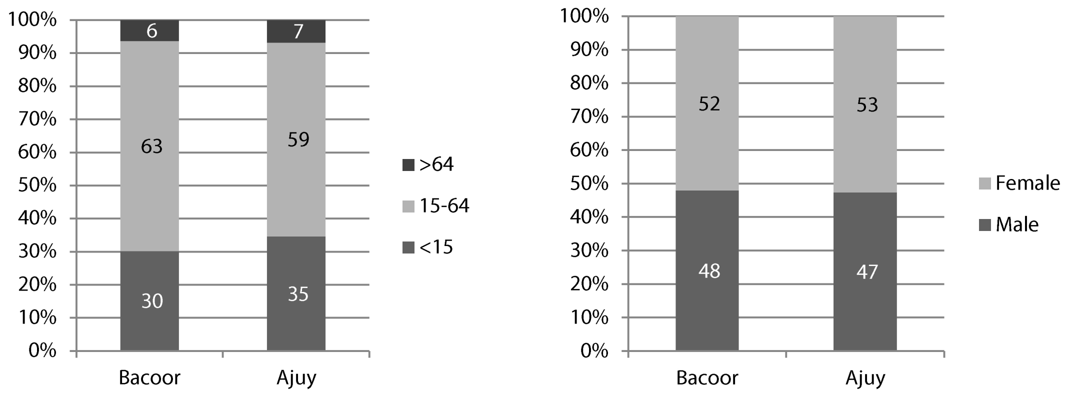


**Figure 3.** Frequency distribution of individuals included in the study based on gender and age

Conforming to the findings of other studies, women, in general, were found to have lower average incomes than that of men. In fact, in Bacoor, the average income of men was 70% higher than that of women, while in Ajuy this discrepancy was 57% (Table 5). According to bargaining theory, the lower income contribution of women may imply their lower bargaining power within the household. As such, in both study sites, the lower income contribution of women might mean that they have a weaker influence on making adaptation decisions, such as whether to evacuate or not, or whether to save money for emergencies. There have been studies that show that women had a higher propensity to save than men (Floro 2002). Therefore, women having a lower income and weaker bargaining power might mean lower savings for the household. From the data, there was a low savings pattern among households, which seems to confirm the above hypothesis.

**Table 5.** Comparison of average individual monthly incomes (in PHP) among demographic groups

| Gender/ Age Group | Bacoor | | | | Ajuy | | | |
|---|---|---|---|---|---|---|---|---|
| | <15 | 15–64 | >64 | All | <15 | 15–63 | >64 | All |
| Male | 29 | 6,577 | 1,188 | 4,313 | 27 | 2,545 | 3,480 | 1,736 |
| Female | 53 | 3,789 | 1,962 | 2,522 | 28 | 1,732 | 1,482 | 1,103 |
| All | 42 | 5,148 | 1,628 | 3,382 | 27 | 2,131 | 2,233 | 1,396 |

Note: Exchange rate: 1 USD: 44 PHP

Another implication is that if the preferences of male and female members of the household deviate from each other, then the lower bargaining power of women may imply that their preferences can be set aside. Fortunately, as our analysis show, men and women have similar ranking of preferences in terms of government interventions.

The types of occupation and the status of employment might shed light on the differences in economic opportunities available to men and women, which consequently might explain the difference in the earning capacity between the two genders. In Ajuy, the predominant occupation for males was fishing. Most women were housewives or were part of the laborer/unskilled workers sector. These women typically engaged in lower paying jobs in the informal sector, such as doing the laundry or being a house helper. The few women who were engaged in farming and fisheries took on jobs that were usually of the more subsistence variety rather than income generating. In Bacoor, the majority of male respondents were office/skilled workers, while only a few are engaged in fishing and farming (generally considered a lower-income occupation). Women in Bacoor were mostly full-time housewives.

Education is an important factor that influences adaptive capacity. Investment in education is an investment in human capital, a resource that is important in human adaptation to climate extremes. When faced with uncertain situations such as weather aberrations, people with more education have a greater capacity to assess their options and have greater flexibility in reacting to situations. In terms of formal education, we found that women had not been disadvantaged compared to men. For instance, in Bacoor, the percentage of women with at least a high school diploma was 68% compared to 67% for men. In Ajuy, the discrepancy was much larger with the percentage of women who graduated from high school estimated to be 58% compared to only 50% for males (Figure 4). Moreover, for those in the <15 years old cohort, a higher proportion of females were in school compared to males. Specifically, in Bacoor, the percentage of males in school was only 56%, compared to 61% for females. In Ajuy, the percentage of males in school was 35%, lower by four percentage points than females (Figure 5).

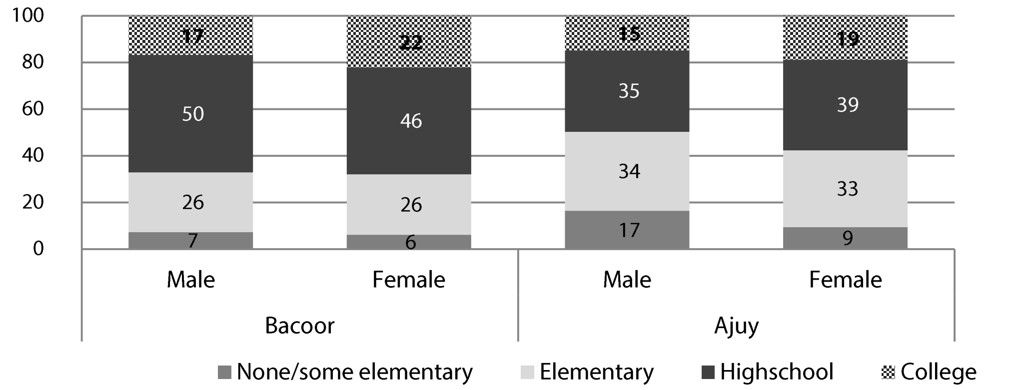


**Figure 4.** Distribution of individuals aged 15 and above, by education and by gender

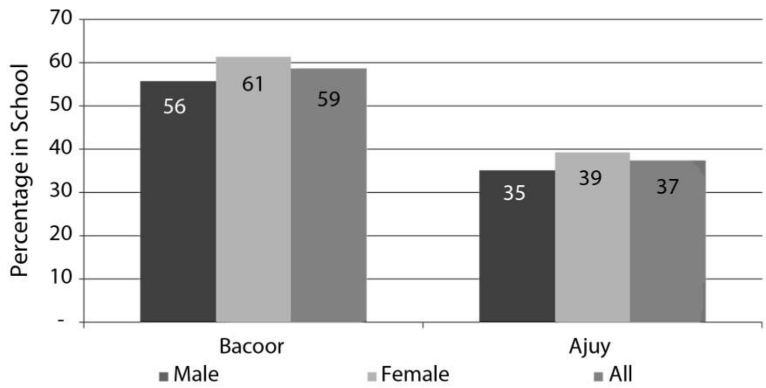


**Figure 5.** Percentage of individuals aged below 15 years old who are in school, by gender

From the several broad indicators of vulnerability and adaptive capacity, we conclude that majority of the households in Ajuy were not as well-equipped to face an extreme typhoon, such as Yolanda, while most of the households in Bacoor had at least the financial capacity to adapt to flooding if given adequate warning and information. Moreover, we found that women had lower earnings than men, but were not disadvantaged in terms of access to education and educational attainment.

## 3.2 Typhoon Yolanda: Ajuy, Iloilo Case Study

### 3.2.1 Adaptation actions and preparations

Having knowledge about disaster preparedness increases the capacity of households to make decisions and increases their propensity to undertake adaptation action. In Ajuy, local government and civil society groups are proactive in providing the necessary support to households in terms of DRRM even prior to typhoon Yolanda. One intervention that they undertook was DRRM training for households.
About 50 households (14% of respondent households) from our study site indicated that they have had at least one household member who had undergone DRRM training prior to typhoon Yolanda. In all the barangays included in the study site, there was at least one household that had received DRRM training. The participants in DRRM training were primarily the decision makers or heads of the household. There were both female and male participants.

Early warning and information was also not lacking. About 99% of the respondents indicated that they had received warning and information about the typhoon prior to its landfall. Some households had even received information from multiple sources. The majority of households received information from the media, particularly radio (69%) and television (66%). Local government also played an important part in information dissemination, with about half (51%) of respondents indicating that barangay officials were their source of information, while 13% were given information by their municipal local government. Some respondents indicated that they had received information from personal contacts such as neighbors (36%) and relatives (28%).

In terms of the type of information received, 88% of respondents indicated that they had been given information regarding the path of the typhoon, 92% about the strength of the typhoon, and 89% about the expected day of landfall. About 43% of respondents received information about the possibility of storm surge and 25% received warning about the possible height of the storm surge.

Even though almost every respondent household received information and warnings about Yolanda, only 69% prepared prior to the arrival of the typhoon. The preparations that households undertook were generally geared toward protecting property, securing equipment essential to their livelihoods, and stocking up on food and water. Since most of the houses in the study site were built with light materials, half of the respondents indicated that they had secured and tied their roofs (52%), while some (16%) had strengthened the walls of their home. Securing and raising their belongings is a low-cost and effective strategy, but only 32% of respondents undertook this activity.

Out of the 37% of households involved in fisheries, 14% indicated that they had secured their boats during the typhoon. There were also households that secured equipment and tools that they use in their livelihoods (12%), as well as those that secured their animals and livestock (6%). A few (3%) prepared sandbags to protect their home. Less than half of the household respondents stocked food (41%) and stored drinking water (37%) (Figure 6).

Many households (69%) indicated that they had evacuated because of the typhoon. Evacuation can be seen as a hazard avoidance adaptation strategy in which households temporarily retreat to a safer location. In extreme weather events, such as typhoons, early evacuation is key to ensure the safety of the people in the community. However, the majority of those who evacuated (49%) did so in an emergency manner (i.e., during the onset of the typhoon), while only 16% were preemptive (i.e., prior to the onset of the typhoon) (Figure 7).

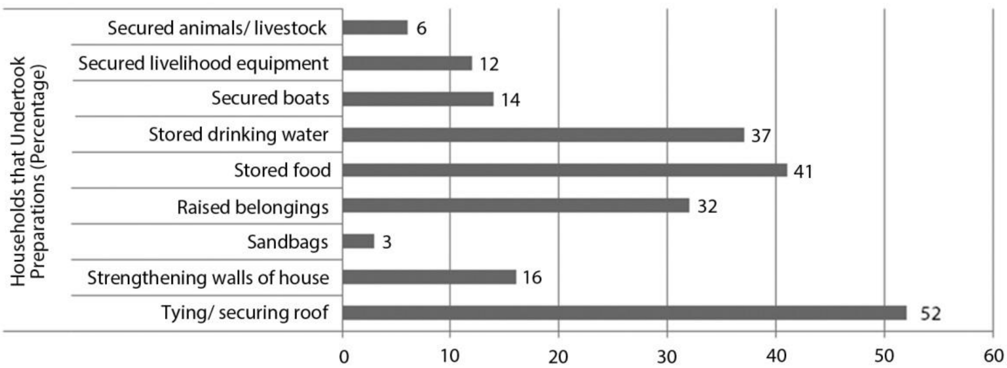


**Figure 6.** Preparations undertaken prior to typhoon Yolanda

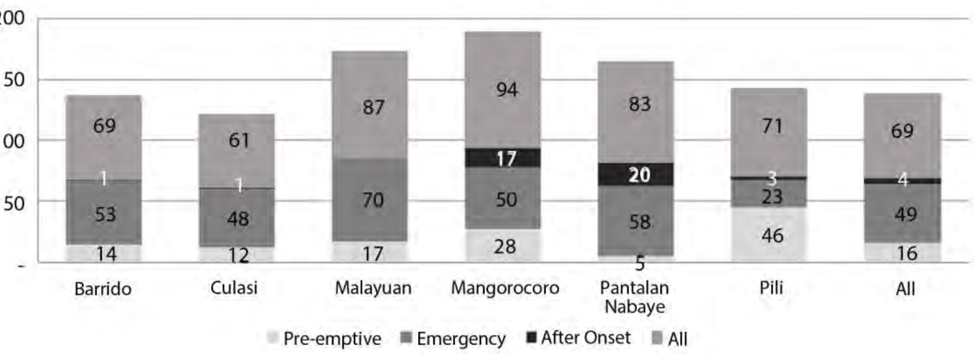


**Figure 7.** Percentage of households that evacuated during typhoon Yolanda

It is important for local government to think of ways to encourage preemptive evacuation, especially in the case of extreme typhoons. If the storm surge in Ajuy had been worse than it was, there might have been fatalities in the area because many households did not evacuate early. In most instances, people are reluctant to evacuate because they do not want to leave their belongings unguarded for fear of being robbed. They are also discouraged from evacuating if they deem the evacuation centers to be inadequate and uncomfortable. This was the case in Ajuy, where the most common complaints cited by household respondents who evacuated were overcrowding and discomfort. The places that served as evacuation centers during typhoon Yolanda included public schools, barangay halls, churches, and the homes of neighbors. One adaptation strategy could be to provide comfortable living arrangements for evacuees. In addition, the local government should be ready to implement mandatory evacuation should the situation demands it. Evacuation centers should also be assessed as to whether they are located in a safe area away from the reach of the storm surge.

Households that did not undertake any preparations were asked for their reasons for not doing so (Figure 8). About half of these households indicated that their main reason was because they had underestimated the severity of the typhoon. Although they had prior knowledge of the typhoon, they thought it was unnecessary to undertake any action. This finding suggests that the mode of evaluating and conveying information is important. There should also be a focus on the quality of information, not merely making information available. Because people may anchor their expectations to their past experiences, it is important that information and warnings are communicated in a manner that will help them process the information much better so that they make appropriate decisions. For instance, it might be useful to convey not only the strength or category of the typhoon but also the potential impacts that it might bring, as well as the appropriate action that households may undertake to minimize the impacts.

Still, there were few households (8%) that did not undertake extreme weather event preparation or adaptation because of a lack of information. In an extreme type of typhoon such as Yolanda, it is important that information and warnings are disseminated to every single household within a local government's jurisdiction. There are some households that may have no access to a television or radio, and some may be located in isolated areas. One strategy that can be employed is to post warnings or announcements in conspicuous areas where people usually congregate, such as the marketplace. Schools can also be tapped as a channel for communicating warnings. Information can be directed through teachers, and students can relay the information to their parents and their household.

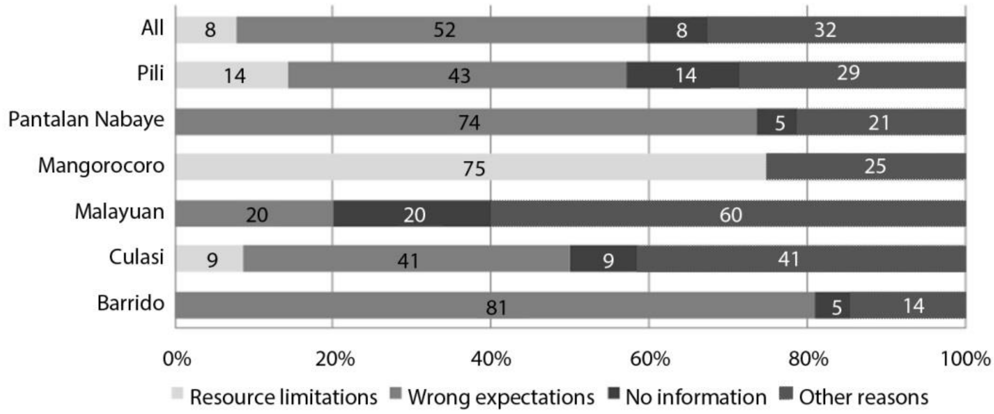


**Figure 8.** Reasons for not undertaking preparations during typhoon Yolanda

To have a more definitive evaluation of the factors that affect preparation or adaptation decisions, we also present the results of the regression analysis. The regression model used multivariate probit, in which the dependent variables included (1) whether the household undertook preparations to protect property, (2) preparations to protect livelihood, or (3) storing emergency food and water (Table 6).

**Table 6.** Results of the multivariate regression analysis on the determinants of adaptation in Ajuy during typhoon Yolanda

| Parameter | Coef. | P > \|z\| |
|---|---|---|
| Protection of Property | | |
| INFOLGU | 0.44*** | 0.00 |
| INFOMEDIA | 0.28 | 0.19 |
| COMMPREP | 0.58*** | 0.00 |
| LNINC | 0.11 | 0.17 |
| TRNGBEFOREYOL | 0.50** | 0.03 |
| HOUSETYPE | –0.29* | 0.06 |
| HHSIZE | 0.02 | 0.49 |
| LNDISTANCE | 0.04 | 0.75 |
| CONSTANT | –1.51* | 0.09 |
| Protection of Assets Used in Livelihood | | |
| INFOLGU | 0.37** | 0.02 |
| INFOMEDIA | 0.48* | 0.06 |
| COMMPREP | 0.33** | 0.03 |
| LNINC | 0.10 | 0.26 |
| TRNGBEFOREYOL | 0.41** | 0.04 |
| HOUSETYPE | –0.25 | 0.12 |
| HHSIZE | –0.01 | 0.78 |
| LNDISTANCE | –0.15 | 0.28 |
| CONSTANT | –1.43 | 0.13 |
| Storing of Emergency Food and Water | | |
| INFOLGU | 0.49*** | 0.00 |
| INFOMEDIA | 0.21 | 0.34 |
| COMMPREP | 0.66*** | 0.00 |
| LNINC | 0.15* | 0.07 |
| TRNGBEFOREYOL | 0.53** | 0.01 |
| HOUSETYPE | –0.13 | 0.38 |
| Storing of Emergency Food and Water | | |
| HHSIZE | 0.03 | 0.34 |
| LNDISTANCE | 0.24* | 0.07 |
| CONSTANT | –3.47*** | 0.00 |
| Multivariate probit (MSL, # draws = 300) | | |
| Wald $chi^2$ = 68.38 | | |
| Log likelihood = –506.44 | | |
| Prob > $chi^2$ = 0.00 | | |

Note: * significant at 10%, ** significant at 5%, *** significant at 1%

The following are the explanatory variables:

1. INFOLGU, which is a dummy variable indicating whether the household received information or warning from barangay or municipal local government;
2. INFOMEDIA, which is a dummy variable for if the household received information or warning from TV, radio, or the newspaper;
3. COMMPREP, which is a dummy variable for if there were community-level preparations in the location of the household;
4. LNINC, which is the natural log of household monthly income;
5. TRNGBEFOREYOL, which is a dummy variable for if the household received DRRM training prior the typhoon;
6. HOUSETYPE, which is a dummy variable indicating whether the dwelling unit of the household is predominantly permanent;
7. HHSIZE, which is the household size; and
8. LNDISTANCE, which is the natural log of the distance to the nearest coastline.

Table 6 also shows the results of the regression analysis. The model was found to be significant and the likelihood ratio test confirms the validity of using multivariate probit.

The main insights from the regression analysis are as follows:

1. *Information and warning from local government matters.* Results suggest that receiving information from local government increases the probability that the household will undertake all categories of adaptation, including protection of property, livelihood protection, and preparation of emergency food and water. This signals the trust that households have in the reliability of information coming from this institution. This also implies that local government plays an important role in encouraging autonomous adaptation activities by means of providing information.
2. *Community adaptation complements autonomous household adaptation.* If the community the household belongs to undertakes community adaptation activities, then the likelihood of autonomous adaptation at the household level also increases. This signals the potential of community mobilization as a means of encouraging autonomous household adaptation.
3. *Household DRRM training builds a household's capacity to adapt.* Attendance in DRRM training positively influences the decision of households to undertake preparations. This strengthens the rationale for widespread information dissemination and training for household members.
4. *Financial resources matter.* Although the coefficient of income was positive for all types of adaptation actions, it was significant only for the preparation of emergency food and water. This suggests a need for assistance from local government in providing these goods during and in the aftermath of a typhoon, as the majority of the households under discussion are low income households.
5. Furthermore, as expected, the structure of the house being predominantly made of permanent materials reduces the likelihood of having to conduct activities to protect the house and its belongings.

### 3.2.2 Impacts of typhoon Yolanda

Households in Ajuy faced multiple hazards during typhoon Yolanda, which included strong winds, heavy rainfall, and storm surges. Based on our household survey, as verified in the interviews we conducted with local government officials, the storm surge at the study site reached a maximum height of about 1.5 m. The northern part of the coastline experienced a higher storm surge height than the south. Fortunately, the storm surge took place during low tide, which reduced its potential impacts on the coast. Apart from storm surges, inland floods were also observed by households.

About one-third of the houses included in our survey had been inundated during the typhoon, with water depth averaging about 1 m. A majority (70%) of the households, however, experienced minor flooding of less than 0.3 m, while 13% experienced inundation of 0.3–1 m, and 17% experienced water levels of more than 1 m. Although floodwater was a contributory factor to the property damage sustained by households, strong winds were identified to have been the primary cause of the devastation. According to the reports of the Philippine Atmospheric, Geophysical and Astronomical Services Administration (the country's weather bureau), typhoon Yolanda reached a maximum wind speed of 234 kph.

Based on our survey, there had been widespread devastation in Ajuy. Almost every house (94% of respondents) included in the survey had been damaged because of the typhoon. The fishing households were the most hard-hit since almost everyone lost their boats (29%). Because floodwater inundated some houses, some households reported that they had lost their personal belongings such as furniture, appliances, and clothing (35%). A few households reported losing equipment and tools used in their livelihoods (6%), and about 29% reported a loss of income due to the super typhoon (Figure 9).

At the height of the typhoon and during the evacuation, some households reported sustaining health impacts. Injuries garnered the highest incidence among households, affecting 14%. Diarrhea and skin infections affected about 2% of the respondent households, and two cases of dengue fever were reported in Barangay Culasi (Figure 10).

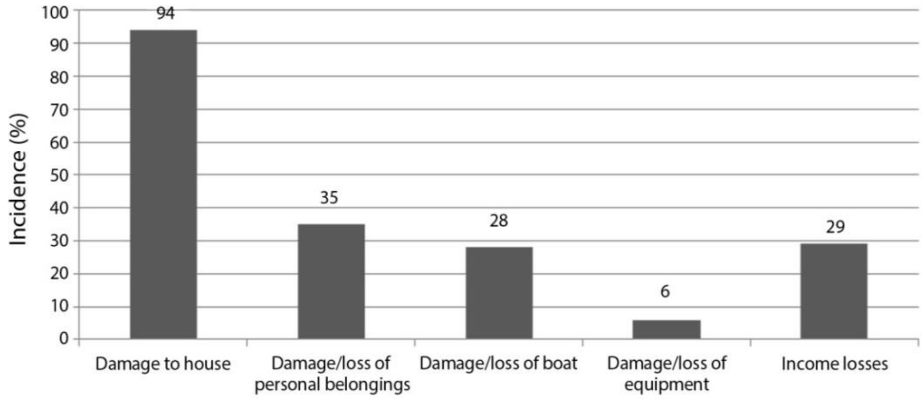


**Figure 9.** Property damage and income loss among respondent households during typhoon Yolanda

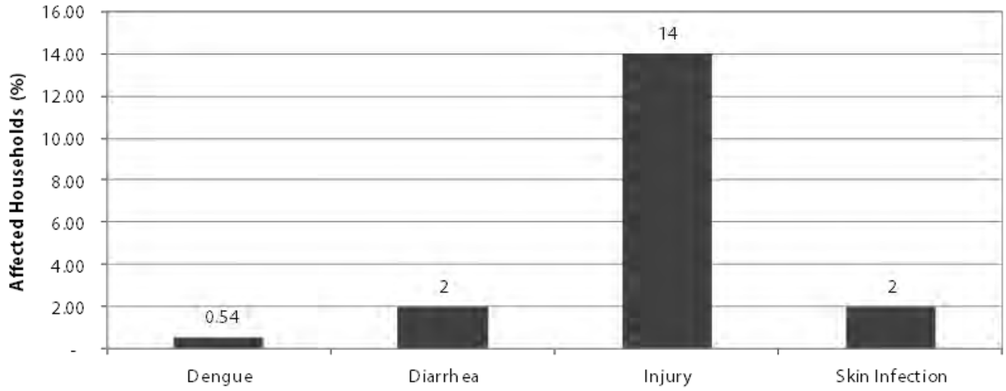


**Figure 10.** Illness and injuries among households due to typhoon Yolanda

The incidence of injuries among males was significantly higher than among females. This health impact also had higher incidence among the 15–64 age group and >65 age group (Tables 7 and 8). This may be due to the roles that men and the adults assume during preparations for a typhoon that requires physical strength (e.g., securing livestock/animals and securing boats), which traditionally falls to male members of households. Men are also usually left behind to guard the home while their families are sent to evacuation centers.

**Table 7.** Percentage distribution and incidence of illness and injuries due to typhoon Yolanda, by gender

| Illness | No. of Affected Individuals | | | Percentage | | Incidence (%) | | |
|---|---|---|---|---|---|---|---|---|
| | Male | Female | Total | Male | Female | Male (n = 867) | Female (n = 969) | Total (n = 1,836) |
| Dengue | 0 | 2 | 2 | – | 100 | – | 0.2 | 0.1 |
| Diarrhea | 10 | 3 | 13 | 77 | 23 | 1.2 | 0.3 | 0.7 |
| Injury | 44 | 18 | 62 | 71 | 29 | 5.1 | 1.9 | 3.4 |
| Skin infection | 5 | 8 | 13 | 38 | 62 | 0.6 | 0.8 | 0.7 |

**Table 8.** Percentage distribution and incidence of illness and injuries due to typhoon Yolanda, based on age

| | No. of Affected Individuals | | | | Percentage Share | | | Incidence (%) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Illness | <15 | 15–64 | >64 | All | <15 | 15–64 | >64 | <15 | 15–64 | >64 | All |
| Dengue | 1 | 1 | | 2 | 50 | 50 | – | 0.2 | 0.1 | – | 0.1 |
| Diarrhea | 6 | 6 | 1 | 13 | 46 | 46 | 8 | 0.9 | 0.6 | 0.9 | 0.7 |
| Injury | 7 | 50 | 5 | 62 | 11 | 81 | 8 | 1.1 | 4.6 | 4.3 | 3.4 |
| Skin infection | 8 | 4 | 1 | 13 | 62 | 31 | 8 | 1.3 | 0.4 | 0.9 | 0.7 |

Another impact of weather hazards that are seldom documented are impacts on education. In the Philippines, kindergarten classes are suspended when Typhoon Signal No. 1 is raised, no classes take place in elementary and high schools during Signal No. 2, and no classes are held at any level when a typhoon is categorized as Signal No. 3. Thus, classes were suspended during typhoon Yolanda. From our survey, we found that about 87% of students had missed school during and in the aftermath of Yolanda. The incidence was only slightly higher for females (89%) than for males (86%) (Figure 11).

As an indicator of impacts on education, the average number of missed school days (including suspended class days) was also collected. On average, students in Ajuy missed a total of 18 school days because of Yolanda. There was no significant difference in the mean number of missed school days between males and females based on the results of the t-test having a p-value of greater than 0.10. There were two main reasons for the prolonged suspension of classes in the study site: some schools were damaged by the typhoon, and some schools were used as evacuation centers.

The fact that schools are being used as evacuation centers are not peculiar only to Ajuy. Public schools all over the country serve as evacuation centers during typhoons; this often results in the displacement of students and the prolonged suspension of classes. The impact of class suspensions may be comparable to school absenteeism if no classes are held to help students catch up on missed lessons. Studies have already established that school absenteeism has a negative impact on students' learning and academic performance both in the short- and long-term (Gottfried 2011). This is alarming because the Philippines already lags behind the world average in terms of science and math standardized test scores, based on the results of the 2003 Trends in International Math and Science Study (IES n.d.). If there is no conscious effort to change these circumstances, then the academic performance of Filipino students may continue to deteriorate in the event of more frequent and severe weather.

The above findings have several policy implications. First, climate-proofing and retrofitting of school infrastructure should be undertaken so that schools can better withstand strong winds and rains. School buildings should not be built in hazard-prone areas such as near the coast. If existing buildings are already exposed to hazards, a benefit-cost analysis should be undertaken to determine whether it is economically viable to relocate the building to a safer place. In addition, the government should look into alternative evacuation facilities, especially for those municipalities or areas that are highly exposed and vulnerable to typhoons and flooding so that students will not be displaced during extended periods of evacuation.

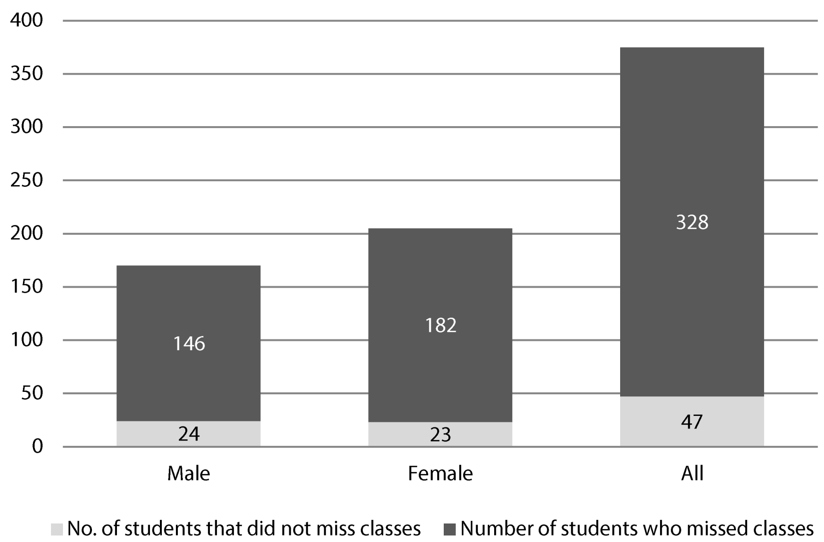


**Figure 11.** School days missed among male and female students due to typhoon Yolanda

In terms of work days lost, we found that 32% of all working individuals covered in the study had been forced to miss work because of typhoon Yolanda. The incidence of missing work was significantly higher for males (37%) than for females (23%) (Figure 12).

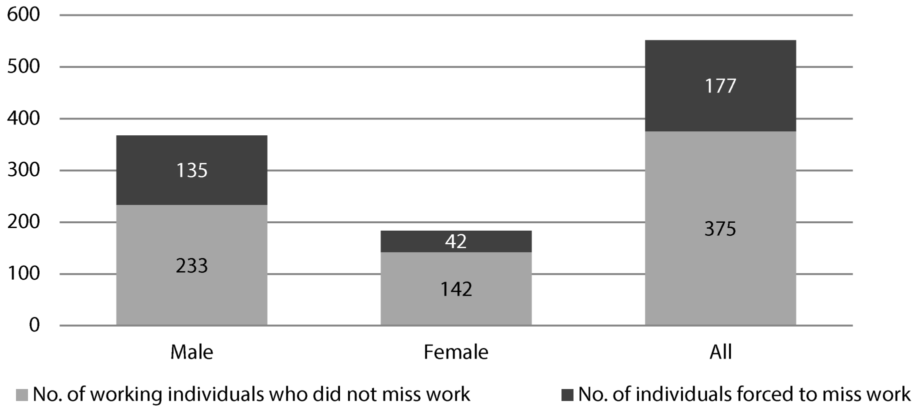


**Figure 12.** Work missed as a result of typhoon Yolanda, males and females

There are two probable reasons for this. First, since men were the members of the household engaged in fishing and the majority of households lost their boats, the women employed outside the fishery sector needed to assume the role of main breadwinner. Second, it was the men who cleaned up and repaired the houses damaged by Yolanda, and they had to miss work to do so. We estimated that the average number of work days lost was about 30, and there was no significant difference in the mean number of work days lost between males and females based also on the t-test.

To provide an indicative measure of the welfare losses experienced by households adversely affected by typhoon Yolanda, the valuation of impacts was undertaken. On aggregate, the lower bound average damage cost per household resulting from typhoon Yolanda was estimated to be PHP 18,532 (USD 421) or about three times the mean household income. The upper-bound estimate, on the other hand, was as high as PHP 40,642 (USD 923) or about six times the value of household income. The lower-bound estimate considered only the actual expenditure incurred in replacing or repairing damaged property, while the upper-bound estimate also included the value of damaged property not yet repaired or replaced. A large proportion of the damage cost c from property losses, followed by income losses, adaptation costs and, finally, by health expenditures (Table 9).

This suggests that, on the average, a household has to have about three to six months' salary worth saved to be able to cope with an extreme typhoon. During natural disasters household savings can help smooth out potential disruptions in consumption and can fund repairs and the replacement of damaged property and livelihood equipment.

However, in Ajuy only about 39% of the households held savings prior to the onset of the typhoon. A majority (22%) held meager savings of PHP 1,000 or less, equivalent to only about 14% of their average monthly income. Some 14% held savings amounting to PHP 1,000–PHP 10,000, while only about 4% held savings greater than PHP 10,000. This means that the majority of affected households in Ajuy would have needed to rely on external support in order to get back to their pre-typhoon welfare levels.

**Table 9.** Average value (in PHP) of impacts of typhoon Yolanda

| Barangay | Average Cost of Impacts per Household (PHP) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Health Expenditures [A] | Income Losses [B] | Adaptation Costs [C] | Property losses Based on Expenditure on Repairs [D] | Property Losses Based on Expenditure on Repairs + Estimated Replacement Cost [E] | Total Damage Cost (Lower Bound) [A + B + C + D] | Total Damage Cost (Upper Bound) [A + B + C + E] |
| Barrido | 33 | 1,259 | 1,540 | 7,580 | 28,664 | 10,411 | 31,495 |
| Culasi | 192 | 5,830 | 533 | 12,734 | 32,791 | 19,288 | 39,346 |
| Malayuan | 58 | 5,087 | 308 | 15,431 | 26,131 | 20,884 | 31,584 |
| Mangorocoro | 472 | 436 | 239 | 4,406 | 31,750 | 5,553 | 32,897 |
| Pantalan Nabaye | 118 | 2,528 | 995 | 26,866 | 66,316 | 30,507 | 69,957 |
| Pili | 297 | 6,234 | 755 | 14,639 | 36,454 | 21,926 | 43,740 |
| All | 166 | 4,324 | 762 | 13,281 | 35,391 | 18,532 | 40,642 |

Note: Exchange rate: 1 USD: 44 PHP

### 3.2.3 Establishing the benefits of protection given by mangroves

There have been anecdotal reports in Iloilo in which some areas were spared from the devastating and deadly impacts of typhoon Yolanda due to the presence of mangroves. Mangrove forests provide shoreline protection benefits by slowing the flow of water and reducing surface waves; they also serve as windbreakers. A study found that storm surge may be reduced by 5–50 centimeters (cm) while surface wind waves can be reduced by 75% per 1 km of mangrove width (McIvor and Spencer 2012). Hence, the mangrove width needs to be large enough to substantially reduce the water flow and waves.

At the study site, mangroves were found in patches along the shoreline. Some houses had mangrove cover and some houses were directly exposed to the sea. In this study, the protection benefit of mangroves was measured at the micro household level. The presence of mangroves was hypothesized to shield houses from devastating winds, thereby lowering the damage to the property.

In order to test this hypothesis, we conducted a regression analysis in which two models were run using dataset from households within 30 m from the shoreline. In the first model, the dependent variable was the cost of repairing the home and replacing damaged belongings; while that in the second model was the total estimated value of damage to the home and belongings (including repairs not yet made and items not yet replaced). The explanatory variables were household size (HHSIZE), household income (HHINCOME), size of house (HOUSESIZE), dummy variable for if the house was predominantly built with permanent materials (DHOUSETYPE), distance to the coastline (DISTCOAST), expenditure on adaptation activities (ADAPEXP), value of assets held by the household (ASSETVALUE), and a dummy variable for if the coastline where the house is located has mangrove cover (DMNGRVE). For DMNGRVE, the interviewees' response was used, which had been validated using maps from Google Earth. We could not rely on actual field observation because some mangroves may have been destroyed by the typhoon.

The Breusch-Pagan and Cook-Weisberg test detected the presence of heteroskedasticity in both OLS Models 1 and 2. To address the problem of heteroskedasticity, WLS were used. Using the Park Test, asset value was found to be closely associated with the variance of the disturbance term. In WLS, it is hypothesized that the absolute value of the disturbance term is proportional to the square of asset value. Table 10 shows that OLS Model 2, WLS Model 1, and WLS Model 2 are statistically significant, while OLS Model 1 is not significant. Referring to the results of the WLS regression, there was evidence to suggest that mangroves had reduced the damage experienced by households during typhoon Yolanda, as can be seen in the negative sign of the coefficient. This estimate was found to be statistically significant at the 1% level. Specifically, the presence of mangrove cover was found to reduce the mean value of damages by as much as PHP 7,360 or USD 167 (Model 1) or PHP 7,461 or USD 170 (Model 2).

However, note that this result might only be true for the study site, and thus cannot be generalized for all areas affected by typhoon Yolanda. The intensity of the typhoon in Ajuy, Iloilo, was not as strong as in other areas, particularly Leyte, Sorsogon, and even the other municipalities of northern Iloilo that were directly hit by Yolanda. This caveat is emphasized so as not to mislead households to take on the risk of staying in government-mandated coastal buffer zones, even if mangrove cover is present. Nonetheless, this finding strengthens the argument that coastal communities should take an active role in protecting and rehabilitating mangrove forests because they can directly reap benefits from this resource.

In addition, we also found that the higher the expenditure on adaptation actions and the farther the distance to the coastline, the lower the damage cost incurred by the household. This emphasizes the importance of encouraging household preparation and autonomous adaptation as well as the strict enforcement of buffer or no-build zones.

**Table 10.** Results of regression analysis on the determinants of property damage during typhoon Yolanda

| Property Damage | MODEL 1 | | | | MODEL 2 | | | |
|---|---|---|---|---|---|---|---|---|
| | OLS | | WLS | | OLS | | WLS | |
| | Coef. | Std. Err. | Coef. | Std. Err. | Coef. | Std. Err. | Coef. | Std. Err. |
| HHINCOME | 0.33 | 0.31 | 0.38** | 0.15 | −0.61 | 0.65 | 1.27*** | 0.15 |
| HHSIZE | −1,100.00 | 1,024.00 | −1,331.00*** | 87.00 | 3,576.00 | 2,103.00 | −1,584.00*** | 87.00 |
| DMANGROVE | −3,038.00 | 5,073.00 | −7,360.00*** | 512.00 | 5,342.00 | 10,418.00 | −7,461.00*** | 512.00 |
| ASSETVALUE | 0.00** | 0.01 | −0.29*** | 0.08 | 0.17 | 0.01 | −0.26 | 0.08 |
| HOUSESIZE | −4.00 | 13.00 | 30.00*** | 5.00 | 35.00 | 26.00 | 24.00** | 5.00 |
| DHOUSETYPE | 8,059.00 | 5,003.00 | −158.00 | 1,267.00 | −13,290.00 | 10,274.00 | −1,563.00 | 1,267.00 |
| DISTCOAST | 170.00 | 153.00 | −122.00*** | 19.00 | 308.00 | 314.00 | −412.00*** | 19.00 |
| ADAPEXP | 2.00 | 3.00 | −5.00*** | 2.00 | −5.00 | 6.00 | −5.00 | 2.00 |
| CONSTANT | −332.00 | 13,384.00*** | 23,866.00 | 1,270.00 | −35,834.00 | 27,484.00 | 52,143.00 | 1,270.00 |
| Prob > F | 0.54 | | 0.00 | | 0.00 | | 0.00 | |
| Adjusted $R^2$ | −0.01 | | 0.97 | | 0.76 | | 0.87 | |

Note: ** and *** are significant at the 5% and 1% levels, respectively.

### 3.2.4 Difference in the preferences and in the roles of men and women

In the survey, the interviewees were asked some attitudinal questions in order to gauge the differences between male and female respondents in perceptions and preferences. Specifically, the respondents were asked to identify the top three interventions that they would like the government to undertake in order to address future similar hazards (i.e., in the event of super typhoons and flooding). The responses were coded, tabulated, and ranked based on the percentage of respondents that had indicated such interventions.

The majority (77%) of the respondents interviewed in Ajuy were female household heads. Their overall average age was 47, while the mean ages for male and female respondents were 46 and 47, respectively. The overall average individual income was about PHP 2,624 per month, with male respondents having a significantly higher mean individual income (PHP 4,671 per month) than the female respondents (PHP 2,054 per month).

In terms of education, about 37% of Ajuy respondents indicated that their highest attainment was a high school diploma, while 34% had an elementary diploma (34%). About 16% were college graduates, while 13% had no education at all or had a little elementary schooling. Of the respondents interviewed in Ajuy, 32% were not employed. About 20% of respondents were employed as laborers/workers, 15% were farmers/fishermen, 14% were homemakers (or stay-at-home), and 13% were professionals, government officials, or self-employed individuals.

The ranking of preferred interventions to prepare for future typhoons was similar for males and females. The most preferred intervention was information and an early warning system, followed by financial/material assistance. The third intervention choice was support in the event of evacuation (Table 11).

**Table 11.** Ranking of interventions in terms of preference by respondents, Ajuy, Iloilo

| Type of Intervention | Points | | | Percentage | | | Rank | | |
|---|---|---|---|---|---|---|---|---|---|
| | Male | Female | All | Male | Female | All | Male | Female | All |
| Information and early warning | 49 | 144 | 193 | 68 | 63 | 65 | 1 | 1 | 1 |
| Financial/material assistance | 32 | 104 | 136 | 44 | 46 | 45 | 2 | 2 | 2 |
| Evacuation | 14 | 38 | 52 | 19 | 17 | 17 | 3 | 3 | 3 |
| DRRM seminars | 4 | 26 | 30 | 6 | 11 | 10 | 6 | 4 | 4 |
| Mangrove/tree planting | 7 | 17 | 24 | 10 | 7 | 8 | 4 | 5, 6 | 5 |
| Infrastructure | 5 | 15 | 20 | 7 | 7 | 7 | 5 | 5, 6 | 6 |
| Building of safe houses | 2 | 14 | 16 | 3 | 6 | 5 | 7, 8 | 7 | 7,8 |
| Livelihood program | 2 | 12 | 14 | 3 | 5 | 5 | 7, 8 | 8 | 7,8 |
| Rescue system | 1 | 10 | 11 | 1 | 4 | 4 | 9, 10 | 9 | 9 |
| Relocation site | 1 | 7 | 8 | 1 | 3 | 3 | 9, 10 | 10 | 10 |

The trend in the participation in different preparatory activities for typhoon Yolanda was also analyzed to determine whether males and females have specialized roles in adaptation. Figure 13 presents the different adaptation activities based on whether they are male-dominated, female-dominated, or gender-neutral activities. The medium-gray-shaded areas represent households where only female members participated in the adaptation activity, the light-gray-shaded areas show households where only male members participated in the preparations, and the dark-gray-shaded areas show households whose both male and female members participated in the activity.

In Ajuy, men and women seemed to play equally important roles in adaptation activities, although the types of activities that they normally engaged in were different. Activities that need physical strength were dominated by males (light-gray-shaded areas are particularly large). This includes tying and securing the roof, strengthening the walls of the house, securing boats, securing equipment used in livelihood, and securing livestock. Adaptation activities that are domestic in nature, such as storing food and water, were dominated by females (medium-gray-shaded areas are particularly large). On the other hand, the activity predominantly shared by both male and female members of the household (dark-gray-shaded area), is securing belongings.

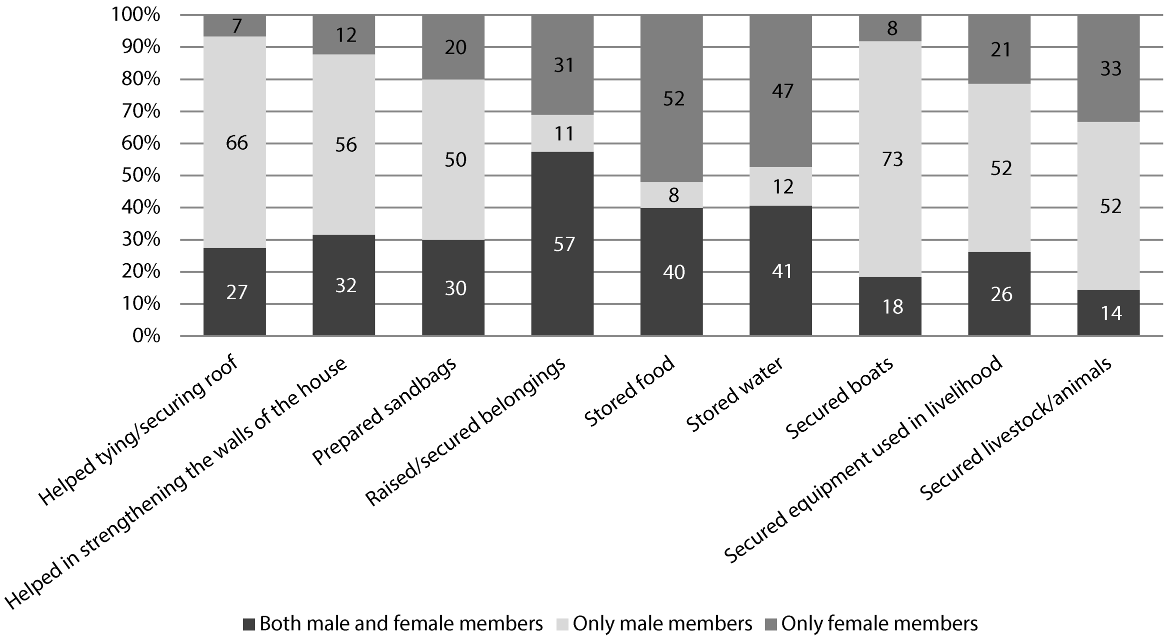


**Figure 13.** Men's and women's involvement in preparations for typhoon Yolanda

## 3.3 Habagat 2013: Bacoor, Cavite Case Study

### 3.3.1 Adaptation actions and preparations

Information dissemination and issuing warnings is the most basic and crucial requirement for an effective disaster risk reduction. Based on our survey, 76% of the household respondents received an early warning or information regarding the occurrence of the heavy monsoon rain. A total of 59% received information through television, while 6% heard the news from the radio. Only about 13% of the respondents received warnings from barangay officials and less than 2% reported receiving information from personal contacts. In Bacoor, which is an urban setting, there seems to be less information exchange and interaction between neighbors, unlike in the rural community of Ajuy. This suggests the need to explore other modes of delivering information in urban areas, such as through social media and the internet.

In terms of the type of information received, 43% of respondents were warned about which areas would be flooded and 21% were actually given an advisory to evacuate their homes. About 16% of the households received further information on where to evacuate. However, despite being given a warning to evacuate, only 1% of the respondents did preemptive evacuation. The remaining 19% of respondents evacuated only when the floodwater had started to rise (Figure 14). Those households that undertook preemptive evacuation were the ones that were located in areas that are often flooded. These households are already used to flooding so evacuation is their routine response at the onset of heavy rain. This finding again indicates that individuals often anchor their expectations to their past experiences. There is rigidity in these expectations and most people take a "wait-and-see" approach. The problem with this approach is that climate change is expected to bring about "unusual" types of weather. If people make their current decisions based only on previous experience, then people would be most likely make sub-optimal decisions.
The challenge for the government is to find ways to improve the quality of information as well as the delivery of warnings.

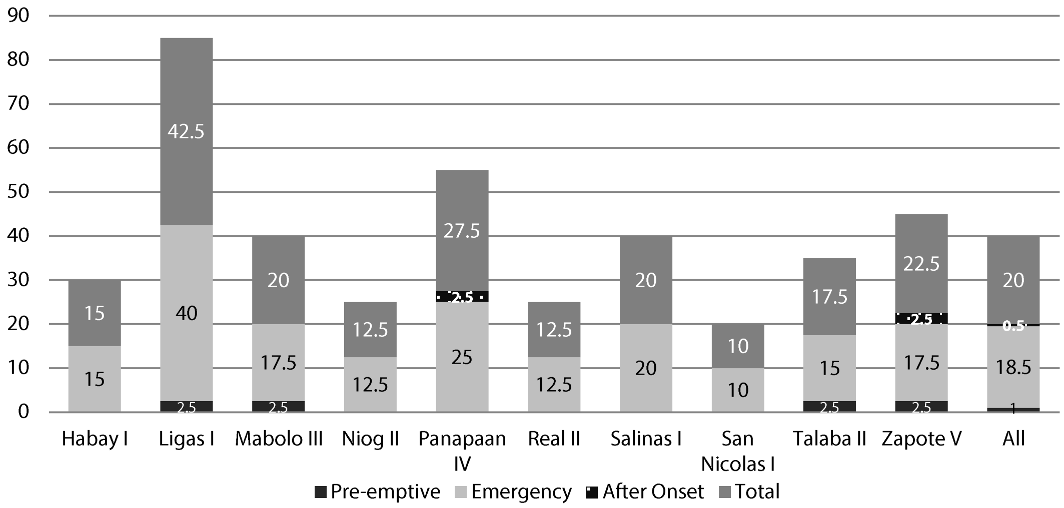


**Figure 14.** Percentage of households that evacuated during Habagat

Although 76% of the respondents had received information about Habagat, only about 57% prepared for the event. A total of 69% of respondents resorted to low expenditure preparations, such securing belongings. Less than 3% of respondents did structural improvements to their homes, such as strengthening walls or building a second floor. About 4% of respondents secured equipment used in their livelihoods, 4% secured their vehicles, and less than 1% secured their animals and livestock. Only 48% of the respondents stored food, while 39% stored drinking water in case of prolonged flooding (Figure 15).

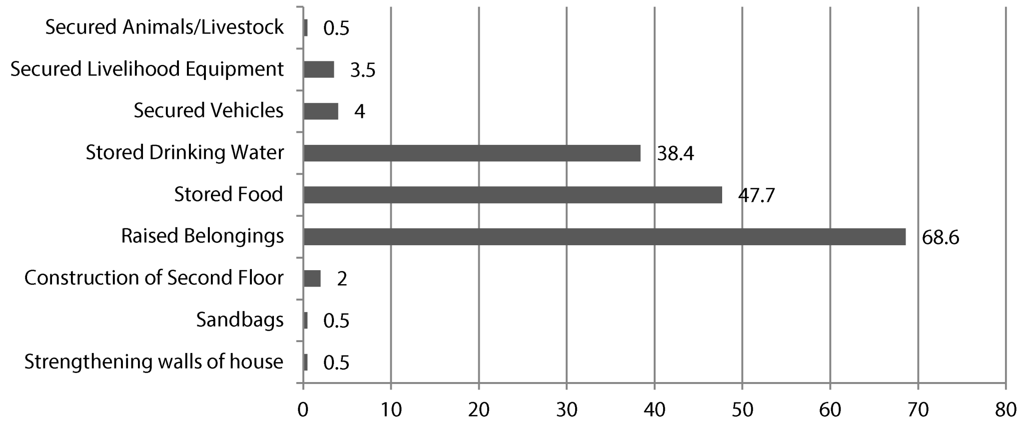


**Figure 15.** Type of preparations undertaken prior to Habagat and the percentage of households who undertook these preparations

For those respondents who did not undertake any preparations, 58% indicated that their main reason had been their inaccurate expectations regarding the severity of the flood. Meanwhile, a significant number of household respondents (20%) indicated that they did not need to prepare because they were already well-adapted to the hazard. Lastly, about 8% of households cited limited resources (monetary or manpower) as the main hindrance to undertaking any preparations (Figure 16).

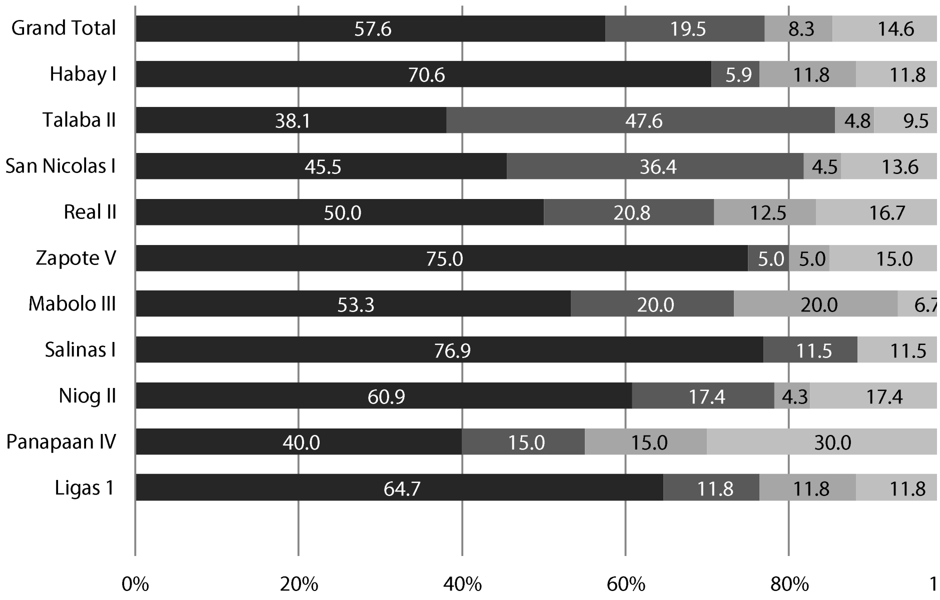


**Figure 16.** Reasons for not undertaking preparations during Habagat

We conducted a regression analysis to analyze the factors that affect the decision of households to undertake adaptation actions in Bacoor. In this case study, we used probit regression in which the dependent variable took the value of 1 if the household undertook any adaptation action, such as raising up or securing belongings, preemptive evacuation, or strengthening the structure of the house; it took on the value of 0 otherwise. The explanatory variables included

1. TRNGBFRHAB, which is a dummy variable for if any of the household members has undergone DRRM training;
2. INFO, which is a dummy variable for if the household received information or warning prior to the onset of Habagat;
3. INCPERCAP, which is the household income divided by the household size;
4. HOUSETYPE, which is a dummy variable for if the dwelling units are built primarily of permanent materials;
5. COMMUNITYPREP, which is a dummy for the presence of community-level adaptation;
6. LNDIST, which is the natural log of distance to the nearest body of water;
7. FLOODSELDOM, which is a dummy variable for if the household is seldom flooded (i.e., one flood over the last three years);
8. FLOODOFTEN, which is a dummy variable for if the household is often flooded (i.e., between three and five floods over the last three years); and
9. FLOODVERYOFTEN, a dummy variable for if the household is flooded very often (i.e., at least six floods over the last three years).

Table 12 shows that the decision to undertake adaptation is affected by different factors, which include information, presence of community adaptation, level of income, distance from a body of water, and household experience of flooding in the last three years. The following insights can be gleaned from the regression results:

1. *Community adaptation complements autonomous household adaptation.* Similar to Ajuy, the presence of community-level preparations also increased the likelihood of autonomous household adaptation.
2. *Households learn from experience.* The more exposed a household is to flooding or the more frequent its experience of flooding is, the higher the probability of undertaking adaptation actions.

**Table 12.** Probit regression results on the determinants of proactive adaptation

| Parameter | Coeff. | P > \|z\| |
|---|---|---|
| TRNGBFRHAB | –0.1103290 | 0.712 |
| INFO | 0.4650320*** | 0.008 |
| INCPERCAP | 0.0000405** | 0.011 |
| HOUSETYPE | 0.2347536 | 0.112 |
| COMMUNITYPREP | 0.4111807** | 0.025 |
| LNDIST | –0.0916599** | 0.010 |
| FLOODSELDOM | 0.4403511** | 0.025 |
| FLOODOFTEN | 0.7386790*** | 0.001 |
| FLOODVERYOFTEN | 0.8987499*** | 0.000 |
| CONSTANT | –0.5534452 | 0.056 |
| Prob > chi$^2$ | = 0.0000 | |
| Pseudo $R^2$ | = 0.1247 | |

Note: ** and *** are significant at the 5% and 1% levels respectively.

Moreover, the presence of information, the higher the per capita income, and the shorter the distance to a body of water, the higher the likelihood that the household will prepare for the climate event. However, there was no evidence to show that participation in DRRM training affects the decision of households to undertake preparations. This is probably because there were only few households in the study site that underwent DRRM training.

### 3.3.2 Impacts of Habagat 2013

In the Bacoor case study, households only faced a single hazard—heavy rainfall, which caused massive flooding across the city. The 2013 event surprised many households because the flooding was more extreme than expected, both in terms of water depth and flood coverage. Our survey showed that 71% of the sampled households reported experiencing floodwater getting inside their home, with water depth averaging about 0.6 m. The average flood height along the roads, which is termed "community flooding," was observed to be higher at about 1 m. This means that the roads were not passable by car and therefore access within and in and out of the city was blocked.

To provide a better picture of the extent of flooding across the different sampled barangays, the distribution of households according to the level of flood inundation inside the house is presented in Figure 17. As can be seen, we were able to get samples from barangays that experienced extreme types of flooding (more than 1.5 m). Overall, this represents 8% of the total household respondents. This type of flood causes not only damage to property but also brings a higher risk to health and lives. In past disasters, such as typhoon Ketsana (local name: Ondoy), drowning was the main cause of death. About 30% of households experienced only moderate flood levels of about 0.8–1 m and the remaining 34% experienced minor flooding of less than 0.8 m.

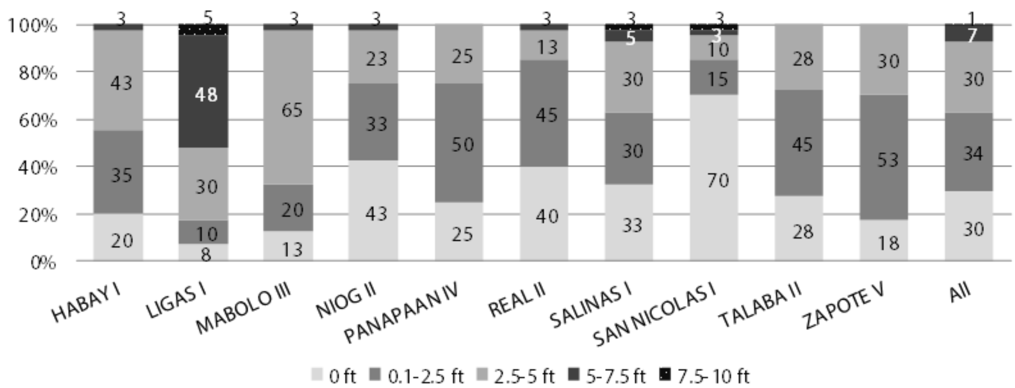


**Figure 17.** Distribution of households based on reported flood height inside the house during Habagat 2013

In Bacoor, the most important and most widespread impact of the extreme weather event was loss of income, which affected 58% of the household respondents. This was mainly because Bacoor residents could not go to work because the roads were impassable. In Ajuy, the majority of the houses in the study site were built with permanent materials and there were no strong winds during Habagat; thus, only 26% of respondents reported damage to the structure of their home. Meanwhile, 27% of respondents reported loss or damage to personal belongings, including clothes, furniture and appliances. About 4% of the respondents lost their boat and 3% lost equipment used in their livelihood (Figure 18). The effect on health was minimal; about 6% of the household respondents reported incidences of skin disease, 4% experienced diarrhea, and there was a single case of leptospirosis (Figure 19). Due to the small incidence of illnesses, we found no clear pattern regarding which demographic groups were more susceptible to health impacts (Tables 13 and 14).

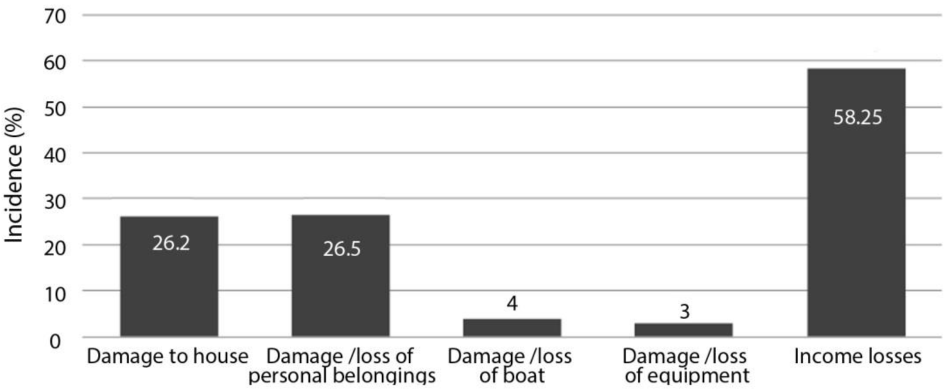


**Figure 18.** Incidence of damage to property and income lost among respondent households during Habagat 2013

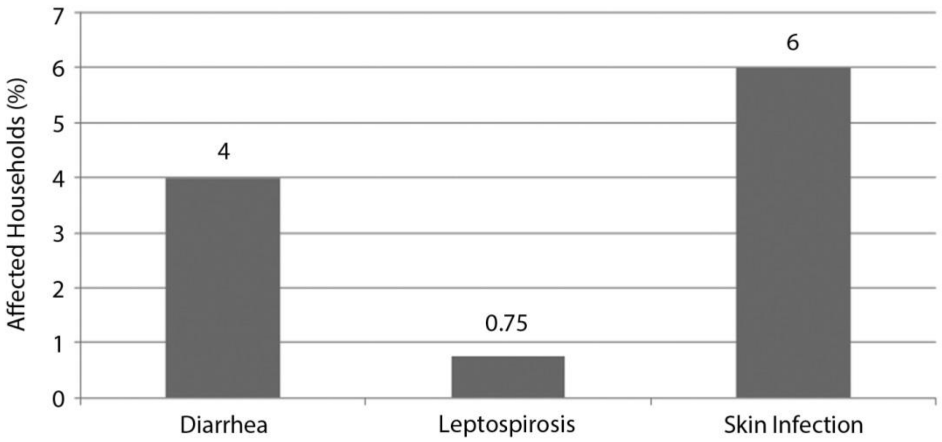


**Figure 19.** Incidence of illness among households due to Habagat 2013

**Table 13.** Percentage distribution and incidence of illness due to Habagat 2013, based on gender

| Illness | Number of Affected Individuals | | | Percentage | | Incidence | | |
|---|---|---|---|---|---|---|---|---|
| | Male | Female | Total | Male | Female | % Male (n = 995) | % Female (n = 1,078) | % Total (n = 2,073) |
| Diarrhea | 7 | 8 | 15 | 47 | 53 | 0.70 | 0.74 | 0.72 |
| Leptospirosis | 1 | 0 | 1 | 100 | 0 | 0.10 | 0.00 | 0.05 |
| Skin infections | 15 | 9 | 24 | 63 | 38 | 1.51 | 0.83 | 1.16 |
| Total no. affected by illness | 104 | 141 | 245 | 42 | 58 | 10.45 | 13.08 | 11.82 |

**Table 14.** Percentage distribution and incidence of illness during Habagat 2013, by age group

| Illness | No. of Affected Individuals | | | | Percentage | | | Incidence | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | <15 | 15–64 | 64> | Total | <15 | 15–64 | 64> | <15 (n = 620) | 15–64 (n = 1,333) | 64> (n = 114) | All (n = 2,067) |
| Diarrhea | 11 | 4 | – | 15 | 73 | 27 | – | 1.8 | 0.3 | – | 0.7 |
| Leptospirosis | – | 1 | – | 1 | – | 100 | – | – | 0.1 | – | 0.0 |
| Skin Disease | 9 | 13 | 1 | 23 | 39 | 57 | 4 | 1.5 | 1.0 | 0.9 | 1.1 |

Because of Habagat, about one in five students missed school (Figure 20). School absence was about the same for males and females. Overall, the average number of missed school days was around four, which is significantly shorter than the experience in Ajuy during typhoon Yolanda. The most important reason students missed class during Habagat was because the roads to school were flooded. The next main reason was because classes were suspended. There were also cases where schools were used as evacuation centers (Figure 21). When the floodwater subsided, most students were able to go back to school, except for those who were studying in schools that served as evacuation centers. This suggests that unless the government does something to control flooding, students will continue to miss classes whenever extreme flooding occurs in the city.

Similar to Ajuy, we found no significant difference between the mean number of missed school days between male and female students. This is an encouraging result since it suggests that there is no bias against women's education during extreme weather events. Insofar as school attendance is concerned, women have the same opportunities as men.

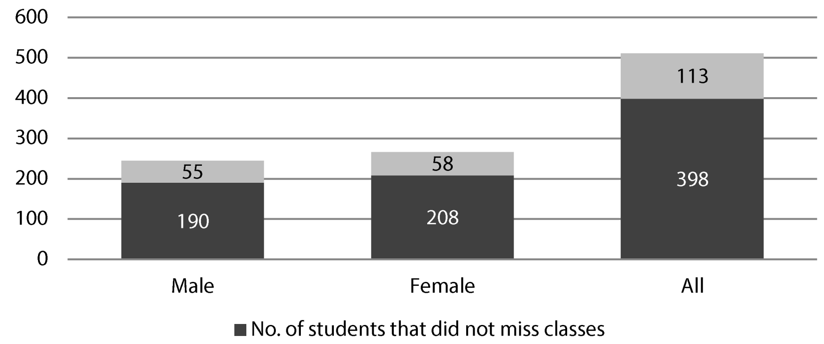


**Figure 20.** Missed school attendance due to Habagat 2013, male and female students

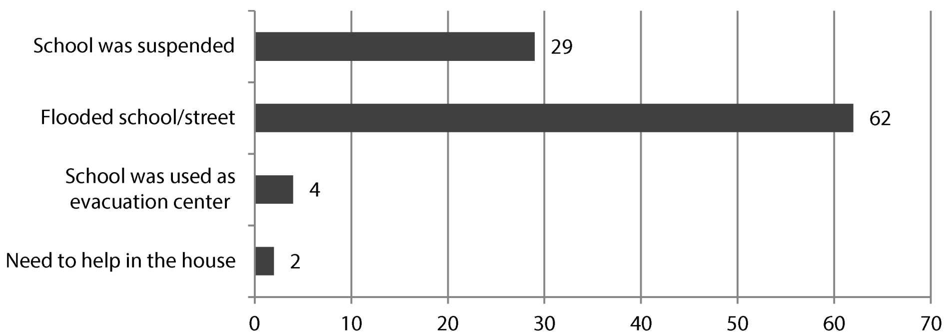


**Figure 21.** Reasons for missing classes, number of students who missed classes

Figure 22 shows that about 48% of the total workers covered in the study were forced to miss work due to the unfavorable weather. The overall incidence of work absenteeism was more pronounced in male workers (58%) than in females (35%). This is similar to our findings in Ajuy. Again, this may be explained by the different roles that men and women have in coping with weather hazards. With their physical strength, men are expected to take care of the clean-up and repair after the flood recedes. Looking at work days lost, the average number of missed work days was about three. Consistent with earlier analysis, there was no significant difference in the mean average work days lost days between male and female working household members.

Summing up the value of all impacts, including lost income, expenditure on adaptation, and the expenses of repair and replacement of damaged property/assets, it was estimated that on average, each household in Bacoor incurred a damage cost amounting to PHP 3,392 (USD 78). If we account for assets not yet replaced nor repaired, then the total average damage cost increases to PHP 6,477 or USD 147 (Table 15). A large chunk of this cost derives from lost income and damage to property.

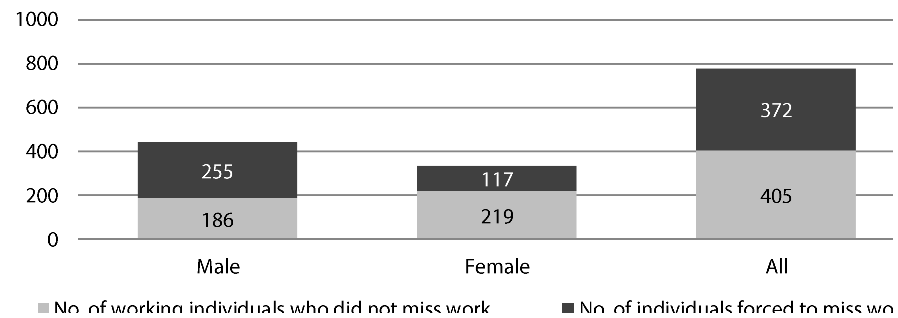


**Figure 22.** Work missed due to Habagat 2013, men and women

**Table 15.** Average cost of impacts of Habagat 2013

| Barangay | Lost Income [A] | Adaptation Expenditure [B] | Property Losses Based on Expenditure on Repairs [C] | Property Losses Based on Expenditure on Repairs Plus Estimated Replacement Cost [D] | Total Damage Cost (Lower Bound) [A + B + C] | Total Damage Cost (Upper Bound) [A + B + E] |
|---|---|---|---|---|---|---|
| Habay I | 2,714 | 398 | 611 | 3,471 | 3,722 | 6,583 |
| Ligas I | 1,451 | 540 | 1,615 | 11,286 | 3,606 | 13,277 |
| Mabolo III | 1,513 | 98 | 929 | 3,491 | 2,540 | 5,102 |
| Niog II | 3,052 | 356 | 706 | 1,831 | 4,114 | 5,239 |
| Panapaan IV | 1,472 | 620 | 1,806 | 6,436 | 3,898 | 8,528 |
| Real II | 729 | 241 | 139 | 774 | 1,109 | 1,744 |
| Salinas I | 4,160 | 137 | 2,251 | 7,564 | 6,548 | 11,861 |
| San Nicolas I | 1,536 | 136 | 245 | 1,065 | 1,918 | 2,738 |
| Talaba II | 3,129 | 90 | 1,038 | 2,366 | 4,257 | 5,585 |
| Zapote V | 662 | 79 | 1,468 | 3,376 | 2,209 | 4,117 |
| All | 2,042 | 270 | 1,081 | 4,166 | 3,392 | 6,477 |

Note: Exchange rate: 1 USD : 44 PHP.

Comparing the household savings in Bacoor with the damage incurred, it seems that the savings were not enough to cover the damage. In fact, only a small fraction (20%) of the respondent households held savings prior to the flood. Some 9% of the respondent households held savings of at most PHP 1,000, while 8% held savings of PHP 1,001–PHP 10,000. Very few (2%) held savings greater than PHP 10,000. Unlike in Ajuy during typhoon Yolanda, the effect of Habagat on the consumption of households in Bacoor may not be as significant because the damages represent only about 17%–33% of household monthly income.

### 3.3.3 Difference in preferences and in the roles of men and women

Similar to Ajuy, the majority (75%) of the respondents in Bacoor were female household heads. The mean age of male respondents was 49, while females were 46, yielding an overall average age of 47. The respondents earned an average individual income of about PHP 9,716 (USD 220) per month, with male respondents earning more than twice their female counterparts, at PHP 15,782 (USD 358) per month for the former and PHP 7,089 (USD 161) per month for the latter. The majority of Bacoor respondents belonged in the high school graduate category, comprising 49%; followed by elementary graduates (28%); college graduates (17%); and pre-elementary (6%). In terms of the respondent's occupation, 35% were homemakers; 27% were professionals, government officials, or self-employed individuals; 17% were laborers or workers; and only 1% were engaged in farming or fishing. About 17% of the respondents were unemployed.

In Bacoor, the construction of flood control infrastructure such as floodways and improved drainage systems earned the top rank in their preferred interventions for both male and female respondents. This was followed by regular clearing of the drainage/river system. These types of intervention are mitigation-type strategies, which mean that most people prefer stopping the flooding instead of merely avoiding its impacts, such as in the case for relocation. Men ranked a warning system in third place, and women put proper garbage disposal in third place. In general, the rankings are quite similar for males and females. Other interventions identified were relief operations and an improved rescue system, financial assistance, evacuation center provision, DRRM training, road improvement, health services, livelihood programs, river dredging, relocation, and tree planting or banning cutting down trees (Table 16).

**Table 16.** Ranking of interventions in terms of preference by respondents, Bacoor, Cavite

| Intervention | Points | | | Percentage | | | Rank | | |
|---|---|---|---|---|---|---|---|---|---|
| | Male | Female | All | Male | Female | All | Male | Female | All |
| Flood control infrastructure | 36 | 100 | 136 | 35 | 34 | 34 | 1 | 1 | 1 |
| Clear drainage/river | 27 | 98 | 125 | 26 | 33 | 31 | 2 | 2 | 2 |
| Early warning/information dissemination | 25 | 68 | 93 | 25 | 23 | 23 | 3 | 4,5 | 3 |
| Proper garbage disposal | 20 | 71 | 91 | 20 | 24 | 23 | 4 | 3 | 4 |
| Relief operations | 13 | 68 | 81 | 13 | 23 | 20 | 5 | 4,5 | 5 |
| Improved rescue system | 11 | 28 | 39 | 11 | 9 | 10 | 6 | 6 | 6 |
| Financial assistance | 6 | 20 | 26 | 6 | 7 | 7 | 8,9 | 7,8 | 7 |
| Evacuation center | 4 | 20 | 24 | 4 | 7 | 6 | – | 7,8 | 8,9 |
| DRRM training | 5 | 17 | 22 | 5 | 6 | 6 | 10 | 9 | 8,9 |
| Road infrastructure | 7 | 10 | 17 | 7 | 3 | 4 | 7 | 10 | 10 |
| Health services | 1 | 10 | 11 | 1 | 3 | 3 | – | 10 | – |
| Livelihood program | 3 | 8 | 11 | 3 | 3 | 3 | – | 10 | – |
| River dredging | 6 | 4 | 10 | 6 | 1 | 3 | 8,9 | – | – |
| Relocation | 3 | 6 | 9 | 3 | 2 | 2 | – | – | – |
| Tree planting/no cutting | 1 | 5 | 6 | 1 | 2 | 2 | – | – | – |

Looking at the contribution of men and women to different flood preparedness activities, storing food and water and raising up belongings beyond the reach of floodwaters were predominantly exclusively female activities; while securing vehicles, animals, and livestock were predominantly male activities. Shared activities include preparing sandbags, building a second floor, and securing livelihood equipment (Figure 23). The construction of a second floor was a shared activity because homeowners undertake supervisory roles and are not themselves involved in the actual construction.


**Figure 23.** Male and female involvement in different adaptation activities prior to Habagat 2013

## 4.0 POLICY IMPLICATIONS AND CONCLUSIONS

This research documented and analyzed the experiences of households and their individual members during two extreme weather events in the Philippines in 2013: coastal households in Ajuy, Iloilo, during typhoon Yolanda (Haiyan); and households in Bacoor, Cavite during heavy monsoon rains (Habagat) and widespread flooding. Ajuy, Iloilo, is a rural municipality where the main source of household livelihoods is fishing. Bacoor, Cavite, is a city whose residents are primarily employed in the nearby commercial areas of Metro Manila.

At both study sites, we found that men had higher incomes than women. The implication of this, as other studies have asserted, is that women may have a weaker voice in the decision making of households, including what adaptation actions to undertake and how much money should be saved. Studies have shown that women have a higher propensity to save, which suggests that increasing their bargaining power within the household also increases household savings, and vice versa. The results of our survey seem to support this notion as majority of the households in both Ajuy and Bacoor were found to have low average savings. Further exploration of the relationship between income, bargaining power and adaptation choice is recommended for future studies.

We found that not all households had received information or warning prior to the typhoon in Ajuy and the flooding in Bacoor. Therefore, local government should find creative ways to ensure that warnings are disseminated to each and every household in their jurisdiction. For instance, in rural Ajuy warnings can be posted in conspicuous places such as the marketplace or schools. In urban Bacoor, where personal contacts constitute the least important source of information, local government can take advantage of social media sites and the internet to disseminate information.

It was observed that even some households that had received warning did not undertake any preparations or action prior to the typhoon and flooding. A majority of those who did not undertake any action stated that their main reason was because they had underestimated the strength and severity of the weather event. Ajuy households had never experienced a typhoon of the magnitude of Yolanda, so they may have anchored their expectations to the strongest typhoon they had experienced so far. This suggests the importance of looking at the quality of information being provided and the need to assess strategies for conveying information. For instance, as well as stating the intensity of the typhoon, it might help households to process the information better if the likely impacts of the weather event and recommended adaptation actions are included in the warning.

To encourage autonomous household adaptation, it is recommended that households (especially those along vulnerable coastal areas) be required to undertake training or attend a seminar on DRRM. This strategy has been found to increase the probability of undertaking adaptation activities in Ajuy.

Support for community-wide action should also be provided by the government since it has an impact on the decision of households to undertake adaptation activities at the household level. In addition, even when other sources of warning and information are available, such as the media, local government should still provide early warning services because it increases the likelihood of household adaptation being undertaken.

We also found that for both study sites, only a small percentage of those who needed to evacuate did so in a preemptive manner. Local government should identify strategies that would encourage households to undertake early evacuation. Early evacuation may help avoid injuries, and it may also be the difference between life and death. Evacuation centers should be livable and comfortable to encourage people to evacuate from their homes and, if possible, local government should assign security personnel to deter looting so that residents will not be reluctant to leave their homes. If the situation calls for it, the local government should also be ready to implement mandatory evacuation.

On average, Yolanda caused damages estimated to be about six times the average household monthly income in Ajuy; Habagat resulted in damage equivalent to about a third of the average household income in Bacoor. These welfare losses were due to various impacts such as damage to property and assets, lost income, illnesses, and injuries. As a safety net to smooth out consumption during extreme events, households should have an emergency fund equivalent to about six times their monthly income.

An impact seldom documented is the effect of extreme weather events on education. In the study, we found that prolonged suspension of classes occurred in Ajuy because some schools had been damaged by Yolanda and some were used as evacuation centers. The average number of school days missed by students in Ajuy was 30. This is alarming, especially since missing school has been linked to poor academic performance both in the short- and long-term. Using schools as evacuation centers is common in the Philippines. The downside is that this often causes disruption to students. It is recommended for the government to look into alternative evacuation facilities or, if the need for evacuation is recurring, they should look into the economic viability of undertaking permanent relocation instead. Moreover, like all public infrastructure, schools should also be subject to climate proofing and retrofitting. This infrastructure should be built away from the coastline. If the relevant buildings are already constructed in hazardous areas, then a benefit-cost analysis can be done to determine if moving the facility is economically viable.

We also found that the ranking of preferred government interventions between male and female respondents was similar for both study sites. In Ajuy, the top three preferred interventions for men and women were: information and early warning, financial assistance, and the provision of evacuation centers. In Bacoor, flood mitigation strategies were the most preferred option, which included the construction of floodways and improved drainage systems. This was followed by the regular cleaning of rivers and waterways. In third place, an early warning system was most preferred by men, while proper garbage disposal was most preferred by women.

Men and women were found to have specialized roles in adaptation. We found that men assumed activities that require physical strength, such as reinforcing the home's walls and roof, while women assumed activities that were domestic in nature such as storing water and food. There were also activities that were shared by both men and women, which included raising and securing personal belongings. Interestingly, we found that the incidence of missing work due to the typhoon/flood had been substantially higher for males than for females. This seems to indicate that women temporarily take on a more important role in income generation in the aftermath of extreme weather.

Lastly, we found that the presence of mangrove cover had significantly reduced the damage to property that households in Ajuy suffered during typhoon Yolanda. However, it must be emphasized that this result may only be indicative of the study site and cannot be generalized for all areas affected by typhoon Yolanda. Note that the intensity of the typhoon in Ajuy was not as strong as in the other areas, particularly Leyte, Sorsogon, and even the other municipalities in northern Iloilo that were directly hit by typhoon Yolanda. This caveat is emphasized so as not to provide the mistaken notion that it is safe for households to stay in government-mandated coastal buffer zones even when mangrove cover is present. However, the results strengthen the rationale to encourage coastal communities to protect and rehabilitate mangrove forests as they will directly benefit from the protection this natural resource has to offer.
In addition, we found that the higher the expenditure on adaptation actions and the further the distance of the household from the coastline, the lower the damage cost incurred by the household.

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