Risk Management and Coping Strategies: Climate Change and Agriculture in the Philippines[1]

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Abstract

We provide an initial framework regarding priorities for government programs to reduce the natural-disaster vulnerability of farm households in the Philippines. We begin with the likelihood that climate change will increase the probability of flooding, since rainfall is expected to both increase and be more concentrated (more storms). We then turn to a conceptual framework for understanding resilience at the household level and evidence from the PCED Social Protection Survey about coping strategies of farm households. The framework can be used to shed light on pros and cons of alternative public policies to reduce household vulnerability, including the role of discounting. In particular, we highlight the limited coping tools available to low-income households. This helps to strengthen the case for preventative polices that lower the probability and/or severity of damages. The inability of poor households to cope with increased exposure to risks, however, does not necessarily imply that social insurance programs should be expanded. Inasmuch as disaster risk management policies at the national level are typically without coherent foundations, we provide tentative indications of how the farm level risk-management framework can be expanded to the national level.

Keywords: Farm-household risk management, natural disaster, shock, coping

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Introduction

Given the prominence of natural disasters, promoting public welfare requires sound risk management as well as economic policies. We provide an initial framework regarding priorities for government programs to reduce the natural-disaster vulnerability of farm households in the Philippines. We begin with the likelihood that climate change will increase the probability of flooding in the Philippines, since rainfall is expected to both increase and be more concentrated (more storms). Initial assessments also suggest that, despite greater mean rainfall, the dry season is likely to become drier.

Climate projections for the Philippines are similar to those in many other parts of the world (e.g. Lansigan; and Lasco and Wilson, forthcoming). Using the Intergovernmental Panel on Climate Change (IPCC) for the (A1B) scenario most relevant for the Philippines, Cinco et. al. (2013) project that the minimum and maximum temperatures will display increasing trends approaching 2050. According to this projection, the mean annual temperature is expected to increase by 1.9^{o}C to 2.2^{o}C by 2050, from the baseline temperatures of 25.5 ^{o}C to 27.6 ^{o}C in 1971-2000.[1]

The increasing mean and concentration of rainfall indicate that the wet seasons of June-August and September-November will become wetter in Luzon and Visayas as we approach 2050. On the other hand, the increased rainfall concentration combined with increased temperatures is likely to increase moisture stress in the dry season.

One implication of these climatic changes is that the experience that farmers have gained about the frequency, duration, strength and timing of rainfall is less reliable than before. This means that the subjective probability distributions inherent in farmer decision-making are becoming more dispersed and that risk is increasing. In particular, it is expected that the frequency of damaging storms is increasing. There has also been some evidence that the frequency of droughts will be greater, albeit this has been disputed (Cruz et. al 2007). What this scientific uncertainty means for the farmer is that climate change increases the dispersion of subjective probabilities regarding drought. Past experience becomes less useful as a guide.

Risk-reducing actions available to farm households are limited and may entail reductions in expected profits that would not be rational to undertake (Roumasset 1976, 1979, 2014; Walker and Jodha 1986; Walker and Ryan 1990; Duflo et al. 2008). Accordingly the increased risk induced by climate change may decrease farmers' welfare by requiring more costly measures to smooth consumption (e.g. removing children from school) and, where such measures are excessively costly, by increasing the intertemporal variability of consumption.

Our objective is to provide a conceptual framework for understanding risk management and resilience at the household level. We use the PCED Social Protection Survey data to explain how Philippine farming households cope with natural disasters. At the national level,

[1] These baseline temperatures are the averages of the minimum and maximum temperatures over the indicated period.

we ask "How can public policy be designed to balance the available ex-ante and ex-post controls to maximize expected economic welfare, given the event distribution, with particular attention to disasters and climate change?" At the farm or micro-level, the question is "How do farmers balance the available risk reducing and coping instruments to maximize their well-being, given the event distribution, with particular attention to climate change and other adverse events?"

In the next section, we review the Philippines' vulnerability to climate change and natural disasters. We then turn to a conceptual framework for understanding resilience at the household level and evidence from the PCED Social Protection Survey about coping strategies among farm households. The framework will be used to shed light on the pros and cons of alternative public policies for reducing household vulnerability.

Vulnerability in the Philippines

The geographical location of the Philippines subjects it to adverse natural events of extreme intensity. The warm Western Pacific waters, normally around 28 degrees, contribute to the formation of typhoons, 18-20 of which reach the Philippines each year on average.[1] Historically, Cagayan Valley (Region II), Central Luzon (Region III) and Cordillera Administrative Region (CAR) has been particularly vulnerable with about 7-9 typhoons crossing over each of these regions annually (Figure 1). Flooding occurs in a number of regions, with Western Visayas registering the highest incidence. Climate change appears to be moving the zone of greatest frequency and intensity south (Figure 1, PAGASA, Climate Data Section 2014).

The Philippines also lies within the Pacific *Ring of Fire* (also known as the circum-Pacific Belt) where most of the earth's volcanic eruptions and earthquakes occur (Encyclopedia Britannica 2014; Sinvhal 2010). Geophysical events, such as earthquakes and tsunamis, occur with regularity in the country, albeit with long intervals. The Bicol Region, home of the active Mayon Volcano, experienced the greatest number of volcanic eruptions from 1991-2006. Earthquakes of high and moderate magnitude occur most frequently in the Central Visayas and Bicol regions (Figure 1).

From the perspective of the Philippines, these natural events that raise the country's disaster risk profile are inevitable. The country ranks second, scoring 28.25% in the risk index among the global hotspots of disaster risk, following behind just Vanuatu at 36.43% (UNU-EHS World Risk Index 2014). The same source defines exposure according to the population at risk and vulnerability to encompass susceptibility, coping and adaptation. Susceptibility is defined as the likelihood of being harmed if a natural hazard occurs. Coping refers to the ability of societies to lessen the adverse impacts of natural hazards. Adaptation is a long-term process

[1] Storms that develop over the northwestern Pacific Ocean are called typhoons. Those that originate in the South Pacific and over the Indian Ocean are called cyclones. The ones that form over the Eastern Pacific Ocean and the Atlantic Ocean are called hurricanes.

that involves structural changes and strategies to better deal with the negative impacts of natural hazards. As the risk of natural hazards increases, there is a tendency for exposure, vulnerability, and susceptibility to increase as well.[1]

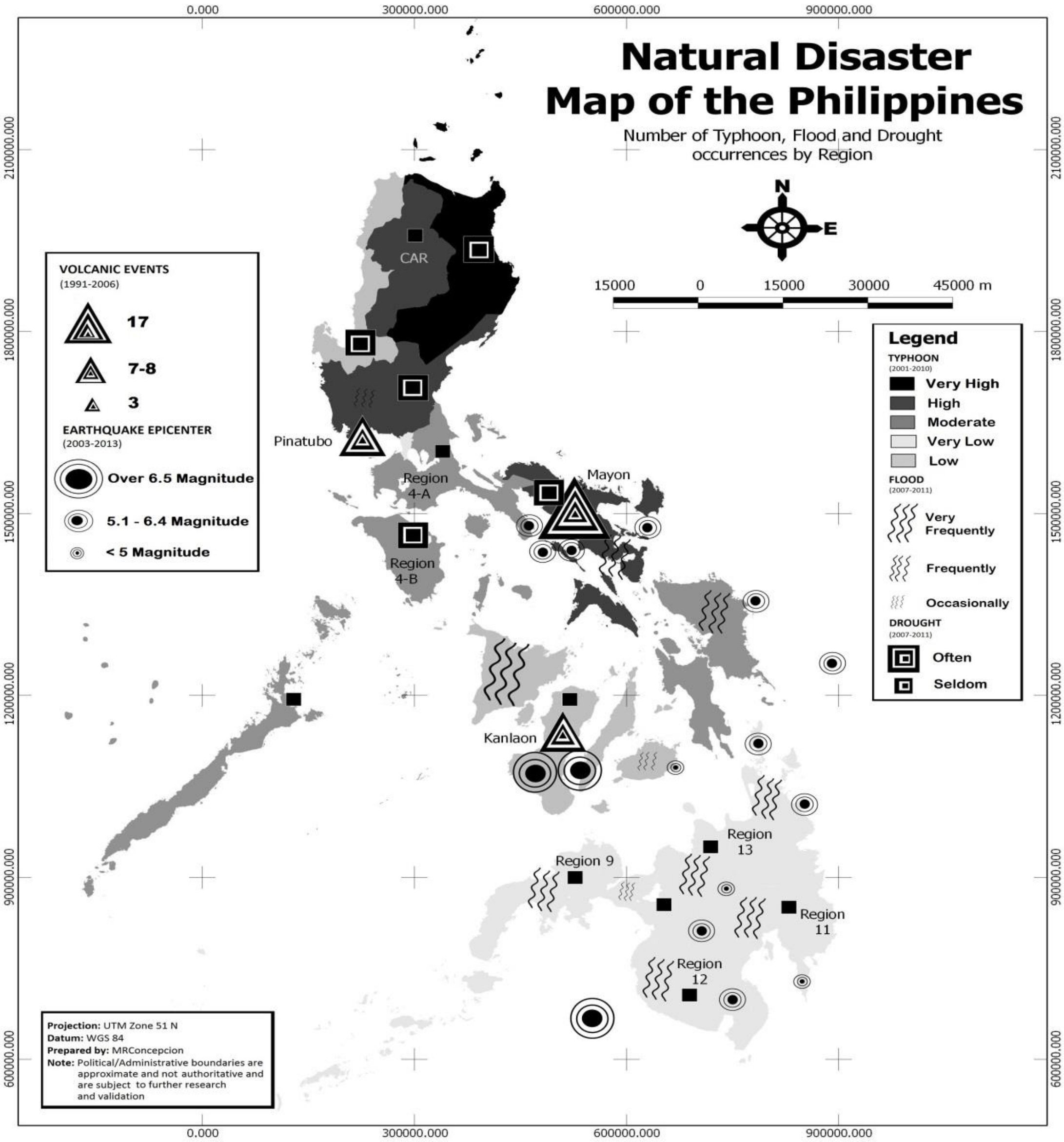

Figure 1 The Incidence of Natural-disasters

Sources: Source of data on typhoons: PAGASA, Climate Data Section (August 2014)

Source of data on floods and droughts: Department of Agriculture, Management Information Division (August 2014)

Source of data on volcanic events: PHIVOLCS, Volcanology Division (August 2014)

Source of data on earthquakes: PHIVOLCS, Seismology Division (August 2014)

[1] Inasmuch as these definitions are somewhat vague, as are the official definitions adopted by the Philippine government, we suggest an alternative taxonomy in Section IV that distinguishes between characteristics of vulnerability and the various levels of actions that can be taken to avoid it.

Naturally occurring events reach disaster status when they overwhelm local response capacity and cause great damage and human suffering. The Centre for Research on the Epidemiology of Disasters (CRED) maintains the Emergency Events Database (EM-DAT), accessible at http://www.emdat.be/country-profile, the largest database of natural disasters at the country level. For a natural hazard to be counted as a disaster by CRED, the following criteria must be satisfied: Ten or more people were killed; 100 or more people are injured or suffered losses; a state of emergency has been declared; and a call for international assistance has been issued.

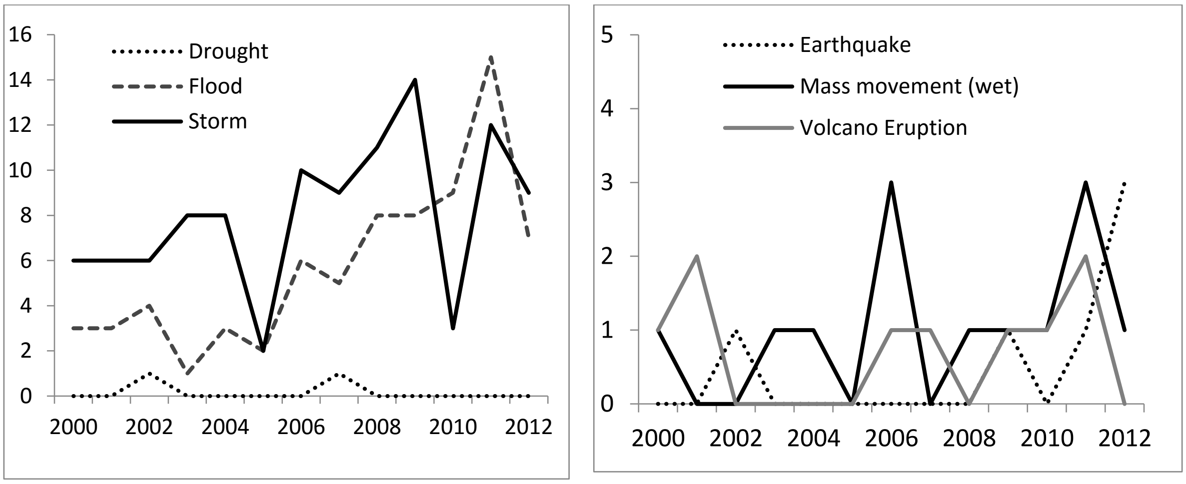

Figure 2 Frequency of natural disasters, Philippines.
Sources: Source of basic data: EM-DAT, CRED (http://www.emdat.be/result-country-profile)

Figure 2 presents the year-on-year occurrence of selected natural disasters, as defined by CRED, from 2000-2012. On the average, out of 20 storms that pass through the Philippines annually, 7 reach disaster status. The figure is suggestive of a slight upward trend, especially from 2005. The trend would be more pronounced with the inclusion of typhoon *Haiyan* (*Yolanda*) in November of 2013. Disastrous flooding has shown an increasing trend over the same period. The data used here does not show any significant increase in droughts however.

Figure 2 does not show a pronounced trend for the incidence of geophysical events, including earthquakes and volcanic eruptions that have reached disaster status. The slight upward trend since 2005 may be partly a consequence of 2005 being a lucky year in terms of adverse events and partly because of increased exposure. Even if the incidence of adverse events is not increasing, more events may reach disaster status due to greater populations in harm's way. At high levels of per capita income, the reverse is likely, because vulnerability is reduced by various avoidance measures. One may thus hypothesize a *disaster Kuznets curve*, with disasters first increasing with per capita income (and population) and then declining. That is, at lower levels of income the population effect dominates. At higher levels, the effect of greater spending on disaster avoidance becomes greater.

Studies have shown that these natural disasters adversely impact different aspects of an economy, from the long-run growth rates to natural-resource prices (see Cavallo and Noy 2010, Cavallo et al 2010, Skidmore and Toya 2002, Prestemon and Holmes 2002). Das (2003) examined both direct and indirect impacts on the agricultural sector. Direct impacts are more immediate in nature, including the destruction of crops, farm buildings, installations, machinery, equipment, means of transport, stored commodities, cropland, irrigation works, and dams. Indirect impacts of disasters include the loss of potential production due to increased costs or decreased availability of some inputs and disruption of the marketing chain.

Vulnerability of the Agriculture Sector

The agriculture sector of the Philippine economy contributes about 10% of the country's total output and employs nearly one third of the total labor force (Ravago and Balisacan forthcoming). The growth performance of the sector has been lackluster over the 2000-2010 period, which may be partly attributable to the vulnerability of the sector to weather-related shocks. Philippine agriculture has always been heavily impacted by natural disasters. Table 1 presents the aggregate value of damage to agriculture commodities from typhoons, floods and droughts. During the period 2000-2013, total damage amounted to PhP195 billion. The crops that were typically damaged were rice and corn, with a total aggregate damage of PhP86b and PhP29b, respectively. Fisheries products also recorded significant damages, with an aggregate value of PhP12m for the same period. Annual value of damages hiked up from 2009-2013. Typhoons *Ondoy* (Ketsana) and *Pepeng* (Parma) hit several parts of Philippines in late September and early October 2009, which brought the total annual damage to agriculture at PhP29.5b. In 2012, Typhoon Pablo significantly destroyed the banana producing areas in the Southern part of the Philippines leaving a damage valued at PhP22.2b. Aggregate damages to irrigation and other agricultural facilities were estimated to be PhP8.9b and PhP15.7b, respectively (see Table 2).

Table 1 Total value of damage to agriculture due to typhoons, floods and droughts in the Philippines, by commodity, 2000 - 2013 (million pesos)

Year	Rice	Corn	HVCC	Banana	Veg	Coconut	Sugar-cane	Others	Fisheries	Live-stock	Total
2000	1,595	58	352	-	91	47	41	95	358	8	**2,644**
2001	805	546	359	-	65	0	74	0	255	95	**2,200**
2002	548	330	115	-	12	0	-		127	16	**1,150**
2003	1,320	1,696	424	-	124	1	-	0	242	49	**3,857**
2004	1,698	1,436	1,155	-	738	439	-	159	1,906	44	**7,576**
2005	1,942	2,446	32	-	20	-	-		6	0	**4,447**
2006	3,401	1,179	3,178	-	233	1,115	-	602	1,081	223	**11,012**
2007	1,882	2,783	376	-	178	0	-		89	3	**5,311**
2008	5,015	1,806	2,283	-	-	1,133	36	12	3,152	246	**13,683**
2009	23,842	1,418	2,504	-	-	-	-	69	1,597	88	**29,519**
2010	15,559	8,486	1,108	-	-	-	-		303	28	**25,484**
2011	17,842	2,752	1,185	-	-	-	-		859	165	**22,804**
2012	3,878	1,719	2,036	22,232	-	1,122		20	723	369	**32,099**
2013	7,139	2,770		1,493	435	17,746	1,211	542	1,552	828	**33,716**
Tota	**86,468**	**29,426**	**15,109**	**23,725**	**1,895**	**21,604**	**1,362**	**1,500**	**12,25**	**2,162**	**195,501**
Ave	**6,176**	**2,102**	**1,079**	**1,695**	**135**	**1,543**	**97**	**107**	**875**	**154**	**13,964**

Sources: Department of Agriculture, Management Information Division (August 2014)

Notes: "Abaca, Tobacco, Cassava, Mango, Root Crops, Other Crops, and NFA" are consolidated under "Others." Average for banana and other crops are based only on one or two years.

Table 2 Total value of damage to agricultural facilities and irrigation due to typhoons, floods and droughts in the Philippines, 2000-2013 (million pesos)

Year	Agricultural Facilities/ Infrastructure/ Equipment	Irrigation
2000	0.23	0.23
2001	880.21	880.21
2002	31.35	31.35
2003	11.66	11.66
2004	636.13	636.13
2005	-	-
2006	1,287.17	1,287.17
2007	2.62	2.25
2008	1,865.86	1,697.50
2009	190.01	3,860.40
2010	167.92	1,279.99
2011	241.72	2,143.55
2012	82.72	1,735.98
2013	3,508.41	2,181.15
Total	8,905.99	15,747.56
Ave	636.14	1,124.83

In 2013, the country endured another typhoon, which is considered to be the most destructive typhoon since the turn of the new millennium. Typhoon Yolanda (Haiyan) hit the country on Nov 8, 2013 devastating the Visayan region the most and subtracting PhP571b from the national economy. The damage to the agriculture sector was PhP62b (see Table 3).

Table 3 Total value of damage and loss to the economy by typhoon Yolanda

Sector	Damage and Loss (Php Million)				
	Damage		Loss		Total
	Public	Private	Public	Private	
Infrastructure Sectors	**16,024.30**	**4,285.00**	**7,108.40**	**6,565.40**	**33,983.10**
Electricity	5,329.30	1,500.00	4,575.20	4,126.40	15,530.90
Roads, bridges, flood control and public buildings	4,255.20	-	322.90	-	4,578.10
Transport	6,010.80	216.00	24.30	-	6,251.10
Water and sanitation	429.00	2,569.00	2,186.00	2,439.00	7,623.00
Economic Sectors	**3,743.50**	**67,560.00**	**87.00**	**106,716.60**	**178,107.10**
Agriculture	3,743.50	27,560.00	87.00	30,716.60	62,107.10
Industry, Services	-	40,000.00	-	76,000.00	116,000.00
Social Sectors	**23,175.30**	**305,472.10**	**3,442.30**	**22,628.80**	**354,718.50**
Education	17,953.50	3,726.20	1,303.90	916.30	23,899.90
Health	1,170.80	1,959.90	1,932.40	510.50	5,573.60
Housing	4,051.00	299,786.00	206.00	21,202.00	325,245.00
Cross-sectoral	**4,000.00**	**-**	**300.00**	**-**	**4,300.00**
Local Government	4,000.00	-	300.00	-	4,300.00
Total (Php Million)	**46,943.10**	**377,317.10**	**10,937.70**	**135,910.80**	**571,108.70**
Total (US$ Million)	1,063.60	8,549.20	247.80	3,079.40	12,940.00

Note: Data from some sectors are incomplete due to ongoing field assessments. These are indicated in the sectoral sub-sections.

Source: Reconstruction Assistance on Yolanda (RAY), NEDA 2012.

Israel and Briones (2012) estimated the impacts of typhoons, floods and droughts on agriculture using the Agricultural Multi-market Model for Policy Evaluation (AMPLE). AMPLE is an 18-production sector partial equilibrium model suitable for understanding the evolution of underlying economic fundamentals, in contrast to actually predicting the movements of the market. The main finding of the study is that typhoons have significant negative impacts on rice production at the local level.

Disaster Management Capacity in the Philippines

Given the history of natural disasters experienced in the Philippines, it is not surprising that disaster risk management in the country can be traced back to the 1930s during the Commonwealth Period. The principal office in-charge was the Civilian Emergency

Administration (CEA), created by Executive Order (EO) 355. CEA through the National Emergency Commission (NEC) was mandated to formulate and execute policies and plans for the protection and welfare of the civilian population under extraordinary and emergency conditions. From thereon, other laws were passed creating—or renaming—the agency in-charge of disaster risk manegement (see Figure 3). The National Disaster Coordinating Council (NDCC) was created by Presidential Decree 1566 in 1978 to coordinate and supervise disaster management in the country. It was composed of Secretaries of various national agencies and chaired by the Secretary of National Defense. In its three decades of existence, the NDCC shifted from reactive emergency management to more proactive and comprehensive disaster risk management. This resulted in disaster risk management being integrated into the country's development agenda.

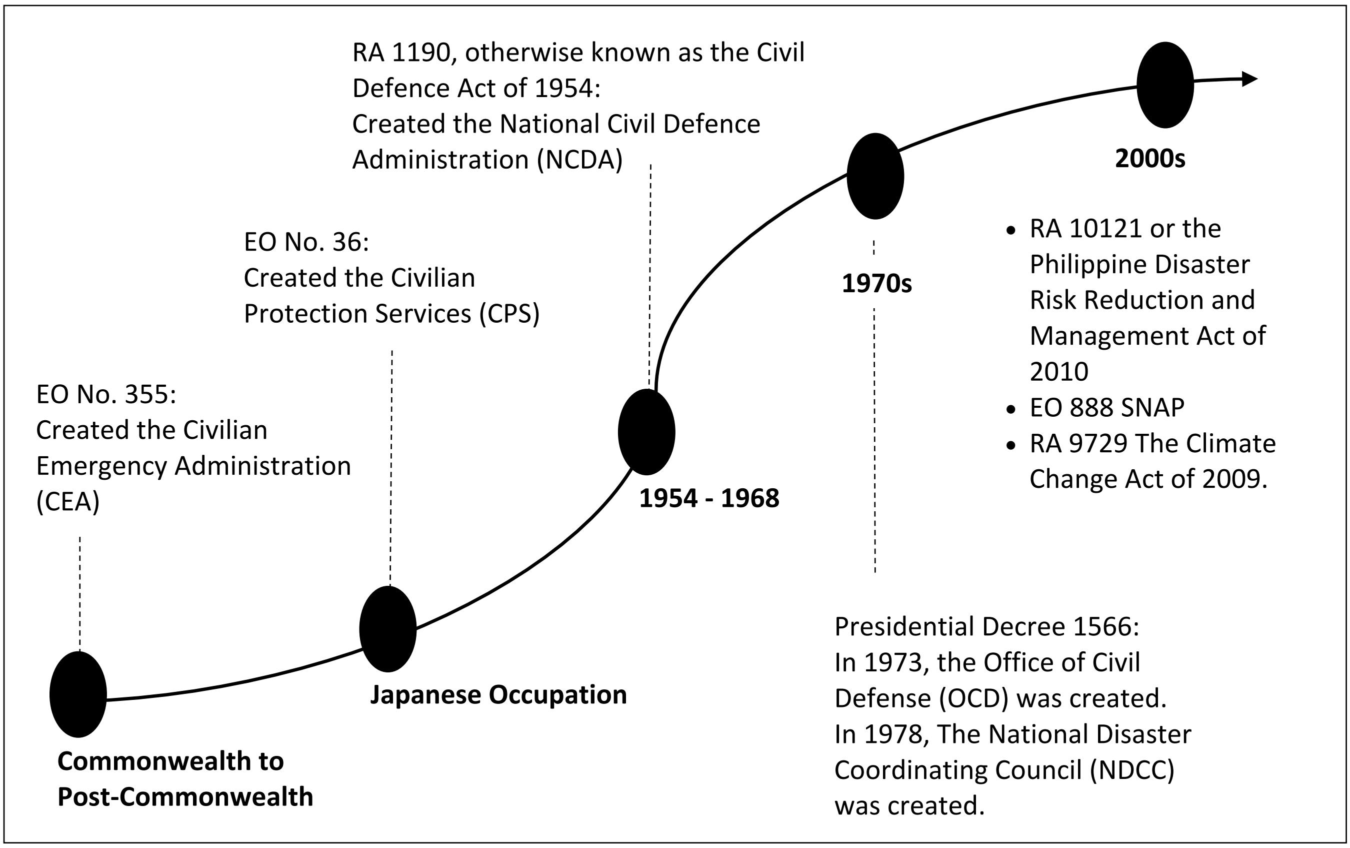

Figure 3 Snapshot of disaster risk management in the Philippines
Source: Israel and Briones 2012.

In July 2009, the Congress passed Republic Act (RA) 9729, also known as the Climate Change Act. The objective is to mainstream climate change into the formulation of government policy by establishing a National Framework Strategy and Program on climate change. The law also created the Climate Change Commission (CCC) with the mandate of coordinating, monitoring and evaluating the programs and action plans of the government relating to climate change. The CCC has the status of a national government agency and is attached to the Office of the President. EO 888 was signed in 2010, adopting the Strategic National Action Plan (SNAP) on Disaster Risk Reduction (DRR) through 2019. SNAP is charged with providing a road map for sustaining disaster risk reduction initiatives in the country and promoting good practices of individuals, organizations, local government units and the private sector. EO 888 also institutionalizes DRR planning by all government agencies.

Shortly after the signing of EO 888, NDCC was reconstituted into the National Disaster Risk Reduction and Management Council (NDRRMC) by the passage of RA 10121. This law empowered NDRRMC with policy-making, coordination, integration, supervision, monitoring and evaluation functions related to disaster risk management. The Secretary of the Department of National Defense is the Chair. In contrast to NDCC where Secretaries of other selected departments only served as members, the Secretaries of Department of Interior and Local Government (DILG), Department of Social Welfare and Development (DSWD), Department of Science and Technology (DOST), and Economic Planning Secretary/DG of the National and Economic Development Authority (NEDA) serve as Vice-Chairpersons of NDRRMC.

After the institutionalization of DRR and the creation of NDRRMC, Administrative Order No. 1 was issued directing the local government units (LGUs) to adopt and use the DRR Guidelines. NDRRMC and the CCC have coordinated their activities by signing a Memorandum of Understanding to harmonize Local Climate Change Action Plans and Local Disaster Risk Reduction Management Plans by the LGUs. NEDA was tasked to conduct capacity-building activities that integrate DRR into planning of the local, regional, and national level government offices. Cognizant that geographical considerations matter in improving the quality of human life, the government put spatial considerations in the Midterm Update Philippine Development Plan (PDP) 2011- 2016 (NEDA, 2013). The PDP Midterm Update categorized the focus of government interventions according to the following criteria: Category 1: the number or magnitude of poor households in the province; Category 2: the provincial poverty incidence, or the proportion of poor individuals to the provincial population; Category 3: the province's vulnerability to natural disasters (floods and landslides, in particular). Table 3 lists the provinces in Category 3 many of which lie along the country's eastern seaboard facing the Pacific Ocean. When natural disasters hit these provinces, the marginally non-poor can easily slide into poverty.

Despite the history of disaster management in the country, the Philippines ability to efficiently and systematically respond to disaster is still a work in progress. Several constraints and issues hamper disaster risk management in the country (NDRRMC 2011): 1) ineffective vertical and horizontal coordination among member agencies; 2) limited coverage by governmental and partner organizations due to resource constraints; 3) ineffective LGU capacities such as the lack of managerial and technical competencies; 4) limited funds, equipment and facilities for monitoring and early warning; 5) insufficient hazard and disaster risk data and information; 6) inadequate mainstreaming of disaster risk management in development planning and implementation; 7) poor enforcement of environmental management laws and other relevant regulations; and 8) inadequate socioeconomic and environmental management programs to reduce the vulnerability of marginalized communities.

Table 4 PDP Midterm Update Category 3, provinces exposed to multiple hazards

Region	Province
Region I: Ilocos	Ilocos Norte, Ilocos Sur
Cordillera Administrative Region	Abra, Benguet
Region II: Cagayan Valley	Cagayan, Quirino, Isabela, Nueva Vizcaya
Region III: Central Luzon	Zambales, Pampanga, Aurora
Region IV-A: CALABARZON	Cavite, Laguna, Rizal, Quezon
Region V: Bicol	Albay, Catanduanes
Region VI: Western Visayas	Antique,Iloilo
Region VII: Central Visayas	Bohol
Region VIII: Eastern Visayas	Eastern Samar, Leyte, Northern Samar, Southern Leyte
Region IX: Western Mindanao	Zamboanga del Sur, Zamboanga Sibugay
Region XIII: Caraga	Dinagat Islands, Agusan del Sur, Surigao del Norte, Surigao del Sur

Note: A number of these provinces are included in the Hazards Mapping and Assessment for Effective Community-Based Disaster Risk Management (READY) Project, NDCC 2006-2011.

In November 2013, the disaster management and response capacity of the country was again put to test when Yolanda (typhoon *Haiyan*) hit the country. The protocol calls for post-disaster needs assessment (PDNA) before formulating a recovery plan. Given the extent of damage (Table 3) and the affected area coverage, however, following the protocol would have taken 6 months to complete the reconstruction and recovery plan. This would have meant unacceptable expenses and adverse impacts on people's lives. In its capacity as Vice-Chair for Rehabilitation and Recovery of the NDRRMC, NEDA, with assistance from the Australian Embassy, the Asian Development Bank, and the World Bank, led the preparation of the document, *Reconstruction Assistance for Yolanda (RAY): Build Back Better*. RAY is an organized framework that aims to restore the economic and social conditions of the affected areas back to their pre-Yolanda levels and at the same time strengthen their resilience to disaster (NEDA 2013).

Studies have shown that there is a very high rate of return to investment in disaster preparedness. Kelman and Shreve (2013) find that for every US$1 of investment, US$3-30 worth of benefits (avoided damages) is obtained depending on the type of disaster or hazard. Improving the country's disaster preparedness is wanting, given the projected increased in both the occurrence and intensity of extreme natural events. Improving national policies requires a framework for natural disaster risk management at the national level as well as risk management at the farm level. We develop these in the following section, after which we provide empirical evidence based on a survey of farm households.

A Framework for Natural Disaster Risk Management

The theory and practice of disaster-risk management appears to economists and many others to be *ad hoc* and full and ambiguities, relative to the theory of decision-making under uncertainty (Alexander, 2013). For example, some approaches to disaster risk management relate to reducing vulnerabilities without considering the full range of possible outcomes and their likelihoods. It is self-evident that this can only lead to sub-optimal strategies inasmuch as the benefits of risk reduction must be weighed against the opportunity costs of strategies foregone. On the other hand, the standard theory of decision making under uncertainty typically relates to a single decision, given a distribution of outcomes for each value of the decision variable. In contrast, the objective of disaster management is to select a sequential portfolio of management strategies as illustrated in Figure 4.

We assume that there is a probability distribution over the levels of an event, such as a hurricane. The national policy problem is to select a strategy corresponding to actions taken at the levels represented by the ovals in the diagram. The rectangles following each action represent distributions and/or summary statistics thereof.

To avoid the usual semantic confusion surrounding the definitions of terms, it is helpful to observe that "mitigation" is a *verbal noun* while "risk," "vulnerability," and "resilience" are *abstract nouns*. Mitigation describes actions that can be taken. The abstract nouns refer to characteristics of the resulting probability distributions. If we follow the official government definition, all the actions taken at various levels are classified as "mitigation".[1] Rather than lumping all such actions together, however, Figure 4 distinguishes them according to the stage at which they are taken. This does not imply, however, that actions can be recursively determined. A complete risk management strategy determines actions simultaneously. For example, the extent of preventative zoning and the strictness of building codes depend on the distribution of event risks and the costs of subsequent coping and other possible actions.

For our purposes, we regard event mitigation as either impossible or exogenous, e.g. the mitigation of climate change for a small economy such as the Philippines. Event risks are thus exogenous probabilities that an event exceeds critical levels (e.g., rainfall, wind speed, Richter levels). Events of different severities are often characterized, for example, as a one in ten year event, a one in one hundred years event and so on. Given "controls" such as seawalls, building codes, zoning requirements etc., event risk can then be translated into the distribution of potential exposure. This relates metrics of potential damages, e.g. people killed, to the various adverse states of the world and their probabilities. A summary statistic of potential exposure could be the sum of the number killed in each adverse state times their respective probabilities, i.e. expected loss. The decision maker then chooses some controls, for example early warning technology and protocols such that the distribution of actual exposure is more favorable than that of potential exposure. Ex-post evasive action includes emergency dredging, repairs, and additional evacuation. Vulnerability refers to the distribution of initial losses. It is

[1]See Philippine Republic Acts 10121 and 9729.

a "risk of loss" measured by probabilities that loss exceeds critical levels, expected loss (integral of density function), or loss at lower end of the density function (e.g. the severity of a "100 year event"). Resilience then is defined to be "security," for example one minus the probability of sustaining losses above a particular threshold. Risk that losses above critical levels at local or national level are sustained beyond particular lengths of time is therefore an integral of the joint frequency distribution of loss and time -- above a particular loss and beyond a particular length of time.[1] Coping is the intervening set of actions that reduces sustained losses, i.e. increases resilience, for example actions that smooth consumption, e.g., borrowing, relief/rehabilitation.

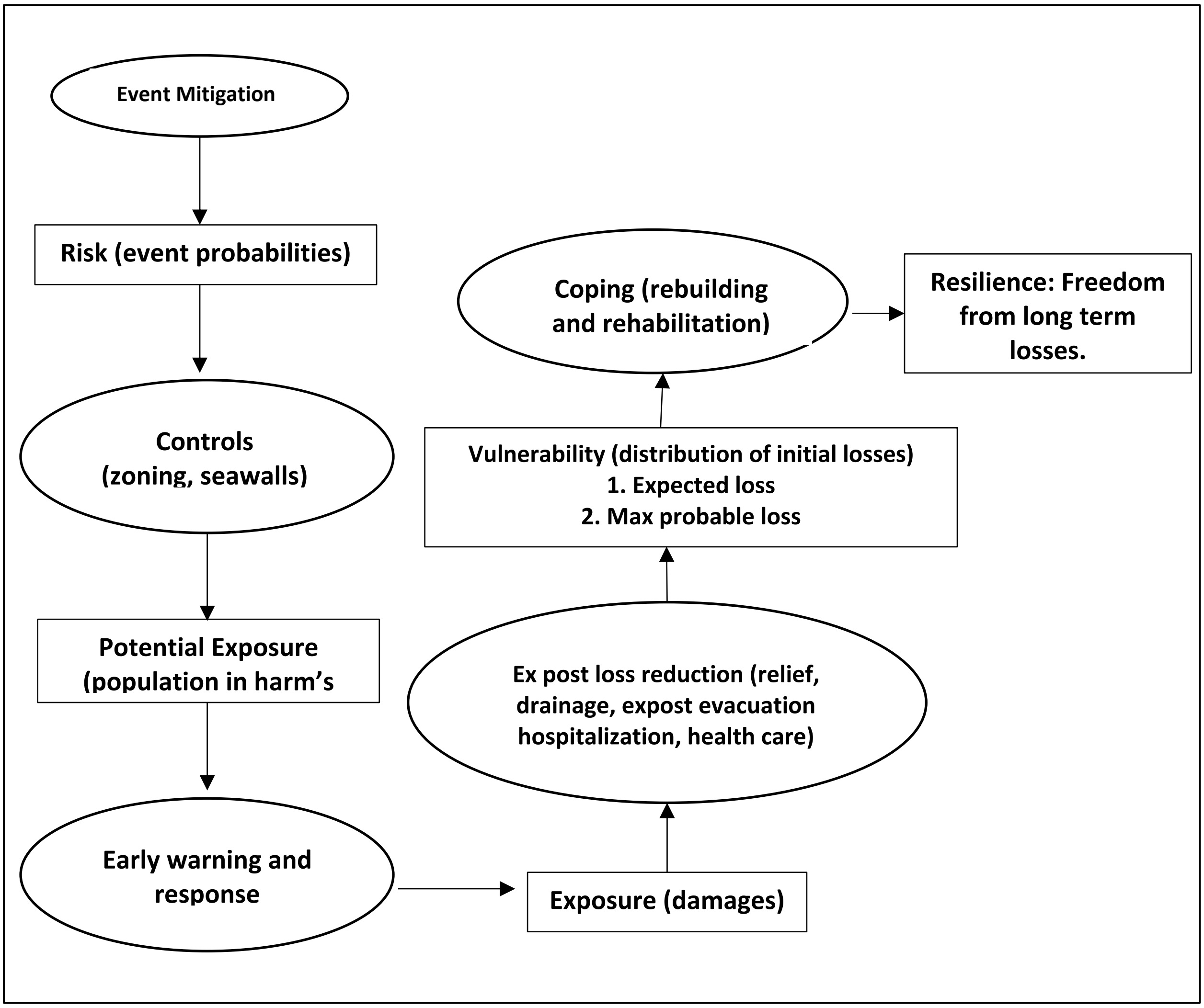

Figure 4 Natural disaster risk management

Note: a) Event Risk: Exogenous probabilities that an event exceeds critical levels (rainfall, wind speed, Richter levels)

b) Decision maker chooses natural capital and infrastructure => exposure (population exposed to levels)

[1]The official Philippine definitions do not distinguish between "vulnerability" and "resilience" other than to indicate that the two are opposites, i.e. that low vulnerability implies high resilience. In figure 4, resilience subsumes vulnerability but not the other way around.

c) Ex-ante evasive action: early warning, evacuation => dose (population actually hit by various levels)
d) Ex-post evasive action: emergency dredging, repairs, additional evacuation => vulnerability (distribution of initial losses) Coping (borrowing, relief/rehabilitation)

Choosing an optimal strategy would then involve finding the least cost combination of strategies at each level of avoidance. The difficulty of optimization is due to the interdependence of the various levels of risk reduction. The extent of risk reduction at one level depends on how much risk has been reduced at prior levels. Optimal risk reduction at early levels also depends on the capacity to reduce risk at higher levels. In particular, the ability of governments or farm households to cope with risks depends on prior decisions. For example, drawing down savings as a way of coping with a disaster, depends on savings behavior in previous periods. In this sense, optimal coping strategies involve prior planning as well as ex post actions.

A search algorithm would be needed to solve for the least cost set of strategies for a single security system, e.g. by backwards induction. One could conceivably solve for optimal ex post coping for each of many vulnerability distributions and then go backwards, solving for ex post relief for various exposure distributions and so on. Given the huge number of potential strategies and the difficulty of establishing all the consequences, this is extremely complex, and we are unaware that even a hypothetical problem of this sort has ever been solved. This is presumably why actual disaster risk management appears to economists as ad hoc.

At the farm level, disaster risk management can be collapsed to two sets of controls, those for reducing risks and those for coping with risks (Figure 5). Risk reduction encompasses all aspects of farming technique. By their choice-of-technique, including capital formation and diversification, farmers are implicitly choosing a probability distribution of outcomes. Risk-reduction strategies consist of actions that reduce the extent of damages in bad times (e.g.; choice of crop, variety, planting date and pest control) and actions that reduce portfolio risk (e.g. crop and employment diversification and the use of multiple planting dates). These strategies can be reduced to a relationship between a "premium," i.e. the sacrifice in expected income (I), and the amount by which risk is reduced (see numerical illustration in part V).

We view the choice of coping strategy here as an ex ante decision involving precautionary mechanisms that can be used to smooth consumption in the face of adverse events such as saving and insurance. Saving includes the purchase of durables that can be sold. Insurance includes the cultivation of relationships (social capital) that can be drawn upon in hard times (Walker and Jodha 1986). Ex-post coping actions involve the execution of precautionary strategies, e.g. cashing in savings or insurance and borrowing from relatives and friends.

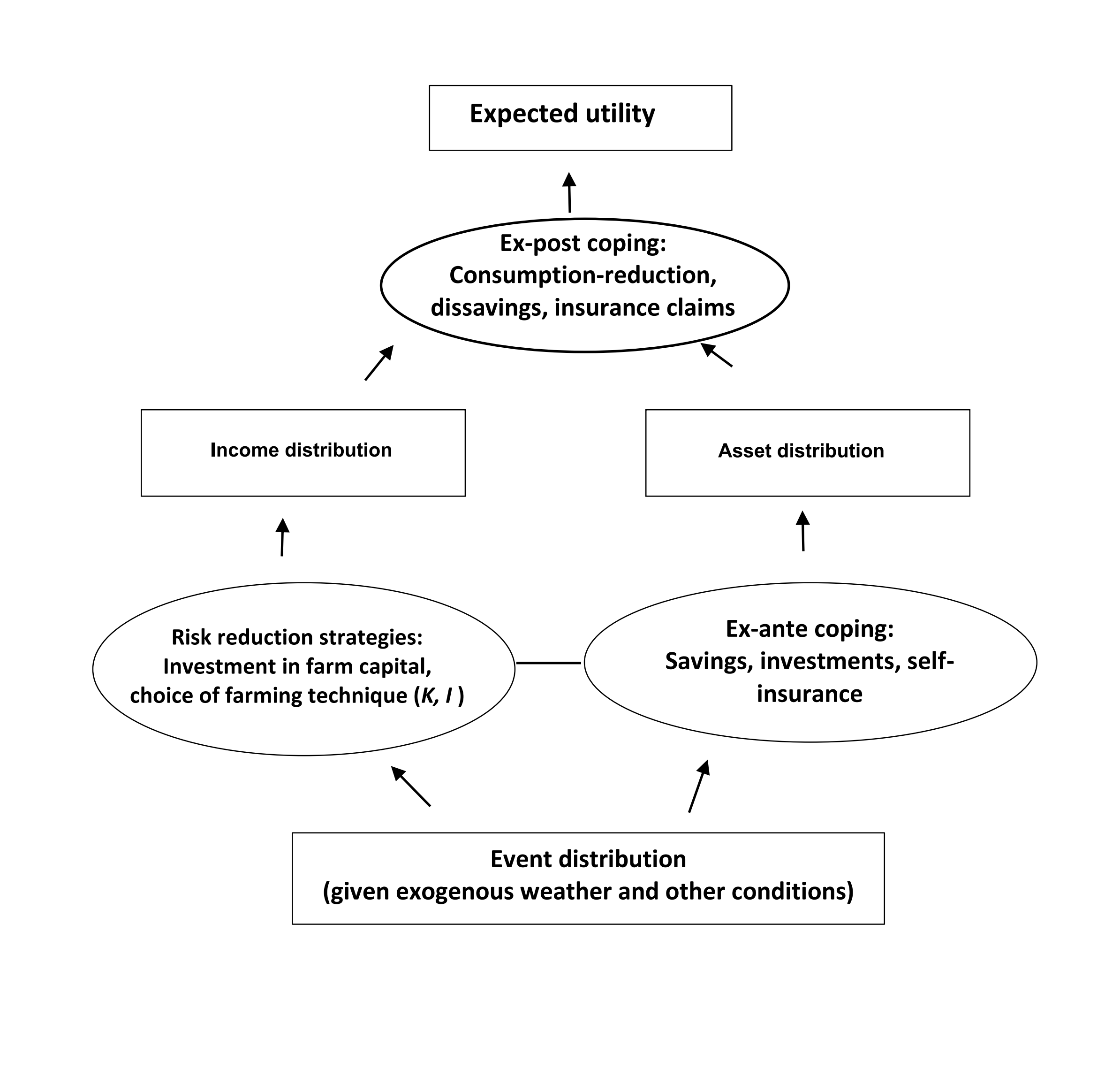

Figure 5 Farm-Level Risk Management

Farm-Household Risk Management

The conceptual challenge lies in integrating risk management and coping strategies into a single decision-making framework. To begin, we consider a two period model with a single stage of decisions, e.g. consider precaution without the *ex post* part of coping.[1] We consider on-farm capital, K, to be at risk p of being damaged. The production function in the undamaged state is AK^{α}. In the damaged state, production is θAK^{α}, $0 \leq \theta \leq 1$. At time 0, the household decides on whether to augment its endowment, W, by borrowing, (B), and how to allocate its augmented endowment to farm capital (K), other investments (N) and initial period consumption (C_0). The budget constraint is $W_0 + B = C_0 + K + N$. We assume that the borrowing rates are higher than lending/investment rates such that if $B > 0$, $N=0$ and vice versa. The borrowing rate is denoted by r while the rate of return of other investments is given by ρ.

The agent's problem is therefore:

$$\max_{K,N} V = U(C_0) + \beta EU(C_1)$$

subject to $C_0 + K + N = W_0 + B$

where β is the discount factor (inverse of one plus the discount rate).

Note that consumption in period 1 is state-dependent, that is,

$$C_{11} = \theta AK^{\alpha} + (1+\rho)N - (1+r)B$$

and

$$C_{12} = AK^{\alpha} + (1+\rho)N - (1+r)B$$

for the bad and good states respectively.

Thus, the objective function can be rewritten as

$$V = U(W_0 + B - K - N) + \beta pU(\theta AK^{\alpha} + (1+\rho)N - (1+r)B) + \beta(1-p)U(AK^{\alpha} + (1+\rho)N - (1+r)B)$$

The First Order Condition of this problem yields two equations. First, we have that

$$\frac{\partial U / \partial C_0}{\beta \left(p\theta \, \partial U / \partial C_{11} + (1-p) \, \partial U / \partial C_{12}\right)} = \alpha AK^{\alpha-1}$$

[1] *Ex post* coping could be included in a two period model by allowing the farm-household to sell undepreciated capital (at a discount) and/or to enjoy a terminal value of undepreciated capital that has not been sold. Of course this would further complicate the analysis.

The left hand side, $U'(C_0)/\beta E[U'(C_1)]$, is the marginal rate of substitution between current and future consumption, where the latter given in expectations form. The right hand side is the marginal product of capital in the undamaged state, $[\alpha A(K)^{\alpha-1}]$. This Ramseyesque equation governs optimal saving. As shown by Gollier (2013), the household discount rate is given by the marginal product of capital in the good state $[\alpha AK^{\alpha-1}]$, adjusted downward for a term reflecting precaution. A household with greater impatience, i.e. with a lower discount factor must have a lower marginal product of capital. This implies greater consumption and less capital formation, a potential factor that increases the difficulty of the poor in climbing out of poverty.

Second, we have that

$$\alpha AK^{\alpha-1}\frac{\left(p\theta\, {\partial U}/{\partial C_{11}} + (1-p)\, {\partial U}/{\partial C_{12}}\right)}{\left(p\, {\partial U}/{\partial C_{11}} + (1-p)\, {\partial U}/{\partial C_{12}}\right)} = 1+\rho = MEI$$

This equation says that the optimal composition of farm and non-farm investments is determined by the condition that the expected-utility-weighted marginal product of farm capital K is equal to the marginal efficiency of non-farm investments.

Even this simplified framework is too complicated to yield unambiguous comparative statics results regarding the increase of risk and risk aversion on saving and the composition of investments. For that we turn to a numerical analysis of an alternative model that includes the option to lower the variance of farm output at some sacrifice to mean output, analogous to purchasing insurance.

Our farm household now has three instruments to control current consumption (time 0) and consumption in each of two states at time 1. It can make on-farm investments (farm capital, K), off-farm investments (N) and can invest in “insurance” (I). I represents the envelope of various forms of diversification and self-insurance encompassing activities that lower the variability of household income at some cost, e.g. the application of pesticide. At time 0, the household decides on whether to augment its endowment, W, by borrowing, B, and how to allocate its augmented endowment to farm capital (K), insurance (I), other investments (N) and initial period consumption (C_0).

The budget constraint faced by the agent is:

$$W + B = C_0 + K + I + N \qquad (1)$$

where

W - agent’s endowment
C_0 - Initial period consumption
K - amount of capital
I - amount of “insurance”
N - off-farm investments
B - agent’s borrowing amount

As before, the borrowing rate for capital is denoted by r; the return on off-farm investments is given by ρ.

Output in period 2 is given by the stochastic production function $y = \theta AK^{\alpha}$ where θ is the stochastic parameter, which takes the form $\theta = \frac{1}{2} \pm \frac{d}{(1+hI)}$. Thus, "investments" in I reduce the variability of output y. The variable h reflects the "attractiveness" of insurance while the parameter d reflects how output will vary. For example, if d = ½ and h = 2, θ goes from $\frac{1}{2} \pm \frac{1}{2}$ to $\frac{1}{2} \pm \frac{1}{6}$ as I goes from 0 to 1. That is, θ becomes more tightly distributed around ½ as I increases.

Consumption in period 2 is state contingent; C_{11} denotes consumption in the bad state and C_{12} denotes consumption in the good state.

$$C_{11} = AK^{\alpha}\left[\frac{1}{2} - \frac{d}{(1+hI)}\right] + [1+\rho]N - [1+r]B \quad (2)$$

$$C_{12} = AK^{\alpha}\left[\frac{1}{2} + \frac{d}{(1+hI)}\right] + [1+\rho]N - [1+r]B \quad (3)$$

The household's period utility function is of the constant relative risk aversion (CRRA) form: $U(C) = \frac{C^{1-\eta}}{1-\eta}$. The parameter η is equivalently the coefficient of relative risk aversion, the absolute value of the elasticity of marginal utility of consumption, and the preference for smoothing (inverse of the intertemporal elasticity of substitution).

The household's problem is to choose the level of K, I, and N to maximize its expected utility (V) subject to the budget constraint (1). That is, the agent's problem is:

$$\underset{K,I,N}{\text{Max}}\, V = U(C_0) + \beta EU(C_1) \quad (5)$$

where $EU(C_1) = pU(C_{11}) + (1-p)U(C_{12})$ and p is the probability of a bad state.

subject to $W + B = C_0 + K + I + N$ and non-negativity conditions for consumption in any state.

We consider two coefficients of relative risk aversion, depending on whether the agent is risk neutral or risk averse The corresponding two-period utility functions of these risk aversion coefficients are:

$$\eta = 0 \Rightarrow V = C_0 + \beta E(C_1)$$

$$\eta = 2 \Rightarrow V = -\frac{1}{C_0} - \beta E\left(\frac{1}{C_1}\right)$$

In what follows, we provide a numerical example to highlight some interesting cases where endowment falls (where agents have the option to borrow) and when the probability of a bad state changes. These are intended to illustrate the interaction of coping and risk-taking and how these are affected by preferences and opportunities.

Simulation results

We first examine a high endowment scenario. The assumptions and parameters used are:

- $W = 10$
- $\beta = 0.97$
- A = 6
- α = 2/3
- $d = 0.5$ and $h = 2$. First period consumption is therefore:
- $C_{1i} = 6\, K^{\frac{2}{3}}\left(\frac{1}{2} \pm \frac{0.5}{1+2I}\right) + [1+\rho]N$
- Rate of return on off-farm investment: $\rho = 0.4$.

We examine cases where the probability of a bad state is low, that is, $p = 1/3$ and the case where the probability increases to ½.

Table 4 shows the results for the high-endowment scenario. For the risk neutral case, current consumption (C_0) and consumption in the bad state (C_{11}) are very low. Without the need for smoothing, the household's best strategy is to put its eggs into the future good-state (C_{11}) basket. They do this by saving and investing in K and N, especially capital.

As the preference for smoothing (η) increases, the sum of *K*, *I* and *N* decreases in order to increase current consumption. Also increasing the proportion of safe and risk-reducing assets (*N* and *I*), relative to *K*, increases bad-state consumption.

As the probability of disaster increases, *K* becomes more vulnerable to damage such that agents increase the allocation of savings to the safe asset, because of its higher expected rate of return. Agents with higher risk aversion increase proportion of their portfolios in *N* even more than risk neutral agents in order to smooth consumption towards the bad state.

In summary, without a preference for smoothing, the expected utility maximizing solution is to invest heavily in high-payoff farm capital, which results in large consumption in the good state and low consumption in the current period and the bad state. As risk and/or the preference for smoothing increases, the household adjusts its portfolio towards safer investments. The result of an increased probability of disaster is to decrease current consumption, affording an increase in savings and an increased percentage of savings going to off-farm investments. The latter effect dominates the former such that investment in vulnerable capital decreases. Risk reducing techniques represented by *I* again increase with risk but only slightly.

Table 4 High endowment scenario

	Risk neutral (η=0)		**Risk averse (η=2)**	
Probability of a bad state	**Low (1/3)**	**High (1/2)**	**Low (1/3)**	**High (1/2)**
K	6.91	2.92	1.09	0.71
I	0.00	0.00	0.13	0.14
N	3.09	7.08	2.93	3.49
$K/(K+I+N)$	0.69	0.29	0.26	0.16
$I/(K+I+N)$	0.00	0.00	0.03	0.03
$N/(K+I+N)$	0.41	0.71	0.71	0.80
C_0	Negligible	Negligible	5.84	5.65
C_{11}	4.33	9.92	4.78	5.42
C_{12}	26.09	22.16	9.79	9.15
Coefficient of Variation (Consumption)	1.38	1.04	0.26	0.31
V	18.27	15.56	–0.30	–0.32

Source: Calculated by authors.

We now consider a low-endowment scenario wherein our household can borrow to finance investment in farm capital and the use of risk-reducing techniques. As before, we disallow any strategy that risks negative consumption in the bad state. In effect this augments the nature of risk aversion. Not only does the household hate to lose more than it likes to gain according to the coefficient of risk aversion, but it is not allowed to violate a subsistence constraint.[1]

With low endowments, agents have the option to borrow at a constant rate r, which is assumed to be higher than the rate of return for non-farm investments ρ. Since the shadow price of loanable funds is r for this case, off-farm investment is zero. We assume that endowment W is set to 1 and all other parameters are the same as in the previous scenario.

Table 5 presents the simulation results of the low endowment scenario. In the risk neutral case, the agent borrows to finance the possibility of high consumption in the good state. However, risk averse agents in this particular example, do not borrow at all. These agents put almost half of their endowment into savings for K and I, and just over half for current consumption. This leaves future consumption in the bad state to be more than half of the amount as current consumption, with future consumption in the good state much higher. The composition of savings also changes in favor of risk reduction. *I*.

[1] Chetty and Looney (2006) suggest that households closer to subsistence are necessarily more risk averse. This is not true inasmuch as a consumption threshold may make households more desperate (Roumasset 1976, Banerjee 2000). To the extent that a subsistence constraint is important, it should be directly manifested in the model, not buried under the rug of risk aversion. This construct is also representative of an endogenous borrowing constraint; the lender does not lend an amount that risks a high probability of default.

Table 5 Low endowment scenario

	Risk neutral (η=0)		Risk averse (η=2)	
Probability of bad state	**Low (1/3)**	**High (1/2)**	**Low (1/3)**	**High (1/2)**
K	1.0000	1.0000	0.254	0.263
I	0.0000	0.0000	0.195	0.223
B	negligible[a]	negligible[a]	0.00	0.00
K/(K+I)	1.0000	1.0000	0.57	0.54
I/ (K+I)	0.0000	0.0000	0.43	0.46
C_0	0.0001[a]	0.0001[a]	0.55	0.51
C_{11}	0.0000	0.0001	0.34	0.38
C_{12}	5.9999	5.9995	2.071	2.086
Coefficient of Variation	1.73	1.73	0.96	0.95
V	4.0414	3.523	–3.09	–3.45

Source: Calculated by authors.

[a]Although the value of borrowing for both high and low probability is a very small positive number, the value in the high probability case is higher than the value in the low probability case.

Increasing the probability of disaster has surprisingly little effect on household choice. On the one hand, the household is tempted to decrease investment in *K* in response to its increased vulnerability. On the other hand, the household needs *K* in order to provide for consumption in the future bad state. In our simulation, the latter effect outweighs the former and thus *K* increases slightly. As expected the increased risk of disaster is reflected in lower expected utility for both the risk neutral and risk averse households.

Low-income households that are less patient, i.e. have lower discount factors will consume more current consumption and allocated less to capital formation. This poses an additional barrier to climbing out of poverty.

In summary, we have shown in this section that as the smoothing parameter η increases, high-endowment agents will put less into on farm-capital and more into off-farm capital to help smooth consumption between the good and bad states. The ability to undertake off-farm investments lowers the need to employ risk-reducing measures on the farm. Low endowment households borrow and invest in capital until its return in expected utility terms is equal to the cost of borrowing. They do not invest in off-farm investments, given the higher borrowing rate. Even risk averse households do not avail of off-farm investments because the expected marginal utility from capital is higher at small investment levels. Increased risk aversion does however result in higher levels of "insurance" as a device to smooth consumption between good and bad states.

In other words, there may be little low income households can do in response to increased vulnerability. This does not imply, as suggested by Chetty and Looney (2006) that there is a strong case for government-subsidized social insurance. Resources may be better spent on removing the underlying causes of poverty such as low agricultural productivity and transaction costs that tend to isolate disadvantaged areas.

Even the ex-ante risk management considered in this section involves non-trivial computations. A more complete model would allow for both *ex ante* and *ex post* coping strategies. This could be done in a three period model, where the household makes consumption and investment decisions at both times 0 and 1. If the adverse event occurs, the household engages in some belt-tightening by cutting back on consumption and investment, augments income by giving up some leisure, and borrows and/or sells durable assets. Alternatively, an augmented two-period model could be used, as suggested in footnote 7.

Farm-Level Risk Management: Empirical Evidence

The farm-household data are from the baseline survey of the Philippine Center for Economic Development Social Protection (PCED-SP) Survey conducted in May-June 2014. The purpose of the PCED-SP Survey is to investigate the full spectrum of shocks and to examine how these households cope with shocks. The survey covered 32 types of shocks, defined as adverse events that reduce welfare, including health and economic shocks and shocks caused by naturally occurring events. The SP Study collected information on the demographic characteristics, income and expenditures, assets and housing characteristics, vulnerability to shocks and coping mechanisms the household employed, and participation in and utilization of social protection programs by the sample households. The SP survey uses a multi-stage cluster sampling design with a nationally representative sample of 3,100 households who were randomly drawn from 57 out of the 80 provinces of the Philippines. The 57 provinces were chosen such that both high and low-risk areas (in terms of weather conditions, population density, and security issues) were represented. The sample includes at least one province per region.

a. Stylized Facts

Table 6 shows the economic profile of household respondents. Out of 3,100 households surveyed, 834 farm-households were identified. A farm or agricultural household is defined to be any of the following: owner/non-owner of the land who is responsible for making day-to-day decisions in operating the holding, including the management and supervision of hired labor; owner/non-owner of the land who works on the land alone or with members of the household; owner of the land who does not work on the land but employs others to do so; self-employed working in a farm; employer in own family-operated farm receiving or not receiving cash or share of farm output; entrepreneur engaged in crop farming or gardening and livestock and poultry raising. About 31% of farm-households sampled are in the poorest quintile.

Table 6 Economic profile of household respondents

	Count	Average	No. of farm HH	Percentage of farm HH
1 - Poorest	620	10,079	190	31
2	620	18,191	173	28
3	620	26,385	174	28
4	620	38,888	148	24
5 - Richest	620	75,756	149	24
Total	**3,100**	**33,860**	**834**	

Note: Constructed based on average Per Capita Expenditure

Natural events of extreme intensity that cause shocks are classified as: 1) frequently occurring natural events, where the reference period of recall is January 2009 up to the time of the survey and 2) less frequently occurring events, where the reference period is from 1980. Frequently occurring natural events of extreme intensity include strong winds and rain, flooding, landslides, drought, extreme heat, big waves (including tsunami and storm surge), biological hazards, and crop losses from pests and disease. Earthquakes and volcanic eruptions are classified as less frequently occurring natural events. The nature of the coping mechanisms used for frequently vs. less frequently occurring events differ markedly, as do policy actions. Charveriat (2000) noted that public investments in preparedness for the more frequent events are typically undertaken because the realization of benefits accrues while those in power are still serving their time. In this paper, we focus primarily on the shocks arising from frequently occurring natural events and investigate the household coping mechanisms used.

Table 7 shows the incidence of shocks experienced by agricultural households that arise from the seven identified frequently occurring natural events. Out of the 834 farm households, 779 households reported having experienced at least one of the seven frequently occurring natural events since January 2009. Among farm households, 355 (43 percent) reported to have experienced strong winds and rain; 200 or 24 percent experienced flooding. The respondents were also asked to rank according severity (from 1 as most severe) the shocks that they have experienced. The ranking is relative to the 32 shocks identified in the SP Survey. Of the 779 households reporting that they have experienced the named events, 445 households experienced these at “most severe” levels. Among the 355 farm-households that experienced strong winds and rain, 233 or 66 percent of the household rank this shock as the most severe. Among the 200 farm-households reported having experienced flooding due to continuous rain and storms, 58 percent of them rank this shock as the most severe. For the 128 farm households that experienced drought, 44 percent rank it as the most severe. The last column of Table 7 shows that cumulative number of households who ranked the respective natural events in their top 5 most severe shocks. Out of the 834 farm household-samples, 523 identified the seven shocks arising from frequently occurring natural events in their top 5 most severe shocks experienced from 2009-2013.

Table 7 Incidence and severity of shocks experienced by agricultural households.

Type of shock (frequently occurring	No. of household	No. of household	No. of households
Strong winds and rain	355	233	268
	(100)	*(66)*	*(75)*
Flooding due to continuous rain, storms, and so on	200	116	137
	(100)	*(58)*	*(69)*
Landslides/mudslides	10	4	4
	(100)	*(40)*	*(40)*
Drought	128	56	68
	(100)	*(44)*	*(53)*
Extreme heat	32	4	11
	(100)	*(13)*	*(34)*
Big waves (tsunamis and storm surges)	5	3	3
	(100)	*(60)*	*(60)*
Pest infestations and crop diseases	49	29	32
	(100)	*(59)*	*(65)*
Total	*779*	*445*	*523*

Source: Calculated by authors from PCED SP survey data. Note: Figures in parenthesis indicate the share of households reporting a result among the total number experiencing the shock. See Column 1 of Table 7.7 for the total number of households experiencing each shock.

After the household respondents reported and identified each shock, the survey explored household losses and damages, investment and consumption adjustment, coping measures, and assistance sought from public and private institutions related to each shock. Table 8 shows the number of households that lost some of their assets from shocks and incurred medical and other recovery-oriented expenses. Damages of crops, livestock, and farming equipment were also reported (Table 9). Of the 355 farm-households that experienced strong winds and rains, 67 percent lost all or part of their crops, 6 percent lost livestock, and 2 percent lost farming equipment. Of the 200 farm-households that experienced flooding, 61 percent, percent 8, and 1 percent lost their crops, livestock, and farming equipment, respectively.

Respondents were then asked whether their households have already recovered from the negative consequences of the shocks. The respondents were asked to rate the extent of their recovery based on the following scale: (a) not at all, (b) not much, (c) much, and (d) yes completely. Table 11 shows that about 20 to 50 percent of the farm-households reported that they have fully recovered from the shock at the time of the survey. The others are still in various stages of welfare loss.

Table 8 Results of the shocks from frequently occurring natural events

Type of shock (frequently occurring natural events)	Loss/ destruction of assets	Unplanned medical expenses	Other expenses	No impact
Strong winds and rain	135	17	32	180
	(38)	*(5)*	*(9)*	*(51)*
Flooding due to continuous rain, storms, and so on	67	13	18	106
	(34)	*(7)*	*(9)*	*(53)*
Landslides/mudslides	3	0	2	5
	(30)	*0*	*(20)*	*(50)*
Drought	29	3	7	89
	(23)	*(2)*	*(5)*	*(70)*
Extreme heat	6	3	2	21
	(19)	*(9)*	*(6)*	*(66)*
Tsunamis and storm surges	2	0	0	3
	(40)	*0*	*0*	*(60)*
Pest infestations and crop diseases	18	0	6	26
	(37)	*0*	*(12)*	*(53)*

Source: Calculated by authors from survey data.

Note: Figures in parenthesis indicate the share of households reporting a result among the total number experiencing the shock. See Column 1 of Table 7 for the total number of households experiencing each shock.

Table 9 Damages experienced by the farm-households.

Type of shock (frequently occurring natural events)	Crop loss	Livestock loss	Loss of farming equipment	No loss
Strong winds and rain	238	20	7	106
	(67)	*(6)*	*(2)*	*(30)*
Flooding due to continuous rain, storms, and so on	122	16	2	68
	(61)	*(8)*	*(1)*	*(34)*
Landslides/mudslides	9	0	0	1
	(90)	*(0)*	*(0)*	*(10)*
Drought	88	5	0	38
	(69)	*(4)*	*(0)*	*(30)*
Extreme heat	17	0	0	15
	(53)	*(0)*	*(0)*	*(47)*
Tsunamis and storm surges	1	0	0	4
	(20)	*(0)*	*(0)*	*(80)*
Pest infestations and crop diseases	46	0	0	3
	(94)	*(0)*	*(0)*	*(6)*

Source: Calculated by authors based on survey data.

Note: Figures in parenthesis indicate the share of households reporting a result among the total number experiencing the shock. See Column 1 of Table 7 for the total number of households experiencing each shock.

Respondents were also asked about the effect of particular shocks on household well-being. Among these, strong winds and rain and flooding affected the greatest number of farm-households, with more than 50 percent of those experiencing shocks reporting that their family's well-being was greatly affected (Table 10).

Table 10 Effect on the family's well being of the shocks.

Type of shock (frequently occurring	No	Some	Much	Extreme	Total
Strong winds and rain	41	133	116	65	355
	(12)	*(37)*	*(33)*	*(18)*	*(100)*
Flooding due to continuous rain, storms,	18	60	74	48	200
	(9)	*(30)*	*(37)*	*(24)*	*(100)*
Landslides/mudslides	2	1	5	2	10
	(20)	*(10)*	*(50)*	*(20)*	*(100)*
Drought	29	48	37	14	128
	(23)	*(38)*	*(29)*	*(11)*	*(100)*
Extreme heat	2	14	13	3	32
	(6)	*(44)*	*(41)*	*(9)*	*(100)*
Tsunamis and storm surges	1	2	1	1	5
	(20)	*(40)*	*(20)*	*(20)*	*(100)*
Pest infestations and crop diseases	2	13	21	13	49
	(4)	*(27)*	*(43)*	*(27)*	*(100)*

Source: Calculated by authors from survey data.

Note: Figures in parentheses indicate the share of households in each category.

Table 11 Perception of recovery from shocks.

Type of shock (frequently occurring natural events)	No recovery	Partial or full recovery: Little recovery	Significant recovery	Complete recovery	Total
Strong winds and rain	72	97	69	117	355
	(20)	*(27)*	*(19)*	*(33)*	*(100)*
Flooding due to continuous rain, storms, and so on	41	40	52	67	200
	(21)	*(20)*	*(26)*	*(34)*	*(100)*
Landslides/mudslides	2	1	2	5	10
	(20)	*(10)*	*(20)*	*(50)*	*(100)*
Drought	44	27	15	42	128
	(34)	*(21)*	*(12)*	*(33)*	*(100)*
Extreme heat	5	8	4	15	32
	(16)	*(25)*	*(13)*	*(47)*	*(100)*
Tsunamis and storm surges	1	2	1	1	5
	(20)	*(40)*	*(20)*	*(20)*	*(100)*
Pest infestations and crop diseases	8	5	17	19	49
	(16)	*(10)*	*(35)*	*(39)*	*(100)*

Source: Calculated by authors from survey data. Note: Figures in parentheses indicate the share of households in each category.

Recovery in the context of the PCED SP Survey is understood to be in terms of the households' financial well-being. The farm household respondent is asked how much money would have to be given to them in order to return to their family's well-being as before. Table 12 presents the households who have ranked the shocks as rank 1-5 according to severity and their perceived monetary value needed for recovery. Those who have answered options (b), (c), and (d) across all shocks in Table 11 are grouped together under "Partial/Full Recovery" in Table 12. Expectedly, the amount required by those who have not experienced any recovery is higher at a median of PhP 15,000 than those who have experienced partial or full recovery at a median of PhP 10,000.

Table 12 Average Amount for Recovery vs Type of Recovery

Type of recovery	**No. of hhs**	**Mean (PhP)**	**Median (PhP)**	**Stdev**	**C.V.**	**Min (PhP)**	**Max (PhP)**
No recovery	119	21,563	15,000	24,121	1.12	500	150,000
Partial or full recovery	403	22,778	10,000	30,280	1.33	1	200,000
Total	522	22,501	10,000	28,974	1.29	1	200,000

Source: Calculated by authors from survey data.

We now examine the various coping strategies employed by the farm households in order to deal with shocks. Appendix Tables A1-A5 present the details of these coping strategies according to the type of frequently occurring natural events. Table 13 presents the incidence of farm households resorting to financial coping strategies such as borrowing, drawing on savings, selling farm goods and equipment, and other financial coping strategies, including selling household assets, harvesting early, delaying investments, and mortgaging and pawning goods and assets. Across all shocks, farm-households mostly depend on loans and drawing on their savings in order to cope with shocks. Appendix Table A1 shows the details of these financial coping strategies according to natural events.

Appendix Table A2-A4 provides the information of drawing on the households' non-cash savings. Appendix Table A2 presents the details by natural events of the incidence of selling goods. About 7% of those households that experienced the various shocks from the frequently occurring natural events reported selling goods, including crops that they might have otherwise consumed. Appendix Table A3 presents the incidence of household reducing consumption. About one third of those households that experienced shocks have reduced their consumption to cope with shocks. Table A4 provides a further disaggregation of the households' dissaving of non-cash assets or reduction in the consumption of food, education, utilities, medical care, and recreation. Many of these households have requested assistance from the government, from individuals or groups, and from non-government organizations (see Appendix Table A5).

Table 13 Financial coping activities of the farm households

Financial coping mechanism	**No. of households that adopted mechanism**	**No. of households that did not adopted mechanism**	**Total**
Took out a loan	88	435	523
	(17)	*(83)*	*(100)*
Used cash savings	171	352	523
	(33)	*(67)*	*(100)*
Sold farm goods and equipment	42	481	523
	(8)	*(92)*	*(100)*
Other	40	483	523
	(8)	*(92)*	*(100)*
None	231	292	523
	(44)	*(56)*	*(100)*

Source: Calculated by authors from survey data.

Note: “Other” includes borrowing from friends/family, pawning items, and so on.

Table 14 shows coping strategies available to the farm-households and perceptions of the relative importance of these strategies. Respondents indicated that spending cash savings, reducing consumption, and borrowing from others were the most important coping strategies. Among the 523 farm households who have identified shocks from frequently occurring natural events in their top 5 most severe shocks, 30 percent said that spending cash savings is the most important coping strategy, 18 percent specified the reduction of consumption, and 14 percent indicated borrowing from others.

Table 14 Most important coping strategies

Most-important coping	**Frequency (no.)**	**Share (%)**
Borrowing from others	74	*(14)*
Using cash savings	156	*(30)*
Delaying investment	2	*(0)*
Selling assets	12	*(2)*
Selling harvest/products	16	*(3)*
Pawning property	1	*(0)*
Stopping school/changing schools	3	*(1)*
Reducing consumption	92	*(18)*
Temporarily migrating	3	*(1)*
Receiving help from a politician	1	*(0)*
Taking on extra work	3	*(1)*
Asking relatives for help	1	*(0)*
None	159	*(30)*
Total	523	*(100)*

Source: Calculated by authors from survey data.

Many farm-households that have experienced shocks took precautionary measures at the start of planting season to lower the risk of loss. These risk management measures include adjusting or delaying planting time, adjusting the choice of crop variety, increasing the use of fertilizer, building better farm infrastructure, building dikes for better water flow, and cleaning streams and canals of sediments and other impediments to flow. Appendix Table A6 shows the details of the incidence of households taking these measures. The data shows that farm-households invest in risk-management measures when they are the primary beneficiaries. Adjusting planting time and choosing crop variety are the most common measures. However, as with other public goods, households seldom invest in cleaning canals and building dikes inasmuch as the whole community benefits from these activities. This is where local governments can fill in the gap.

Table 15a shows the incidence of households who have taken risk-management measures by economic profile. About 77% of the 523 farm households who have experienced shocks actually did take these measures. Of these, relatively more are from the upper 60% segment of the sample. This is to be expected from the exercises in Section V. Poorer households have less ability to access the instruments of risk-management in the face of shocks. Datt and Hoogeveen (2003) also found that poor Philippine households have limited ability to cushion consumption against shocks, relative to the non-poor.

Table 5a Adoption of risk-management measures, by economic profile

Economic profile	**No. of households that adopted measure**	**No. of households that did not adopt measure**	**Total**
Lower 40 percent	156	39	195
	(80)	*(20)*	*(100)*
Upper 60 percent	249	79	328
	(76)	*(24)*	*(100)*
Total	405	118	523
	(77)	*(23)*	*(100)*

Pearson chi2(1) = 1.1682 Pr = 0.280 | Source: Calculated by authors from survey data.

We have also examined whether prior experience of a shock would prompt the households to take on ex-ante measures to cope with shocks and to manage risk. Table 15b shows that out of those who have experienced a similar shock before, 78 percent took long-term risk-management precautionary measures. Prior experience may also influence household responses when there is already an imminent natural event. These responses include those precautionary measures typically undertaken right after receiving warning, such as securing the dwelling with ropes, stockpiling food and other essentials, moving to evacuation areas, going to the houses of relatives and friends, and moving productive assets to safer places. Table 15c (lower panel) shows that of those who have prior experience, only 11 percent have taken some form of these immediate precautionary measures after receiving warning.

Table 15b Incidence of taking risk management measures

Experienced Shock Before	Took Risk Management Measures		
	No	Yes	Total
No	**53**	**171**	**224**
	(24)	*(76)*	***(100)***
Yes	**65**	**234**	**299**
	(23)	*(77)*	***(100)***
Total	**118**	**405**	**523**
	(23)	*(77)*	***(100)***

Pearson chi2(1) = 0.2706 Pr = 0.603

Table 15c Incidence of taking risk management and ex-ante coping measures

Experienced Shock Before	Took both risk management and ex-ante coping measures after receiving warning		
	No	Yes	Total
No	**207**	**17**	**224**
	(92)	*(8)*	***(100)***
Yes	**271**	**28**	**299**
	(90)	*(10)*	***(100)***
Total	**478**	**45**	**523**
	(91)	*(9)*	***(100)***

Pearson chi2(1) = 0.5132 Pr = 0.474

A primary motivation for undertaking precautionary measures is the risk of losing crops and other farm assets. Consistent with the risk-management measures of adjusting planting time and choosing crop variety, Table 16 shows that about two-thirds of the farm-households that experienced the shocks are worried about losing their crops.

Table 16 Damages that concern farm households

SHOCK	Crop loss	Livestock	Loss of	No loss
Strong winds and rain	258	29	15	82
	(73)	*(8)*	*(4)*	*(23)*
Flood due to continuous rain, storms, etc.	135	29	8	47
	(68)	*(15)*	*(4)*	*(24)*
Landslide/mudslide	10	1	0	0
	(100)	*(10)*	*(0)*	*(0)*
Drought	96	11	2	26
	(75)	*(9)*	*(2)*	*(20)*
Extreme heat	21	4	0	9
	(66)	*(13)*	*(0)*	*(28)*
Tsunamis and storm surges	2	0	0	3
	(40)	*(0)*	*(0)*	*(60)*
Pest infestation, crop diseases	47	2	0	2
	(96)	*(4)*	*(0)*	*(4)*

Note: Figures in parenthesis are percentages of the number of household reporting to total number that have experienced each shock. Total number of household that experienced each shocks are found in Colum 1 of Table 7.

In summary, floods and strong winds and rain are the most commonly experienced shocks that result in damages to assets and crops. About half the farm households experiencing these events recover to some extent and are able to smooth consumption by using savings, obtaining loans, or selling farm goods and equipment.

b. Empirical Model

Given the stylized facts presented above, we now investigate the factors that determine the partial or full recovery of farm households. We use a *logit* model[1] to explain the probability of partial to full recovery of the households, where partial or full recovery is coded as 1. The number of sample considered in the model (n=523) are the farm households who rank the shocks arising from frequently occurring natural events as their top 1-5 most severe shocks (ranking is relative to 32 shocks identified in the SP Survey). The model in Table 17a presents the full range of the farm household's financial and non-financial coping mechanisms. The precautionary measures that have been described primarily involve risk management. Ex-post coping measures in this analysis include spending cash savings and availing of loans, as discussed in the previous section. Depletion of non-cash savings are also included, e.g., selling crops and farm equipment, as well as the reduction of expenses on education, utilities and recreation, and stopping schooling altogether. Other forms of coping with shocks include migration and seeking assistance from the government and private groups. The model includes initial conditions of the households, such as educational attainment, age, gender of the household head, and whether the household is a beneficiary of the government's conditional cash transfer (CCT) program. CCT is also interacted with the two prominent coping mechanisms: spending cash savings and selling farm goods to account for behavioral effects. A dummy for prior experience of the same shock is added to test if learning from past experience affects recovery. A dummy for Region 8 is also included given that Tyhoon *Yolanda*, the most recent natural event of extreme magnitude, severely hit the region. The model also includes a dummy for the farm households that rank the shock arising from these natural events as the most severe. These are the 445 farm households presented in Table 7 (column 2).

The results of the *logit* models (full and reduced models) are presented in Tables 17a and 17b. The full model in Table 17a and the reduced model in Table 17b have likelihood ratios (chi-square statistics) between 44.35 and 41.83, with p-values between 0.0001 and 0.0021. The p-values indicate very low probabilities that the independent variables of each model, taken together, have no effect on the dependent variable. In the full model (Table 17a), the coefficient for spending cash savings is significantly positive (within the 95% confidence interval). This is also true for the dummy variable for Region 8 and the educational variables.

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[1] The empirical exercise follows the model in Ravago and Mapa (2014).

Table 17a What influences recovery (Full Model)

Dependent Variable: Household has Partially/Completely Recovered				
Explanatory Variables	**Coeff.**	**Robust SE**	**p-value**	
HH took precautionary measures	0.04	0.28	0.84	
Loan	0.02	0.31	0.91	
Spent cash savings	0.81	0.29	0.01	*
Sold farm goods and equipment	0.87	0.66	0.18	
Reduced consumption (educ, utilities, and recreation)	0.03	0.27	0.92	
Moved to another area	-0.09	0.78	0.89	
Received assistance (government and private)	-0.08	0.28	0.85	
HH head is elementary graduate	0.39	0.34	0.22	
HH head is high school undergraduate	1.02	0.39	0.01	*
HH head is high school graduate	0.57	0.33	0.09	*
HH head is college undergraduate	0.85	0.40	0.03	*
HH head is college graduate	0.97	0.54	0.08	*
Age of HH head	-0.01	0.01	0.24	
Sex of HH head (female = 1)	0.70	0.43	0.10	*
HH has other sources of income	0.33	0.33	0.28	
CCT household	0.06	0.30	0.87	
HH experienced similar shock before	-0.01	0.24	0.16	
Interaction: Spent cash savings and CCT HH	0.10	0.68	0.84	
Interaction: HH sold goods and CCT HH	0.19	1.27	0.85	
Region 8 =1	-0.64	0.24	0.01	*
HH ranked shock as most severe = 1	-0.53	0.35	0.13	
Constant	1.39	0.64	0.01	*

Note: Number of Obs. = 523; Log pseudolikelihood = -256.78874 -255.78045; Wald chi^2 = 44.35 46.51 (p-value= 0.0021 0.0011);
McFadden R-squared = 0.0841 0.0880; the significant variables (95% confidence interval) are indicated with *.

Even though expenditures on education and discretionary consumption were not significant explanators of recovery, it may well be that reducing educational expenditures keeps families in poverty. For example, Chetty and Looney (2007) examine the effect of household unemployment shocks on distributions of food consumption and education-expenditure growth rates for Indonesia. They show that the negative skewness of these distributions increases two to three times the decrease in the mean levels. Consumption and education expenditures at the top decile continue to grow at the same rate as before the shock. But the bottom 40-50% of households suffers lower growth rates and most of these experience negative growth rates. As households cut back on education and other investments, they damage their prospects for eventually climbing out of poverty.

Table 17b presents the results of Reduced Model 2, showing the marginal effects of various variables on the probability of recovery. Significant variables are indicated by asterisks. The result shows that the most prominent coping activity for farm-households is spending cash savings and selling farm goods and equipment. The coefficients of these two variables are positive for the 95 percent confidence interval. For households that utilized cash savings, the probability of partial to full recovery increases by about 13 percentage points (marginal effect) relative to households without savings, controlling for other factors. For households who sold their farm goods to cope with shocks, the probability of partial to full recovery increases by about 12 percentage points relative to households who did not sell goods, again controlling for other factors. As expected, the dummy variable for Region 8 has a negative sign. The farm households are most likely reporting Typhoon *Yolanda* as the most recent shock that they have experienced. For farm-households who are in Region 8, the probability of partial to full recovery decreases by about 8 percentage points.

Table 17b What influences recovery (Reduced Model)

Dependent Variable: Household has Partially/Completely Recovered					
Explanatory Variables	**Coeff.**	**Robust SE**	**P-value**		**Marginal effects**
Spent cash savings	0.86	0.26	0.00	*	0.13
Sold farm goods and equipment	0.93	0.58	0.11	*	0.12
HH head is elementary graduate	0.40	0.33	0.22		0.06
HH head is high school undergraduate	1.03	0.39	0.01	*	0.14
HH head is high school graduate	0.59	0.32	0.07	*	0.09
HH head is college undergraduate	0.86	0.40	0.03	*	0.12
HH head is college graduate	1.00	0.53	0.06	*	0.13
Age of HH head	-0.01	0.01	0.36		0.00
Sex of HH head (female = 1)	0.73	0.43	0.09	*	0.10
CCT household	0.11	0.26	0.68		0.02
Region 8 HH = 1	-0.67	0.23	0.01	*	-0.12
HH ranked shock as most severe	-0.52	0.34	0.13		-0.08
Constant	1.36	0.61	0.03		

Note: Number of Obs. = 523; Log pseudolikelihood = = -257.38184; Wald chi^2 = 41.83 (p-value= 0.0001); McFadden R-square = 0.0823

The results also show that education substantially increases the probability of recovery. If the household head had one or more years of high school, the probability of partial to full recovery increases by 14 percentage points. If s/he graduated high school, it increases by 9 percentage points. If the household head had college education but did not graduate, the probability of partial to full recovery increases by 12 percentage points. For college graduates the probability increases by 13 percentage points.

The gender of the household head also influences recovery as the result in Table 17c shows. For female-headed households, the probability of partial to full recovery increases by about 10 percentage points relative to male-headed households.

Concluding Remarks

This paper provides an initial framework regarding priorities for government programs to reduce the natural-disaster vulnerability of farm households in the Philippines. We provide a conceptual framework for understanding resilience at the household level and evidence from the PCED Social Protection Survey about coping strategies of farm households. The numerical example helps to clarify what coping really means and how coping strategies are affected by an increased probability of shocks/disasters. As the preference for smoothing (risk aversion) and/or the probability of disaster increases, high endowment households will put less into on farm-capital in order to increase current consumption and a greater proportion of savings into off-farm capital and risk-reducing investments in order to smooth consumption between the good and bad states. The ability to undertake off-farm investments also lowers the need to employ risk-reducing measures on the farm.

As either risk aversion or the probability of disaster increases, wealthier households tend to substitute less-vulnerable off-farm capital for farm capital and to increase risk-reducing investments to avoid dramatic decreases in consumption when a negative event occurs. Poorer households, who are unable to borrow for off-farm investments, are also incented not to borrow more than negligible amounts for farm capital because of high borrowing rates and the fact that farm capital is vulnerable to natural disasters. Increased risk aversion does, however, result in higher levels of risk-reducing investments as a device to increase consumption when the bad shock hits. Given the severe limits on risk-reducing investments, there may be little that low-income households can do in response to increased vulnerability from climate change.

Empirical evidence from the Social Protection Survey shows that farm households employ various strategies to cope with adverse shocks and avoid severe disruption of consumption levels. Examples of these coping strategies include borrowing; drawing on savings; selling household assets; harvesting early; selling harvests they might otherwise have consumed; and asking for assistance from individuals, groups, the government, and nongovernment organizations. Using cash savings, reducing consumption, and borrowing were the most important and most-frequently employed strategies. Empirical data also shows that farm households that experienced shocks also took risk-reducing measures at the start of planting season. Adjusting planting time and choosing a different crop variety were the most common and important of these measures. Any public goods, however, households seldom invest in cleaning streams and canals or building dikes because these activities benefit the whole community. Further research is needed to determine priorities among the risk management and coping strategies represented in the conceptual framework provided.

The poorest farm-households are also those with the fewest tools for reducing risks at the farm level and coping with losses at the household level. The fact that low-income households are largely unable to cope with shocks does not, however, imply a strong case for government-subsidized social insurance. Crop insurance, for example, is likely to be already oversubsidized (Wright 2014 and 2015).

Risk-management interventions are more appropriately directed toward the sources of risk aversion. A primary reason why farmers dislike losing more than they like gaining (i.e. are risk averse) is transaction costs (Roumasset 1979, 2015). Buying prices are higher than selling prices because of transportation, communication, and the costs of contracting. Borrowing costs are typically higher than the returns to saving for the same reasons. Government policies that decrease *unit transaction costs* (such as the cost of transporting one kilogram of produce one kilometer) thus decrease the costs of risk. Insofar as climate change increases the costs of risk, it also increases the benefits of transportation and communications infrastructure. Just as households find that costly mechanisms to maintain consumption levels in times of crisis may be worthwhile, countries can ameliorate scarcity across locations through better infrastructure, thereby lowering the consequences of adverse events. Similarly, policies that improve the rule of law in commercial transactions (such as enforcing standards and measures) decrease the costs of risk. Undertaking costly measures of managing risks without commensurate attention to the artificial creation of risk aversion is clearly inefficient.

Similarly, climate change increases the costs of agricultural policies that increase transaction costs. For example, the policies of the National Food Authority both increase consumer prices and displace private investments in in transportation and storage that would decrease the associated transaction costs (Roumasset 2000). Similarly land-reform policies have increased transaction costs, most notably in the agricultural land market, to the point that legal transactions are uncommon (Sicat 2014). Reforming these risk-increasing policies should be the first priority in helping farmers adapt to climate change.

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Appendix

Table A1 Number of farm household resorting to financial coping strategies.

SHOCK	Loan (1)	Spent cash savings (2)	Sold household assets and goods (3)	Harvest/ manufactured products or crops in advance (4)	Delayed/ forego investments (5)	Mortgaged or pawned goods and assets (6)	None (7)
Strong winds and rain	40	121	7	16	1	1	173
	(11)	*(34)*	*(2)*	*(5)*	*(0)*	*(0)*	*(49)*
Flood due to continuous rain, storms, etc.	37	68	5	5	1	0	87
	(19)	*(34)*	*(3)*	*(3)*	*(1)*	*0*	*(44)*
Landslide/mudslide	2	7	0	2	0	0	0
	(20)	*(70)*	*0*	*(20)*	*0*	*0*	*0*
Drought	19	40	7	8	1	0	55
	(15)	*(31)*	*(5)*	*(6)*	*(1)*	*0*	*(43)*
Extreme heat	3	10	3	0	0	0	16
	(9)	*(31)*	*(9)*	*0*	*0*	*0*	*(50)*
Tsunamis and storm surges	1	1	0	0	0	0	3
	(20)	*(20)*	*0*	*0*	*0*	*0*	*(60)*
Pest infestation, crop diseases	17	10	3	5	0	0	14
	(35)	*(20)*	*(6)*	*(10)*	*0*	*0*	*(29)*

Note: Figures in parenthesis are percentages of the number of household reporting to total number that have experienced each shock. Total number of household that experienced each shocks are found in Column 1 Table 7.

Table A2 Incidence of selling goods to cope from shock

SHOCK EXPERIENCED	Sold Goods To Cope from Shock			Items Sold to Cope from Shock		
	Yes	No	TOTAL	Crops	Livestock	Farming Equip't
Strong winds and rain	**26**	**329**	**355**	**23**	**4**	**0**
	(7)	*(93)*	*(100)*	*(88)*	*(15)*	*(0)*
Flood due to continuous rain, storms, etc.	**14**	**186**	**200**	**9**	**6**	**0**
	(7)	*(93)*	*(100)*	*(64)*	*(43)*	*(0)*
Landslide/mudslide	**2**	**8**	**10**	**2**	**0**	**0**
	(20)	*(80)*	*(100)*	*(100)*	*(0)*	*(0)*
Drought	**11**	**117**	**128**	**7**	**4**	**0**
	(9)	*(91)*	*(100)*	*(64)*	*(36)*	*(0)*
Extreme heat	**3**	**29**	**32**	**3**	**0**	**0**
	(9)	*(91)*	*(100)*	*(100)*	*(0)*	*(0)*
Tsunamis and storm surges	**0**	**5**	**5**	**0**	**0**	**0**
	(0)	*(100)*	*(100)*	*(0)*	*(0)*	*(0)*
Pest infestation, crop diseases	**4**	**45**	**49**	**3**	**1**	**0**
	(8)	*(92)*	*(100)*	*(75)*	*(25)*	*(0)*

Table A3 Number of households reducing consumption due to shocks.

SHOCK	Agri HH		
	Yes	No	TOTAL
Strong winds and rain	**121**	**234**	**355**
	(34)	*(66)*	*(100)*
Flood due to continuous rain, storms, etc.	**74**	**126**	**200**
	(37)	*(63)*	*(100)*
Landslide/mudslide	**3**	**7**	**10**
	(30)	*(70)*	*(100)*
Drought	**27**	**101**	**128**
	(21)	*(79)*	*(100)*
Extreme heat	**8**	**24**	**32**
	(25)	*(75)*	*(100)*
Tsunamis and storm surges	**2**	**3**	**5**
	(40)	*(60)*	*(100)*
Pest infestation, crop diseases	**16**	**33**	**49**
	(33)	*(67)*	*(100)*

Table A4 Number of households reducing consumption due to shocks.

SHOCK	Food only	Educa -tion	Utilities	Medical Care	Recrea tion	Other Non-food
Strong winds and rain	**41**	**19**	**38**	**0**	**53**	**5**
	(34)	*(16)*	*(31)*	*(0)*	*(44)*	*(4)*
Flood due to continuous rain, storms, etc.	**32**	**6**	**21**	**0**	**31**	**0**
	(43)	*(8)*	*(28)*	*(0)*	*(42)*	*(0)*
Landslide/mudslide	**1**	**0**	**0**	**0**	**2**	**0**
	(33)	*(0)*	*(0)*	*(0)*	*(67)*	*(0)*
Drought	**14**	**3**	**7**	**0**	**8**	**1**
	(52)	*(11)*	*(26)*	*(0)*	*(30)*	*(4)*
Extreme heat	**4**	**0**	**1**	**0**	**3**	**1**
	(50)	*(0)*	*(13)*	*(0)*	*(38)*	*(13)*
Tsunamis and storm surges	**0**	**0**	**0**	**0**	**1**	**0**
	(0)	*(0)*	*(0)*	*(0)*	*(50)*	*(0)*
Pest infestation, crop diseases	**11**	**0**	**3**	**0**	**3**	**0**
	(69)	*(0)*	*(19)*	*(0)*	*(19)*	*(0)*

Table A5 Incidence of asking for assistance

SHOCK	Government assistance		Individual/ group assistance		NGO/charity assistance		No, did not receive nor ask for assistance	
	Yes	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**
Frequently occurring natural events								
Strong winds and rain	45	310	16	339	30	325	279	76
	(13)	*(87)*	*(5)*	*(95)*	*(8)*	*(92)*	*(79)*	*(21)*
Flood due to continuous rain, storms, etc.	25	175	5	195	10	190	163	37
	(13)	*(88)*	*(3)*	*(98)*	*(5)*	*(95)*	*(82)*	*(19)*
Landslide/mudslide	1	9	0	10	0	10	9	1
	(10)	*(90)*	*0*	*(100)*	*0*	*(100)*	*(90)*	*(10)*
Drought	3	125	4	124	1	127	121	7
	(2)	*(98)*	*(3)*	*(97)*	*(1)*	*(99)*	*(95)*	*(5)*
Extreme heat	0	32	1	31	0	32	31	1
	0	*(100)*	*(3)*	*(97)*	*0*	*(100)*	*(97)*	*(3)*
Tsunamis and storm surges	0	5	0	5	0	5	5	0
	0	*(100)*	*0*	*(100)*	*0*	*(100)*	*(100)*	*(0)*
Pest infestation, crop diseases	1	48		49	0	49	48	1
	(2)	*(98)*	*0*	*(100)*	*0*	*(100)*	*(98)*	*(2)*

Note: Figures in parenthesis are percentages of the number of household reporting to total number that have experienced each shock. Total number of household that experienced each shocks are found in Column 1 Table 7.

Table A6 Long-term risk-management (precautionary) measures

SHOCK	Adjusted planting time/Delay planting time	Chose crop variety suited for the shock	Increased use of fertilizer	Built better farm infrastructure	Built dikes for better water flow	Cleaned streams canals	None
Strong winds and rain	**172**	**75**	**24**	**22**	**0**	**0**	**84**
	(48)	*(21)*	*(7)*	*(6)*	*(0)*	*(0)*	*(24)*
Flood due to continuous rain, storms, etc.	**83**	**34**	**13**	**16**	**1**	**1**	**56**
	(42)	*(17)*	*(7)*	*(8)*	*(1)*	*(1)*	*(28)*
Landslide/mudslide	**4**	**4**	**4**	**2**	**0**	**0**	**0**
	(40)	*(40)*	*(40)*	*(20)*	*(0)*	*(0)*	*(0)*
Drought	**59**	**38**	**14**	**10**	**1**	**0**	**24**
	(46)	*(30)*	*(11)*	*(8)*	*(1)*	*(0)*	*(19)*
Extreme heat	**10**	**7**	**3**	**4**	**0**	**0**	**9**
	(31)	*(22)*	*(9)*	*(13)*	*(0)*	*(0)*	*(28)*
Tsunamis and storm surges	**3**	**0**	**0**	**0**	**0**	**0**	2
	(60)	*(0)*	*(0)*	*(0)*	*(0)*	*(0)*	*(40)*
Pest infestation, crop diseases	**30**	**17**	**8**	**2**	**0**	**0**	2
	(61)	*(35)*	*(16)*	*(4)*	*(0)*	*(0)*	*(4)*

Note: Figures in parenthesis are percentages of the number of household reporting to total number that have experienced each shock. Total number of household that experienced each shocks are found in Column 1 of Table 7.