Coping with Disasters Due to Natural Hazards: Evidence from the Philippines[*]

Majah-Leah Ravago,[*] Dennis Mapa, [*] Jun Carlo Sunglao[*] and James Roumasset[**]
[*]University of the Philippines and [**]University of Hawaii

Abstract

We explored how local governments respond to disasters due to natural hazards to determine the mix of risk management and coping strategies (ex ante and ex post) they employ to improve welfare. We focused on disasters caused by hydro-meteorological hazards that occur with high frequency and high probability. Using data from a novel survey we conducted on disaster risk management practices of local government units (LGUs) in the Philippines, we developed indices of the various risk management and coping strategies of LGUs to explain what aids in their recovery from disasters.

The most prominent strategies are risk-coping activities, especially cleanup operations and receiving relief from others. Among ex ante activities, employing long-term precautionary measures improve recovery. These include building resilient housing units; investing in stronger public facilities; building dams, dikes, and embankments; upgrading power and water lines; maintaining roads; identifying relocation areas; and rezoning and land-use regulations. In contrast, interruption of lifeline services such as water and electricity contributes adversely to recovery. Evidence also shows that LGUs' profile characteristics matter. An LGU with higher local revenues has higher chances of recovery. On the other hand, being located in a province where dynasty share is high contributes negatively to an LGU's recovery. The combination of these ex ante and ex post risk management strategies informs policies on where to put priority and investments in disaster risk management.

Keywords: Disaster, shock, coping, risk management, local government
JEL Codes: Q54, D81, I38,

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1. Introduction

How can public policy be designed to balance the available ex ante and ex post controls to maximize expected economic welfare? What public interventions mediate in the adaption of risk management strategies and how? How effective are such public interventions in mitigating the adverse effects of these shocks on the welfare of the constituents of the local government units (LGUs)? Our objective is to investigate the economic dynamics of disaster risk management at the local level. Studies show that disasters due to natural hazards adversely impact different aspects of an economy, from long-run growth rates to natural-resource prices (see Cavallo and Noy 2011; Cavallo et al. 2013; Skidmore and Toya 2002; Prestemon and Holmes 2002). However, focusing on the local level is critical because this is where the distributional impacts of both disasters and disaster policies can be effectively assessed. Collecting data from LGUs allows us to evaluate the potential return on various investments in risk management strategies undertaken by local governments.

Our study focused on disasters due to hydro-meteorological hazards (i.e., strong winds and rain, flood, landslides, and big waves).[1] Our study contributes to the literature in two ways: first, by developing a survey instrument that collects primary data from local government units, and second, by developing a general conceptual framework on disaster risk management. While their particular application is the Philippines, the model and conceptual framework can be useful also to other countries that frequently experience disasters due to natural hazards.

[1] While our survey covered eight shocks caused by natural hazards, including drought and geological-related hazards, the difference in frequency of occurrence, probabilities, and political economy responses (Vorhies 2012; Charveriat 2000) warranted a separate analysis of disasters due to hydro-meteorological hazards from those due to geological hazards.

The benefits of disaster risk management are clearly identified, yet there is a clear under-investment in mitigation and preparedness in both developing and developed countries (Charveriat 2000). One reason is that investments in disaster risk management are largely public goods, which explains why the markets are not adequately providing them. Moreover, some political economy issues may also explain why public policy tends to fail at providing adequate levels of disaster risk reduction. On the supply side, these investments (e.g., land-use planning and construction of disaster-proof infrastructure) are generally long term. Because the benefits are intangible and occur in a period longer than most political mandates, the incentives for decision-makers to invest political power into long-term safety benefits are limited.

In the next two sections, we review the Philippines' vulnerability to disasters due to natural hazards and discuss related literature. Section 4 provides a conceptual framework for understanding resilience. The framework is used to shed light on the pros and cons of alternative public policies for reducing vulnerability. The succeeding sections present and discuss evidence from our survey about risk management strategies among local government units (LGUs) in the Philippines. The last section provides conclusions and recommendations.

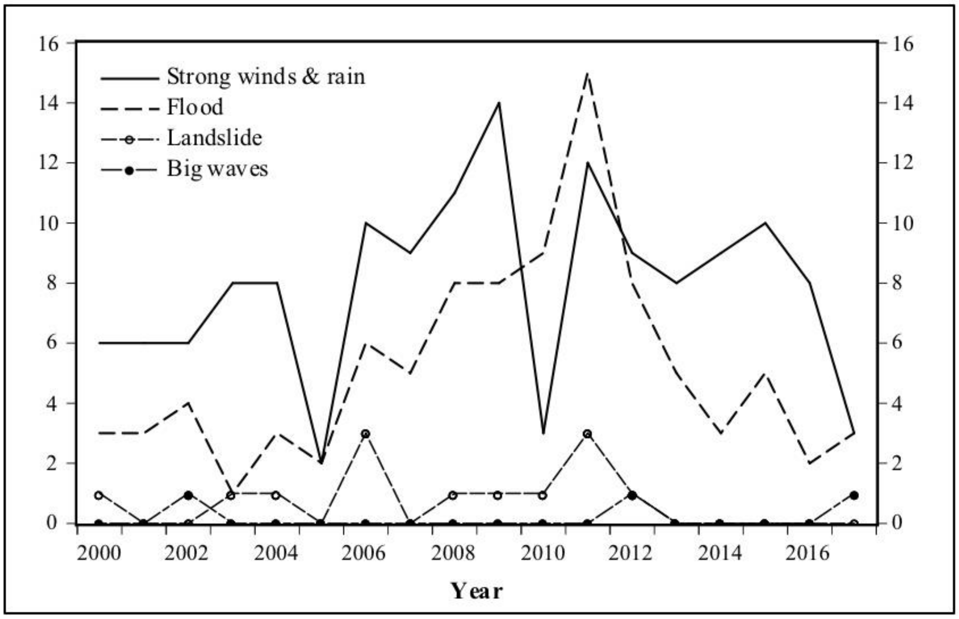
2. The Philippines' Vulnerability to Disasters

The Philippines routinely experiences severe disaster events, including El Niño, La Niña, earthquakes, and typhoons. Over the past decade, these disasters have increasingly become more severe and frequent, adversely affecting the exposed population, more so its poorer segment. People still vividly recall the shocking damages in the wake of typhoons *Haiyan* (local name *Yolanda*) in 2013, and *Ketsana* (local name *Ondoy*) and *Parma* (local name *Pepeng*) in 2009. Given the prominence of natural disasters, promoting public welfare requires sound risk management as well as economic policies.

The natural hazards, which raise the country's disaster risk profile, are inevitable because of the Philippines' geographical location. The World Risk Report consistently ranks the Philippines third in terms of geographical exposure toward natural hazards. It is important to distinguish natural hazards versus a disaster. Naturally occurring events only 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), which is the largest database of natural disasters at the country level (accessible at http://www.emdat.be/country-profile). For a natural hazard to be counted as a disaster by CRED, the following criteria must be satisfied: 10 or more people were killed, 100 or more people were injured or suffered losses, a state of emergency has been declared, and a call for international assistance has been issued.

Figure 1 presents the year-on-year occurrence of disasters in the Philippines from 2000 to 2017 based on CRED's definition of disasters due to hydro-meteorological hazards. An upward trend is observed from 2005 to 2011, and in 2013 due to typhoon *Haiyan* (*Yolanda*). An average of 20 typhoons (strong winds and rains) annually pass through the Philippines; 14 reached disaster status in 2009. Disastrous flooding has also increased, registering the highest incidence of 15 in 2011.

Figure 1. Incidence of disasters due to hydro-meteorological hazards, 2000-2017.



Note: *Hydro-meteorological hazards: Strong winds and rain, flood, landslide, and big waves
Sources of basic data:

(1) EM-DAT: The Emergency Events Database - Universite catholique de Louvain (UCL) - CRED, D. Guha-Sapir, Brussels, Belgium (www.emdat.be) accessed on 20 Feb 2018
(2) National Centers for Environmental Information – National Oceanic and Atmospheric Administration (NOAA) - Boulder, CO USA (www.ngdc.noaa.gov) accessed on 20 Feb 2018

When local response capacity is limited, natural hazards can easily elevate into disasters and take a toll on the economy. Table 1 shows the total value of damages and losses from disasters due to flood, strong winds and rains, landslides, and big waves from 2000 to 2017. Not surprisingly, the more severe the disaster is, the higher is the value of damages and losses. The costliest disaster since 2000 had been due to typhoon *Haiyan* (*Yolanda*), where economic damages and losses reached about USD 12 billion. This experience demonstrates that gains from various economic reforms undertaken over the years can be negated by a single disaster.

Table 1. Total value of damage and loss to the economy due to hydro-meteorological hazards.*

Year	No. of occurrences	Total deaths	Injured	Affected	Homeless	Total affected	Total damage ('000 USD)
2000	10	736	393	6,230,269	125,250	6,355,912	87,544.00
2001	9	630	480	3,441,257	100,000	3,541,737	107,061.00
2002	11	305	136	1,134,628	3,000	1,137,761	15,376.00
2003	10	350	75	604,471	83,203	687,749	42,302.00
2004	12	1,918	1,321	3,252,957	8,700	3,262,978	138,867.00
2005	4	39	-	213,057	-	213,057	2,515.00
2006	19	2,984	2,703	8,566,265	-	8,568,968	347,281.00
2007	14	129	24	2,009,032	-	2,009,056	16,815.00
2008	20	959	1,015	8,404,236	54,645	8,459,896	481,202.00
2009	23	1,307	898	13,303,957	100	13,304,955	962,017.00
2010	13	376	157	5,443,250	-	5,443,407	335,087.00
2011	30	1,933	6,500	11,681,893	-	11,688,393	730,025.00
2012	19	2,271	2,756	12,136,613	35,762	12,175,131	993,467.00
2013	13	7,520	28,917	22,415,992	-	22,444,909	12,371,351.00
2014	12	331	2,269	13,211,844	-	13,214,113	1,062,899.00
2015	15	201	131	3,834,083	3,300	3,837,514	1,881,567.00
2016	10	79	2	5,534,608	-	5,534,610	180,074.00
2017	7	67	12	1,848,350	-	1,848,360	10,100.00

Notes: *Hydro-meteorological hazards: strong winds & rain, flood, landslide, and big waves
Sources of basic data:

(1) EM-DAT: The Emergency Events Database - Universite catholique de Louvain (UCL) - CRED, D. Guha-Sapir, Brussels, Belgium (www.emdat.be) accessed on 20 Feb 2018
(2) National Centers for Environmental Information – National Oceanic and Atmospheric Administration (NOAA) - Boulder, CO USA (www.ngdc.noaa.gov) accessed on 20 Feb 2018

Given the Philippines' vulnerability to disasters, the challenge to the government has been to improve the local response capacity to mitigate damages and losses. By all accounts, disaster risk management in the Philippines still has a long way to go (Santiago et al. 2016; Ravago et al. 2016a). Budgeting is clearly lagging behind expressed needs for disaster risk management programs, and there is little flexibility in the budget to account for shocks in fiscal spending brought about by natural hazards. Local Government Units (LGUs) across the country have varying disaster-related demands and revenue-raising capabilities, but these variances are not considered in the allocation of disaster funds, creating an imbalance between local resources and risk exposure. Furthermore, funding is not only inadequate in terms of amount but also underutilized, mostly due to misidentification of needs and bureaucratic inefficiencies, as outlined in a report of the Commission on Audit (2014).

3. Related Literature

An important theme in disaster research is local or regional impact. After all, disasters are localized shocks -- that is, every disaster that hits a country can have catastrophic impact in some areas, while other areas can be completely unaffected. Bertinelli and Strobl (2013) and Strobl (2012), employing nightlight satellite imagery, investigated the impact of hurricane strikes on the local economic activity in the Caribbean. Evidence shows that the impact at the local level is more than twice what is shown in the aggregate analysis. Similarly, Rodriguez-Oreggia et al. (2013) found that disasters had significant impact on affected municipalities in Mexico in terms of human development and poverty. On the average, the human development index regressed to its level a couple of years back. Disaggregating by type of event, they found that floods and droughts had more significant adverse effects. The political variables seem to be relevant in explaining the magnitude of the impact of disasters, opening a room for analysis on such issue.

We note that decentralization of post-disaster response may be undermined by damages on local government infrastructure, such as heavy casualties among staff; damage to buildings, equipment, or files used in administration and service provision; and loss of local taxes through lost lives, property, and businesses. These damages not only decrease the local government's capacity, but also increases their dependence on the central government. Sobel and Leeson (2006) argue that these difficulties are due to two things. One, there is incentive for local officials to exaggerate requests, and little incentive to provide accurate information on needs. Two, there are no price signals that can efficiently allocate the provision of mitigation 'goods'.

On the economic recovery following a disaster due to natural hazards, four competing hypotheses are offered in the literature describing the long-term evolution of welfare as represented by the gross domestic product per capita. Hsiang and Jina (2014) provide a schematic illustration of these trajectories, namely: creative destruction, build back better, recovery to trend, and no recovery.

The “creative destruction” hypothesis posits that disasters provide temporary economic stimulation (i.e., innovation) due to higher demand for goods and services as lost and damage capital is being replaced. Skidmore and Toya (2002); Belasen and Polachek (2008); Hsiang (2010); and Deryugina (2011) are some examples that follow this line of analysis. The “build back better” hypothesis argues that disaster adversely impacts growth initially but the gradual replacement of lost and damage assets results in a positive effect on long-run growth (Cuaresma et al. 2008; Hallegatte and Dumas 2009). The “recovery to trend” hypothesis also conjectures a negative effect on growth but only for a finite period; then economic growth rebounds to an aberrantly high level until income levels converge to the pre-disaster trend (Yang 2008; Strobl 2011). Finally, the “no recovery” hypothesis, which is the pessimistic among the four hypotheses, posits that lost and damage productive capital is replaced, but there is no rebound effect. Post-disaster output may continue to grow in the long run but it is permanently lower than the pre-disaster trend. Examples of studies along this line include Field et al. (2012) and Anttila-Hughes and Hsiang (2013). Field et al. (2012), however, note that no study thus far has falsified any of the four hypotheses on trajectory of welfare.

4. Survey of Local Government Units

We explored how local governments in the Philippines respond to disasters due to natural hazards to determine the mix of ex ante and ex post risk management strategies they employ to improve welfare. With officials from the Local Disaster Risk Reduction and Management Offices (LDRRMOs) as respondents, we conducted a survey on disasters due to natural hazards that had struck their respective areas. This is the first contribution of our study to the literature on disaster management.

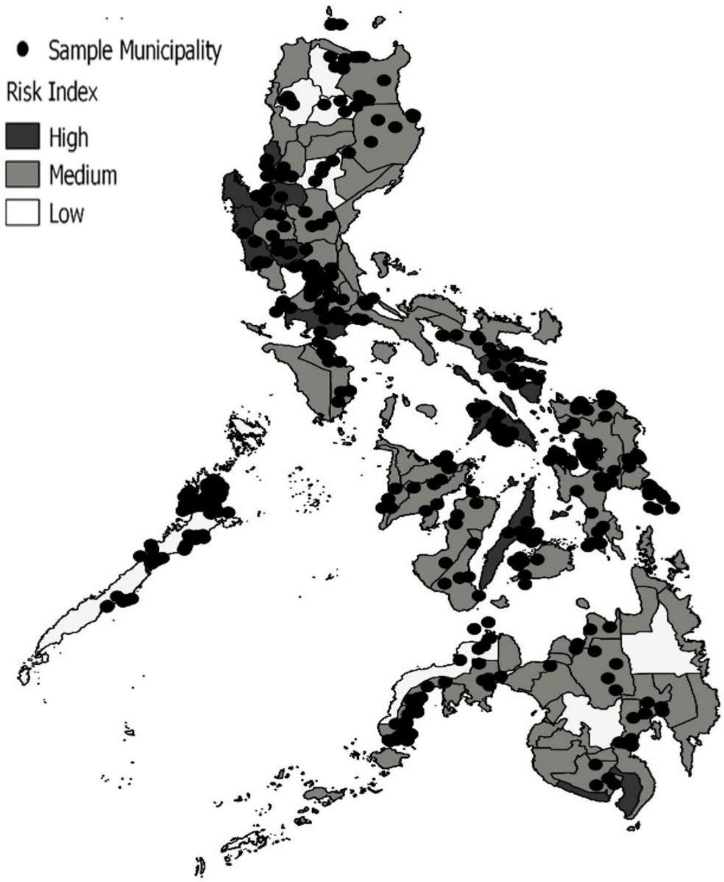
The survey used a multi-stage cluster sampling design with a nationally representative sample of 193 municipalities and cities that were randomly drawn from 47 out of the 81 provinces of the Philippines. The sample selection was based on high- and low-risk in terms of weather conditions, population density to account for exposure, and security issues (especially in southern Philippines), resulting in the exclusion of 34 provinces (see online Appendix Table 2). The bases of risk classification were the calculated risk by the Manila Observatory (2005) for the provincial level and Project NOAH[2] for the municipal level. The survey was done from November 2016 to April 2017 and from September to October 2017.[3]

Figure 3 shows the risk classification by province and the distribution of 193 sample municipalities and cities.

[2] Project NOAH (Nationwide Operational Assessment of Hazards) is a multidisciplinary research with the goal of helping reduce the impacts of hazards.

[3] The declaration of martial Law in Mindanao affected the schedule of the survey. It was initially announced that the martial law would be lifted on 22 July 2017, but was extended until 31 December 2017. Due to safety concerns, some of the provinces in Mindanao had to be replaced with other provinces of similar characteristics.

Figure 3. Risk classification and distribution of sample municipalities in the Philippines.



Source of basic data on mapping: VM Observatory (accessed in November 2017)
http://vm.observatory.ph/risk_maps.html

The initial conditions of an LGU, such as population size and income, matters. The population of about 85 percent of the sample municipalities ranged from 41,000 to 2 million (online Appendix Table 3). In terms of poverty incidence, 22.8 percent were in the fourth and fifth quantiles, indicating that these municipalities/cities had a high poverty incidence. The revenues of the sample municipalities were coming largely from local sources, external source, tax, and internal revenue allotment (IRA) (online Appendix Table 4). Moreover, about 18 percent of the sample cities had a total income of PhP 400 million and above; about 30 percent of sample municipalities had income of more than PhP 55 million (online Appendix Table 5).

Institutions and the political economy play a role in shaping the economic policies on disaster risk management strategies (Vorhies 2012; Charveriat 2000; Cohen and Werker 2008). We used the dynastic nature of governance (Mendoza et al. 2016; Balisacan and Fuwa 2004) in the Philippines as proxy variable for institutions. Table 6 shows data on political dynasty in the sample municipalities. "Dynasty share" is the proportion of elected local officials occupied by dynasties.

We developed our survey instrument for this study by modifying and augmenting the questionnaire of the Philippine Center of Economic Development (PCED) Social Protection Survey (Ravago et al. 2016b). We focused on only eight shocks caused by natural hazards. Shock is defined as an unforeseen adverse event or disaster due to natural hazards that can lead to a decrease in welfare of the community. These eight shocks were disasters due to: (1) strong winds and rains, (2) flood due to continuous rains and storms, (3) landslides/mudslides, (4) big waves, including tsunami and storm surge, (5) drought, (6) biological hazards (e.g., leptospirosis), (7) earthquakes, and (8) volcanic eruptions.

Table 7 shows the blocks constituting our survey instrument. Block A asks for the profile and characteristics of the Local Disaster Risk Reduction and Management Office (LDRRMO) officers and their respective LGUs. Block B covers the incidence of shocks, related damages, and state of recovery. Block C, D, and E cover the risk management strategies corresponding to potential actions taken at the various levels represented by the ovals in Figure 3. These strategies include controls or ex ante reduction of exposure, early warning and response, ex post reduction of exposure, and coping strategies (Table 7).

Table 7. Coverage of the survey instrument.

	Block	Description
A1	Profile	Profile of the city/municipality and the LDRRMO officer
A2	LDRRM plan and budget	Information on the LDRRMO and its budget
A3	DRRM Training	Disaster-related training received and conducted by the LDRRMO
A4	Assets	Inventory of disaster management assets
B1	Incidence of shocks	Incidence of shock(s)
B2	Damages	Damages from the shock(s) that hit the area
B3	State of recovery	Recovery from the shock(s) that hit the area
C1	Controls: ex ante reduction of exposure	Short-term, mid-term, and long-term harm mitigation activities implemented by the city/municipality
C2	Early warning and response	Warnings received and issued by the city/municipality in relation to the shock(s)
D1	Ex post loss reduction: evacuation	Conduct of evacuations
D2	Ex post loss reduction: search and rescue	Conduct of search and rescue operations
D3	Ex post loss reduction: state of calamity	Activities carried out by LDRRMO after declaration of state of calamity
D4	Ex post loss reduction: relief	Assistance provided by the LDRRMO to the constituents to help them cope with the shock(s)
D5	Ex post loss reduction: response from others	Assistance provided by government agencies and other LGUs in response to the shock(s)
E1	Coping: clean-up operations	Conduct of cleanup operations
E2	Coping: employment	Effect of the shock(s) on employment and housing
E3	Coping: loans	Loans applied for as additional funding to cope with the shock(s)
E4	Coping: rehabilitation of lifeline services	Impact of the shock(s) on electricity, water, and telecommunication services
E5	Coping: rebuilding and reconstruction	Spending of the city/municipality as a result of the shock(s)
E6	Coping: housing and relocation	Effect of the shock(s) on housing
F	Risk perception	Perception on the likelihood of shock(s) happening again in the future
G	Harm mitigation: agriculture and fisheries	Impact of the shock(s) on agriculture

Block F asks for the respondents' perception on the likelihood of the shock happening again in the future. Block G is a special block focusing on agriculture.

The demographic profile of the respondents (LGUs represented mostly by LDRRMO officials) shows that they were 18-60 years old and mostly (72.54%) reached or graduated from college while more than a fourth (26.42%) held postgraduate degrees (online Appendix Table 8).

5. Survey Results

The analysis in this paper, focuses on four shocks or disasters caused by hydro-meteorological hazards,[4] namely: (1) strong winds and rains, (2) flood due to continuous rains and storms, (3) landslides/mudslides, and (4) big waves, including tsunami and storm surge. The respondents were asked to recall any experience of these shocks starting in January 2009. Table 9 shows the incidence of these shocks, with 189 out of 193 sample municipalities having been affected by at least one of these four hazards. Among the four shocks experienced by the municipalities, the most prevalent is the shock due to strong wind and rains, accounting for 87 percent of the incidence of shocks among the sample LGUs.

Table 9. Incidence of shocks due to hydro-meteorological hazards in the sample municipalities of the Philippines starting in 2009.

Shock	Yes (%)	No (%)	Total (%)
Combined hydro-meteorological hazards	189	4	193
	(98)	(2)	(100)
Strong winds and rain	167	26	193
	(87)	(13)	(100)
Flood due to continuous rain, storms	147	46	193
	(76)	(24)	(100)
Landslide/mudslide	46	147	193

[4] Shocks due to geological hazards would require a different approach in analysis given the low probability and less frequency of occurrence.

	(24)	(76)	(100)
Big waves (including tsunami and storm surge)	31	162	193
	(16)	(84)	(100)

After reporting the shocks they had experienced, the respondents were asked to qualify these shocks in terms of severity. About 60 percent of them ranked the hydro-meteorological shocks they experienced as "very severe" and "most severe" (online Appendix Table 10). The respondents were also asked about valuation of damage and loss to infrastructure, economic, social, and cross-sectoral sectors.[5]

As regards recovery, 67 percent of the sample municipalities indicated having completely recovered from the shocks they experienced starting in 2009 (Table 11a). As of 2017, about 79 percent of the 189 sample municipalities reported that their recovery had been better than before (Table 11b). Recovery in this context is understood to be in terms of the well-being of the municipalities, using as indicators the number of families affected and the cost of damage and loss. The evolution of recovery (Hsiang and Jina 2014) matters when evaluating the welfare of the municipalities that have experienced shocks.

Table 11a. Incidence of recovery from shocks experienced by the sample municipalities starting in 2009.

Shock	Not at all (%)	Not much, but some (%)	Much, but not completely (%)	Yes, completely (%)	Total (%)
Combined hydro-meteorological hazards	5	13	44	127	189
	(3)	(7)	(23)	(67)	(100)
Strong winds and rain	4	12	42	109	167
	(2)	(7)	(25)	(65)	(100)
Flood due to continuous rain, storms, etc.	8	4	30	105	147

[5] Whenever possible, an official written loss and damage report is requested if available.

	(5)	(3)	(20)	(71)	(100)
Landslide/mudslide	4	3	9	30	46
	(9)	(7)	(20)	(65)	(100)
Big waves (including tsunami and storm surge)	6	1	8	16	31
	(19)	(3)	(26)	(52)	(100)

Table 11b. State of recovery of the sample municipalities as of 2017.

Shock	Better than before (%)	Same as before (%)	Worse than before (%)	Don't know (%)	Total (%)
Combined hydro-meteorological hazards	150	32	2	5	189
	(79)	(17)	(1)	(3)	(100)
Strong winds and rain	132	29	2	4	167
	(79)	(17)	(1)	(2)	(100)
Flood due to continuous rain, storms	113	29	0	5	147
	(77)	(20)	(0)	(3)	(100)
Landslide/mudslide	34	7	1	4	46
	(74)	(15)	(2)	(9)	(100)
Big waves (including tsunami and storm surge)	20	4	0	7	31
	(65)	(13)	(0)	(23)	(100)

We also examined whether prior experience of a disaster prompted the LGUs to take on ex ante measures to cope with shocks. On the average, LGUs experienced the hydro-meteorological disasters more than three times (Table 14). Those that had experienced these shocks more than three times undertook the above precautionary activities (see Appendix Table A1a, b, and c)

Table 14. Frequency of shocks experienced by the sample municipalities starting in 2009.

Shock	N	Mean	SD	Min	Max
Combined hydro-meteorological hazards	189	3.667	6.870	1	60
Strong winds and rain	167	3.605	6.621	1	60

Flood due to continuous rain, storms	147	3.340	5.745	1	42
Landslide/mudslide	46	2.630	4.720	1	27
Big waves (including tsunami and storm surge)	31	1.677	1.759	1	8

To determine the various disaster risk management strategies these municipalities have undertaken to deal with the consequences of the aforementioned disasters, the respondents were asked about risk management activities, ex ante and ex post, that helped them cope with the adverse effects of the shock. These strategies are undertaken at various time frames – before, during, and after the disaster. The ex ante strategies or controls are classified as long-term, medium-term, and short-term precautionary measures. Long-term precautionary measures are activities conducted by the LGUs in less than a year to as long as more than three years. Table 12 shows the long-term precautionary measures undertaken, which include building resilient housing, investing in stronger public facilities, building dams, upgrading power lines, road repairs, identifying relocation areas, rezoning, and building drainage. Interestingly, rezoning and land-use regulations were conducted by less than 50 percent of the sample municipalities as of 2017.

Table 12. Incidence of long-term precautionary measures undertaken due to hydro-meteorological hazards, (%)

Build resilient housing units	Invest in stronger public facilities	Build dams, dikes embankments	Upgrade power and water lines
90	102	108	60
(48)	(54)	(57)	(32)

Major road repairs	Identify relocation areas	Rezoning and land-use regulations	Build drainage	Others
104	106	88	120	37
(55)	(56)	(47)	(63)	(20)

The medium-term precautionary measures are activities conducted in anticipation that these hazards will take place soon. The time horizon for these activities are typically one year or shorter. These include cleaning sewers and canals and strengthening embankments. Table 13 reports that more than 50 percent of the sample municipalities had undertaken medium-term precautionary measures.

Table 13. Incidence of mid-term precautionary measures due to hydro-meterological hazards.

Assess safety of public buildings	Strengthen embankments	Clean sewers and canals	Assess/repair roads	Repair/rehabilitate classrooms	Others
142	122	154	137	127	20
(75)	(65)	(81)	(72)	(67)	(11)

Receiving timely information is crucial in reducing losses and damages resulting from these hydro-meteorological hazards. About 94 percent of the respondent municipalities received a warning before the disaster occurred and most of them responded to the warnings (Table 15).

Table 15. Incidence of early warning and response of municipalities due to hydro-meteorological hazards.

Receive or hear a warning before the shock occurred	Conduct preparatory checks after receiving the warning	Issue a warning to the constituents
177	174	175
(94)	(92)	(93)

Once these natural hazards are known to occur at a certain time, the sample municipalities conducted short-term precautionary measures in order to minimize exposure and damages (see Section 3). Such activities are implemented typically about a day or so before the shock. They include suspension of classes, issuance of gale warnings, road closures. The most frequent is suspension of classes; 91 percent of the sample municipalities reported doing this for all hydro-meteorological hazards (Table 16).

Table 16. Incidence of short-term precautionary measures due to hydro-meteorological hazards.

Class suspension	Gale warning	Road closures	Others
172	106	67	32
(91)	(56)	(35)	(17)

When these hydro-meteorological hazards strike and overwhelm the local capacity, they become a disaster. When this happens, immediate responses -- including search and rescue operations, evacuation, and declaration of state of calamity – should be immediately undertaken to reduce the distribution of initial losses. Evacuation was a top immediate response among the respondents, with more than 80 percent of the 189 municipalities issuing warnings and ordering evacuation (Table 17).

Another immediate response of LGUs had been to declare their area as being under a state of calamity. Doing so made them eligible to avail themselves of funds from local and national sources. About 21 percent of the respondents availed themselves of the National Calamity Fund (Table 17). More LGUs availed themselves of the Quick Response Fund because it is local and relatively easier to access. Local governments are mandated as per Republic Act 10121 to set aside 5 percent of their estimated revenue from regular sources for their disaster council. Of this allocation, 30 percent is automatically set aside as Quick Response Fund, which serves as a standby fund for relief and recovery programs when disaster strikes. The remaining 70 percent of the 5 percent allocation can be used for ex ante precautionary measures.

Extending assistance or relief is also an immediate response. About 94 percent of the 189 municipalities reported that they provided relief to their constituents (Table 17). About 85 percent reported that they had received assistance from other government agencies, LGUs, and nongovernment organizations (NGOs).

Table 17. Incidence of various risk management activities undertaken by the sample municipalities.

		Yes (%)	No (%)	Total (%)
Ex post loss reduction: evacuation	Issue a warning for evacuation	167	22	189
		(88)	(12)	(100)
	Issue an order for evacuation	153	36	189
		(81)	(19)	(100)
	Designate an evacuation center	178	11	189
		(94)	(6)	(100)
Ex post loss reduction: search and rescue	Conduct search and rescue	104	85	189
		(55)	(45)	(100)
	Disaster resulting in death, illness, or injury	84	105	189
		(44)	(56)	(100)
Ex post loss reduction: state of calamity	Declare a state of calamity	145	44	189
		(77)	(23)	(100)

		Yes (%)	No (%)	Total (%)
	Avail of the Quick Response Fund	132	57	189
		(70)	(30)	(100)
	Avail of the Calamity Fund	39	150	189
		(21)	(79)	(100)
Ex post loss reduction: relief	Extend assistance to the constituents after the shock	178	11	189
		(94)	(6)	(100)
Ex post loss reduction: response from others	Other government agencies, LGUs, or NGOs extend assistance during and/or after the shock	160	29	189
		(85)	(15)	(100)
Coping: cleanup operations	Undertake cleanup operations	172	17	189
		(91)	(9)	(100)
Coping: employment	Offer cash-for-work program after the shock	88	101	189
		(47)	(53)	(100)
	Offer food-for-work program after the shock	66	123	189
		(35)	(65)	(100)
Coping: loans	Ask for a loan after the shock	7	182	189
		(4)	(96)	(100)
Coping: rehabilitation of lifeline services	Any services that were interrupted during the shock (e.g., power and water)	165	24	189
		(87)	(13)	(100)
Coping: rebuilding and reconstruction	Any infrastructure or facility that broke down during or after the shock	145	44	189
		(77)	(23)	(100)
	Loss of any municipality records	27	162	189
		(14)	(86)	(100)
Coping: housing and relocation	Create a housing program because of the shock	43	146	189
		(23)	(77)	(100)

After the initial shock of a disaster had worn off, the LGUs undertook coping strategies for recovery, usually starting with cleanup operations. The cash- and food-for work strategy has gained popularity in the Philippines, with almost half of the sample municipalities offering such programs to speed up recovery among their constituents. In contrast, the facility for loans at the

LGU level is yet to develop (Table 17). Only a handful fully understand that LGUs can actually take out loans.

After the ex post loss reduction strategies, rebuilding and rehabilitation activities were began to fully restore the welfare of the constituents. About 87 percent of the municipalities reported that either water or power services were interrupted during the disaster and they had to fix these as soon as possible. About 77 percent of the sample municipalities also indicated that their public infrastructure broke down during or after the disaster (Table 17).

Finally, there are cases when a disaster totally wipes out the livelihoods and houses in a village. A housing and relocation program is the most expensive strategy to rebuild a community, often requiring funding from the national government. Only about 23 percent of the sample municipalities put in place a housing program because of a shock.

6. Empirical Analysis

Given the information presented above, we investigated which among the various risk management activities aid in the recovery of the municipalities. As discussed in the framework for disaster management, natural hazards are exogenous events. Ex ante and ex post risk management activities are mainly undertaken to reduce the potential exposure of the population, infrastructure damages, and expected losses. The ultimate goal is to build resilience.

a. Data

Our survey defined shock to respondents as an unforeseen adverse event that can lead to a decrease in their welfare. The incidence of shocks and severity reported in Tables 9 and 10 are respondents' perceptions based on this definition. To validate that these shocks were indeed severe and can potentially decrease welfare, we ran a correlation between the reported severity and several indicators of typhoon strength, which include storm signal, cyclone scale, intensity, and peak. Table 18a shows that storm signals as defined by the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) and peak are positively correlated with the reported severity. Table 18b shows the test of independence between the perceived severity and each of the four indicators of typhoon strength. Except for cyclone scale, the three pairings resulted in significant and dependent relationships. Hence, the correlation and independence tests validated that the respondents' perceived shock and severity according to the standard measure of typhoon strength.

Table 18a. Correlation of severity of shocks due to hydro-meteorological hazards and typhoon variables.

Variable	Type			Remarks
Storm signal+	Ordinal	Asymmetric Somer's D	0.169	Weak positive linear relationship
		95% CI	(0.013, 0.317)*	
Cyclone scale++	Ordinal	Asymmetric Somer's D	0.090	Not significant
		95% CI	(-0.059, 0.234)	
Intensity (hpA)	Ratio	Point-Biserial Correlation	0.057	Not significant
		t-stat	0.785	
		p-value	0.434	
Peak (kmh)	Ratio	Point-Biserial Correlation	0.245	Weak positive linear relationship
		t-stat	3.4502	
		p-value	0.001**	

Notes: * significant at 5% level; ** significant at 1% level.
(+) Based on PAGASA public storm signal warning
(++) Based on the Australian tropical cyclone intensity scale

Table 18b. Test of independence: combined shocks' severity and typhoon variables.

Variable	Type	Pearson Chi^2 Coefficient	p-value	Remarks
Storm signal+	Ordinal	13.69	0.003**	Dependent
Cyclone scale++	Ordinal	1.44	0.23	Independent
Intensity (hpA)	Ratio	47.18	0.001**	Dependent
Peak (kmh)	Ratio	28.08	0.044*	Dependent

Notes: * significant at 5% level; ** significant at 1% level
(+) Based on PAGASA public storm signal warning
(++) Based on the Australian tropical cyclone intensity scale

After determining the various actions taken before and after a disaster, our survey probed deeper, asking about the length of implementation and number of activities or items, such as training, assets, and other information pertaining to a particular type of risk management activities. To capture all this information, we developed an index for all risk management activities, including precautionary measures, response, recovery, rehabilitation, and rebuilding.

Equations (1) to (3) are examples of the computation of the indices. For the Long-Term Precautionary Measure Index (LTPMI), equation (1) is the index for each type of hydro-meteorological hazards, equation (2) is the unweighted index, and equation (3) is the weighted index. The LTPMI is simply the weighted average of the product of type of long-term precautionary measures conducted by a city/municipality before the hydro-meteorological hazard occurred and its length of implementation.

$$LTPMI_{i,s} = \frac{\sum_{j=1}^{4} LTPM_{ij,s} \times LI_{ij,s}}{8 \times 4} \times 100\% \quad (1)$$

$$\widetilde{LTPMI}_{i} = \frac{\sum_{s=1}^{4} LTPMI_{i,s}}{4} \times 100\% \quad (2)$$

where:

$LTPMI_{i,s}$ ≡ Long-Term Precautionary Measures Index of i^{th} city/municipality for s^{th} type of hydro-meteorological hazard [SHOCK];

$LTPM_{ij,s}$ ≡ Indicator variable for the type of long-term precautionary measure conducted by i^{th} city/municipality for s^{th} hydro-meteorological hazard (1–Yes, 0–No);

LI_{ij} ≡ Ordinal variable for the length of implementation of j^{th} type of long-term precautionary measure conducted by i^{th} city/municipality for s^{th} type of hydro-meteorological hazard ≡ {1-less than 1 year before [SHOCK], 2-1 to 2 years before [SHOCK], 3-2 to 3 years before [SHOCK], 4-more than 3 years before [SHOCK]}; i ≡ city/municipality ≡ 1, 2, 3, …, N;

j ≡ Type of long-term precautionary measure ≡ {1-build resilient housing units, 2-invest in stronger public facilities, 3-build (cement) dams, dikes and river embankments, 4-upgrade power and water lines, 5-major road repairs, 6-identify relocation areas, 7-rezoning and land-use regulations, 8-build drainage};

s ≡ Type of hydro-meteorological hazard [SHOCK] ≡ {1-strong winds & rain, 2-flood, 3-landslide, 4–big waves}.

$\widetilde{LTPMI_i}$≡ Unweighted Long-Term Precautionary Measures Index of i^{th} city/municipality;

We used weights according to incidence of shocks experienced. Among the 189 cities/municipalities that experienced the most severe combined hydro-meteorological shocks, the distribution of those affected is as follows: strong winds & rain - 167, floods - 20, landslide – 2 and big waves – 0. Hence, the weights of each shock are as follows:

$$w_1 = \frac{167}{189}, w_2 = \frac{20}{189}, w_3 = \frac{2}{189} \text{ and } w_4 = 0$$

where w_1 is the weight for strong winds & rain; w_2 is the weight for floods; w_3 is the weight for landslide; and w_4 is the weight for big waves. This weighting method gives more importance on the preparedness of LGUs on the hazards that many of them experienced, i.e., strong winds and rain.

$$\overline{LTPMI_i} = \left(w_1 LTPMI_{i,1} + w_2 LTPMI_{i,2} + w_3 LTPMI_{i,3} + w_4 LTPMI_{i,4}\right) \times 100\% \qquad (3)$$

where $\overline{LTPMI_i} \equiv$ Weighted Long-Term Precautionary Measures Index of i^{th} city/municipality.

The value of the index is between 0 and 1, with 1 being the best measure. A complete list of all these indices is given in Appendix Table A2. The computational details of all indices are in Ravago et al. 2018.

The complete summary statistics for the data used in the analysis is provided in Appendix Table 19.

b. Empirical model

We consider the perceived "recovery" variable as indicator of resilience. We use the *logit* model given in equation (4) to determine which among the risk management activities available to LGUs contribute to the probability of full recovery. The left-hand side takes on the value 1 when the respondent experiences full recovery, and 0 otherwise. The *logit* model is represented by:

$$\Pr(\mathrm{Y} = 1|\mathrm{X}, \mathrm{N}, \alpha, \beta) = \frac{\exp(\alpha N + \beta X + u)}{1 + \exp(\alpha N + \beta X + u)} \qquad (4)$$

where N represents the various risk management activities -- long-, mid-, and short-term precautionary measures -- undertaken by LGUs in anticipation of shocks. The *logit* model takes into account all other ex ante and ex post risk management activities listed in Table 13. We control for initial conditions of the LGUs, denoted by the vector of variables X, which include educational attainment of the DRRM officer, LGU's population, poverty index, disaster risk classification, DRRM funding, total local revenues, non-tax revenues, training received and conducted by the DRRM staff, and various assets owned by the DRRM office. The error term is represented by u.

We consider two *logit* models. Model 1 has the complete observation of 189 LGUs and uses the N variables from our survey and secondary data in X. Model 2 has only 177 LGUs because the additional variables on dynasty representing institutions do not have information for all the LGUs in the sample. Table 19 presents the final model. The results of the full model are shown in Appendix Tables A3.

Table 19. Risk management activities that influence recovery (final model).

	Model 1		Model 2	
Dependent variable: full recovery = 1	**Coefficient**	**Margin**	**Coefficient**	**Margin**
Shock severity				
Severity of [SHOCK]	-1.096	-0.177	-1.240	-0.209
	(1.05)	(0.169)	(1.059)	(0.177)
Indices of ex ante risk management activities				
Long-Term Precautionary Measures Index	1.094	0.177	1.109+	0.187+
	(0.851)	(0.133)	(0.864)	(0.142)
Warnings Index	-0.801	-0.130	-0.656	-0.111
	(0.72)	(0.114)	(0.75)	(0.126)
Indices of ex post risk management activities				
Evacuation Order and Center Index	-2.441	-0.395	-2.491	-0.420
	(1.315)*	(0.217)*	(1.494)*	(0.253)*
Interaction of Evacuation Index and Severity	1.132	0.183	1.031	0.174
	(1.536)	(0.252)	(1.682)	(0.286)
Relief Index	-1.418	-0.230	-2.060	-0.347
	(1.755)	(0.279)	(1.811)	(0.297)
Interaction of Relief Index and Severity	-0.830	-0.134	-0.558	-0.094
	(1.855)	(0.301)	(1.946)	(0.329)
Relief and Assistance from Others Index	1.889	0.306	1.858	0.313
	(1.098)*	(0.17)*	(1.063)*	(0.172)*
Cleanup Operations Index	2.445	0.396	2.816	0.475
	(0.97)**	(0.151)***	(1.007)***	(0.160)***
Employment Index	-1.662	-0.269	-1.884	-0.318
	(1.164)	(0.184)	(1.181)	(0.191)
Service Interruption Index	-1.685	-0.273	-1.585	-0.267
	(0.823)**	(0.128)**	(0.785)**	(0.127)**
Infrastructure Index	1.378	0.223	1.318	0.222
	(1.12)	(0.176)	(1.096)	(0.18)

Control variables				
Dynasty share 2013			-4.397 (2.035)**	-0.742 (0.332)**
Log of poverty incidence 2012			0.466 (0.286)	0.079 (0.0481)
Education of DRRM officer	0.484 (0.422)	0.078 (0.0679)		
Poverty Index	0.016 (0.0173)	0.003 (0.00281)		
Log of total local revenues	0.463 (0.147)***	0.075 (0.022)***	0.403 (0.131)***	0.068 (0.020)***
Number of Observations	189		177	
Log pseudo-likelihood	-92.6230		-89.6450	
p-value	0.0016		0.0044	
McFadden R-square =	0.2255		0.2180	

Notes: Robust standard errors are in parentheses.
***significant at 1% level; **significant at 5% level; * significant at 10% level; + one-sided significant

The results` show that severity of disasters matters in the LGU's complete recovery (Table 19): the more severe the disaster, the lower the likelihood for complete recovery. Not significant? The probability decreases by about 17 percentage points (marginal effect) in Model 1 as disaster becomes more severe, controlling for other factors. The results also show that cleanup operations and receiving assistance from others are the most prominent risk management activity for LGUs. Carrying out long-term precautionary measures is also significant, albeit one-sided.

Since the values of all the index variables are between 0 and 1, we interpret the marginal effect not in terms of the "stated marginal effect value" but by the "stated marginal effect divided by 100." For the LGUs that undertook precautionary measures before the onset of the hydro-meteorological hazards, a one-percentage point effect on the LTPMI increases the estimated probability of full recovery by 0.0018 (0.187/100), controlling for other factors. While a one-percentage point increase in the LTPMI may be small on a cursory examination, however, for an

LGU without any LTPMI (value equal to 0) and an LGU with all the LTPMI (value is 1 or 100%), the increase in the estimated probability of recovery of the latter is 0.187 percent , which is large, controlling for other factors.

We similarly interpret the coefficient of the other index variables. For an LGU with an index value for cleanup operations equal to 1, the probability of recovery is 0.48 percent relative to an LGU with index value equal to zero. An LGU with an index value equal to 1 for relief and assistance from others, the probability of recovery is 31 percent.

Delays in the restoration of interrupted lifeline services (e.g., water and power) have an adverse effect on the welfare of the LGUs. For an LGU with service interruption index equal to 1 (full service interruption), the decrease in probability of recovery is 27 percent.

Some risk management activities, such as issuing evacuation order and providing relief assistance, obtained unexpected signs, although insignificant. One plausible explanation is that the disaster experienced may be very severe that even undertaking these activities are not sufficient for recovery. Severity is coded as a nominal (binary) variable.[6] A point increase in severity decreases the probability of complete recovery by 25 percentage points (marginal effect), controlling for other factors. We interacted the activities with the severity variable, but the interaction terms did not come out to be significant.

The characteristics of the LGUs also matter in the likelihood of recovery after a disaster. A one-percentage point increase in the total revenues of an LGU increases recovery by 7 percentage points (marginal effect). A one-percentage point increase in dynasty share in the province where the LGU is located decreases the probability of recovery by 0.74 percentage point.

[6] 1 – most or very severe, and 0 – somewhat or least severe

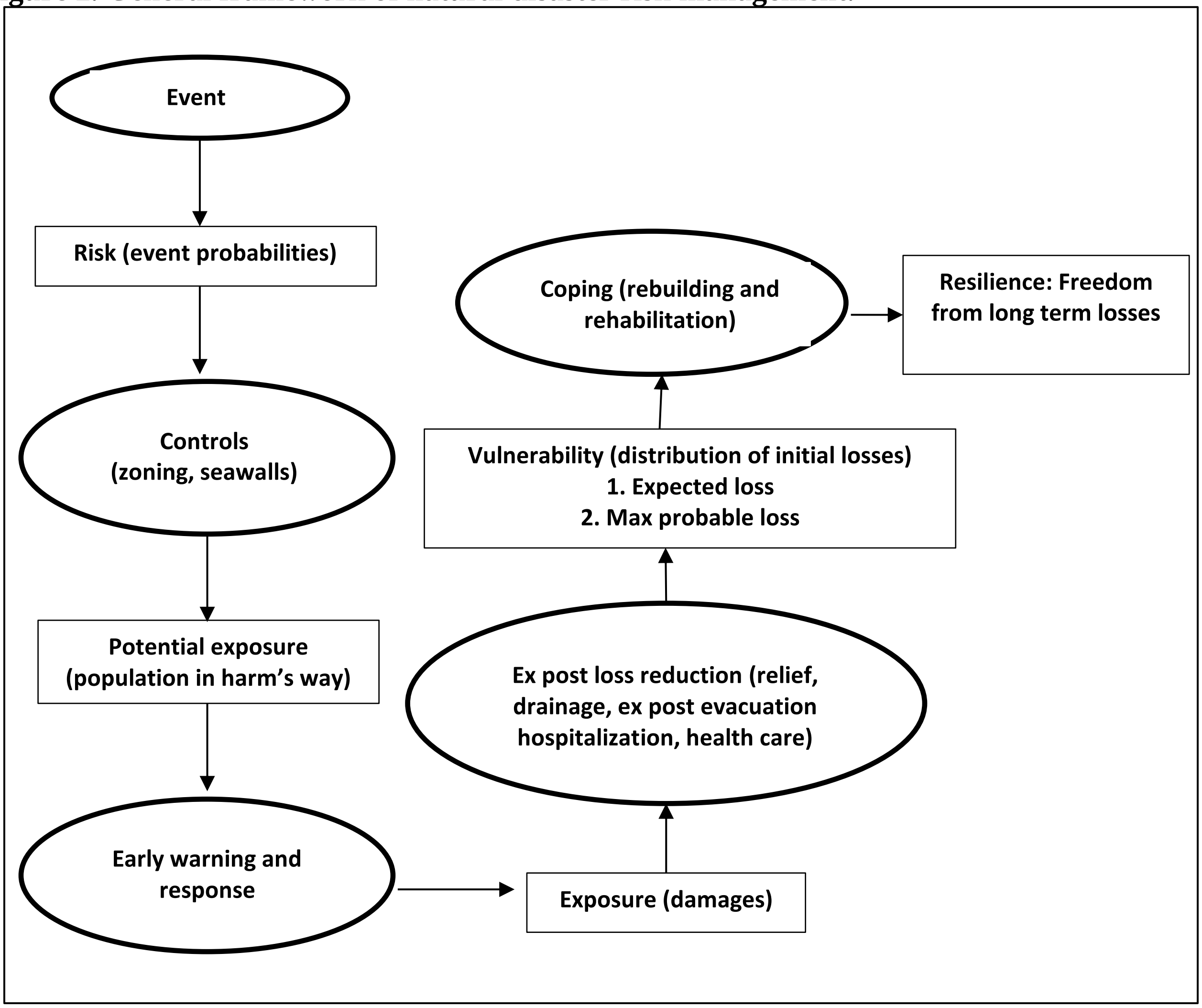
7. A Framework for Natural Disaster Risk Management

In this section, we offer a general framework for natural disaster risk management, focusing on the decentralized level of government. This framework serves as our guide in developing our empirical analysis.

Relative to the theory of decision-making under uncertainty, the theory and practice of disaster risk management appears to economists and many others to be ad hoc and full of ambiguities (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. This can only lead to sub-optimal strategies since the benefits of risk reduction are not weighed against the foregone opportunity costs of all possible strategies. Whereas, 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 2.

In our general framework of natural disaster risk management (Figure 2), we assume that there is a probability distribution over the levels of an event, such as a typhoon. The policy problem at the national and/or local level is to select a strategy corresponding to actions taken at the levels represented by the ovals. The rectangles following each action represent distributions and/or summary statistics thereof.

Figure 2. General framework of natural disaster risk management.



Source: Adapted from Ravago et al. 2016a

Event risk is an exogenous probability that a natural hazard exceeds critical levels (rainfall, wind speed, Richter levels). The decision maker chooses controls, including natural capital and infrastructure, that translate into exposure distribution among population. Other ex ante evasive actions include early warning and response, resulting in a dose of population actually hit at various levels. Then comes the ex post evasive actions: emergency dredging, repairs, and additional evacuation resulting in a distribution of initial losses (vulnerability). The last action item is coping (rebuilding and rehabilitation). Resilience or the freedom from long-term losses is a distribution or summary statistics determined by actions taken at the various levels of disaster risk management.

It is helpful to distinguish 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. In the Philippine government definition, all actions taken at various levels are classified as "mitigation" (see Philippine Republic Acts 10121 and 9729). Rather than lumping together all such actions, our general framework 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 preventive zoning and the strictness of building codes depends on the distribution of event risks and the costs of subsequent coping and other possible actions.

In Figure 2, we regard event mitigation as either impossible or exogenous (e.g., the mitigation of typhoon or 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 as, for example, one in 10 years, one in 100 years, and so on. Given controls such as seawalls, building codes, zoning requirements etc., an 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 multiplied by their respective probabilities (i.e., expected loss). The decision maker then chooses some controls (e.g., early warning technology and protocols) such that the distribution of actual exposure is more favorable than that of potential exposure.

Vulnerability refers to the distribution of initial losses. It is a “risk of loss” measured by probabilities that loss exceeds critical levels, expected loss (integral of density function), or loss at the lower end of the density function (e.g., the severity of a “100-year event”). Finally, resilience is defined to be “security” -- for example, one minus the probability of sustaining losses above a particular threshold. The risk that losses above critical levels 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.[7] 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, rebuilding and rehabilitation).

8. **Concluding Remarks**

Empirical evidence shows that local governments employ various risk management strategies to cope with shocks/disasters and smooth consumption in the process. To lower the risk of loss, empirical data show that the most prominent risk-reducing strategies are the long-term precautionary measures. These include building resilient housing units; investing in stronger public facilities; building dams, dikes, and embankments; upgrading power and water lines; maintaining roads; identifying relocation areas; and rezoning and land-use regulations. Doing cleanup operations is another prominent strategy, and receiving assistance from others also aid toward the recovery of LGUs.

While the case for having aggressive mitigation policies may be rather weak, there is a very strong case for investment in adaptation and coping strategies at both the macro and micro

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[7]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 3, resilience subsumes vulnerability but not the other way around.

level. The recent occurrence of natural disasters has prompted renewed interests of the national government and its development partners to enable the vulnerable sectors of the society to better adapt and cope with disasters. There is an appropriate emphasis on ex ante adaptation to reduce vulnerability to extreme events such as floods, which may be exacerbated by the triple whammy of more frequent and concentrated precipitation and by sea-level rise. At the macro level, the consequences of these risks can be reduced by simultaneous watershed conservation and water management. An integrative approach is necessary to appropriate the potential gains from watershed conservation. At the micro level, households already have different coping strategies in place, including formal and informal market-based arrangements that serve as consumption-smoothing facility for all kinds of shocks that they experience. However, the occurrence of natural disasters put a strain to these consumption-smoothing mechanisms due to covariance of risks involved.

Public interventions aim to dampen the risks associated with natural disasters. How do these interventions interact with household strategies to adapt to shocks arising from extreme climatic events? Little is known about such interactions, and the consequences they have on the welfare of the vulnerable sectors of society. Considering that the Philippines aims to establish a well-functioning social protection program, it is imperative to know the magnitude of the effects of natural disasters on the various dimensions of welfare and how the macro and micro coping strategies complement or crowd out each other in mitigating the impact of the adverse consequences. Understanding the factors that determine why households choose a particular coping method or combination thereof is critical in formulating effective targeting interventions at both the community and national levels. This is the future direction of our research.

References

Alexander, D. 2013. "Resilience and Disaster Risk Reduction: An Etymological Journey." *Nat. Hazards Earth Syst. Sci.* 13:2707–2716.

Anttila-Hughes, J., and S. Hsiang. 2013. "Destruction, Disinvestment, and Death: Economic and Human Losses Following Environmental Disaster." SSRN: https://ssrn.com/abstract=2220501 or doi.org/10.2139/ssrn.2220501.

Bureau of Meteorology, Australia. 2018. "Australian tropical cyclone intensity scale," http://www.bom.gov.au/cyclone/about/intensity.shtml

Belasen, A.R., and S.W. Polachek. 2008. "How Hurricanes Affect Wages and Employment in Local Labor Markets." *The American Economic Review* 98(2):49–53.

Balisacan, A., and N. Fuwa. 2004. "Going Beyond Cross-Country Averages: Growth, Inequality and Poverty Reduction in the Philippines." *World Development* 32:1891-1907.

Bertinelli, L., and E. Strobl. 2013. "Quantifying the Local Economic Growth Impact of Hurricane Strikes: an Analysis from Outer Space for the Caribbean." *Journal of Applied Meteorology and Climatology* 52(8):1688–1697.

Department of Finance. 2015. "Bureau of Local Government Finance Statement of Expenditure 2015." http://blgf.gov.ph/lgu-fiscal-data/

Cavallo, E., and I. Noy. 2011. "Natural Disasters and the Economy - A Survey." *International Review of Environmental and Resource Economics* 5(1):63-102. http://dx.doi.org/10.1561/101.00000039

Cavallo, E., S. Galiani, I. Noy, and J. Pantano. 2013. "Catastrophic Natural Disasters and Economic Growth." *Review of Economics and Statistics* 95(5):1549-1561.

Charveriat, C. 2000. "Natural disasters in Latin America and the Caribbean: An Overview of Risk", Working Paper 434, Inter-American Development Bank. https://www.unisdr.org/preventionweb/files/2544_ENVNatDisastLACeline.pdf

Cohen, C., and E. D. Werker. 2008. "The Political Economy of 'Natural' Disasters." *Journal of Conflict Resolution* 52(6):795–819. https://doi.org/10.1177/0022002708322157.

Commission on Audit. 2014. *Disaster Management Practices in the Philippines: An Assesment*. https://www.coa.gov.ph/disaster_audit/doc/National.pdf

Cuaresma, J. C., J. Hlouskova, and M. Obersteiner. 2008. "Natural Disasters as Creative Destruction? Evidence from Developing Countries." *Economic Inquiry* 46 (2):214–226.

Das, H. 2003. "Agrometeorology Related to Extreme Events." *WMO No. 943*. Geneva: World Meteorological Organization.

Datt, G., and H. Hoogeveen. 2003. "El Niño or El Peso? Crisis, Poverty, and Income Distribution in the Philippines." *World Development* 31(7):1103-1124.

Deryugina, T. 2011. "The Dynamic Effects of Hurricanes in the US: The Role of Non-Disaster Transfer Payments." Working Papers 1107, Massachusetts Institute of Technology, Center for Energy and Environmental Policy Research. https://dspace.mit.edu/handle/1721.1/66278.

Duflo, E., M. Kremer, and J. Robinson. 2008. "How High are Rates of Return to Fertilizer? Evidence from Field Experiments in Kenya." *American Economic Review* 98(2): 482-88.

EM-DAT: The Emergency Events Database - Universite catholique de Louvain (UCL) - CRED, D. Guha-Sapir, Brussels, Belgium (www.emdat.be) accessed on 20 Feb 2018

Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds). 2012. *Managing* *the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation*. Cambridge University Press: New York. https://www.ipcc.ch/pdf/special-reports/srex/SREX_Full_Report.pdf

Hallegate, S. 2014. "What is a Disaster? An Economic Point of View." *Natural Disasters and Climate Change*. Switzerland: Springer International Publishing. pp. 9-47.

Hallegatte, S., and P. Dumas. 2009. "Can Natural Disasters have Positive Consequences? Investigating the Role of Embodied Technical Change." *Ecological Economics* 68 (3):777–786.

Hsiang, Solomon M. 2010. "Temperatures and Cyclones Strongly Associated with Economic Production in the Caribbean and Central America." *Proceedings of the National Academy of Sciences* 107 (35):15367–15372.

Hsiang, S., and A. Jina. 2014. "The Causal Effect of Environmental Catastrophe on Long-Run Economic Growth: Evidence from 6,700 Cyclones." *NBER Working Paper No. 20352*. http://www.nber.org/papers/w20352

Lyons, M. 2009. "Building Back Better: The Large-Scale Impact of Small-Scale Approaches to Reconstruction." *World Development* 37(2): 385–398.

Manila Observatory. 2005. "Mapping Philippine Vulnerability to Environmental Disasters." http://vm.observatory.ph/summary.html accessed in June 2015.

Mendoza, R., E. Beja Jr., V. Venida, and D. Yap. 2016. "Political Dynasties and Poverty: Measurement and Evidence of Linkages in the Philippines." *Oxford Development Studies* 44(2).

National Centers for Environmental Information – National Oceanic and Atmospheric Administration (NOAA) - Boulder, CO USA (www.ngdc.noaa.gov) accessed on 20 Feb 2018

National Disaster Risk Reduction and Management Council (NDRRMC). http://www.gov.ph/2013/11/11/ndrrmc-typhoon-yolanda-report-per-province-november-11-2013/ accessed on 10 Dec 2014.

National Economic and Development Authority (NEDA). "Reconstruction Assistance for Yolanda." http://www.neda.gov.ph/wp-content/uploads/2014/10/ray_ver2_final.pdf accessed in October 2014.

Oxfam. 2005. "Back to Work: How People are Recovering their Livelihoods 12 Months after the Tsunami." *Oxfam Briefing Paper No. 84*. London: Oxfam.

Prestemon, J., and T. Holmes. 2002. "Timber Price Dynamic Following a Natural Catastrophe." *American Journal of Agricultural Economics* 82(1):145-160.

PAGASA 2018. https://www1.pagasa.dost.gov.ph/index.php/20-weather

Philippine Republic Act 10121. 2009. Philippine Disaster Risk Reduction and Management Act of 2010 http://www.ndrrmc.gov.ph/attachments/article/45/Republic_Act_10121.pdf

Philippine Republic Act 9729. Climate Change Act of 2009. http://climate.gov.ph/images/documents/Republic_Act_No.9729.pdf

Philippine Statistics Authority. 2012. "Poverty Incidence." https://www.psa.gov.ph/content/poverty-incidence-among-filipinos-registered-216-2015-psa

Ravago, M., and D. Mapa. 2015. "Household Coping and Recovery from Nature's Wrath: Rising from the Ruins of Yolanda." *UPSE Discussion Paper 2015-16.* http://www.econ.upd.edu.ph/dp/index.php/dp/article/view/1486.

Ravago, M., and D. Mapa. 2014. "Eastern Visayas after Yolanda: Evidence from Household Survey." *PCED Policy Note 2014-5*. http://www.pced.gov.ph/wp-content/uploads/2014/11/PN-2014-5-rev-4-111014.pdf.

Ravago, M., J. Roumasset, and K. Jandoc. 2016a. "Risk Management and Coping Strategies: Climate Change and Agriculture in the Philippines." *Philippine Review of Economics* 53(2):64-103.

Ravago, M., S. Quimbo, D. Mapa, A. Kraft, and J. Capuno. 2016b. "Technical Report on Social Protection Survey of the Philippine Center of Economic Development." *UP School of Economics Working Paper 2016-06*. Quezon City, Philippines: UPSE.

Ravago, M., D. Mapa. J. Sunglao, A. Aycardo. 2018. "Coping Strategies to Natural Disasters: Micro-Meso-Macro Interactions and Consequences[8] Technical Report on the Survey of Local Government Units DRRM Office."

Rodriguez-Oreggia E., A. De La Fuente, R. De La Torre, and H.A. Moreno. 2013. "Natural Disasters, Human Development and Poverty at the Municipal level in Mexico." *The Journal of Development Studies* 49 (3):442–455.

Roumasset, J. 2015. "Reflections on the Foundations of Development Policy Analysis." In *Sustainable Economic Development: Resources, Environment, and Institutions*, edited by A. Balisacan, U. Chakravorty, and M. Ravago. USA: Elsevier Academic Press.

Roumasset, J. 2000. "Black-Hole Security." *WP 00-5* Economics Dept., University of Hawaii, USA.

Roumasset, J. 1979. "Risk Aversion, Agricultural Development and the Indirect Utility Function." In *Risk, Uncertainty and Agricultural Development*, edited by J. Roumasset, J.M. Boussard, and I. Singh. Philippines: SEARCA/ADC.

Roumasset, J. 1976. *Rice and Risk: Decision-Making among Low-Income Farmers in Theory and Practice*. Amsterdam: North-Holland Publishing Co.

Sakai, Y., J. Estudillo, N. Fuwa, Y. Higuchi, Y. Sawada. 2017. "Do Natural Disasters Affect the Poor Disproportionately? Price Change and Welfare Impact in the Aftermath of Typhoon Milenyo in the Rural Philippines." *World Development* (94): 16-26. https://doi.org/10.1016/j.worlddev.2016.12.036.

Santiago, J.S.S., W.S. Manuela, M.L.L. Tan, S.K. Sañez, and A.Z.U. Tong. 2016. "Of Timelines and Timeliness: Lessons from Typhoon Haiyan in Early Disaster Response." *Disasters* 40:644–667. doi:10.1111/disa.12178.

Shreve, C.M. and I. Kelman. 2014. "Does Mitigation Save? Reviewing Cost-Benefit Analyses of Disaster Risk Reduction. *International Journal of Disaster Risk Reduction* 10: 213-235

Skidmore, Mark, and Hideki Toya. 2002. "Do Natural Disasters Promote Long-Run Growth?" *Economic Inquiry* 40 (4):664–687.

Skidmore, M., and H. Toya. 2013. "Natural Disaster Impacts and Fiscal Decentralization." *Land Economics* 89(1):101–117.

Sobel, R., and P. Leeson. 2006. "Government's Response to Hurricane Katrina: A Public Choice Analysis." *Public Choice* 127(1-2):55–73.

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Strobl, Eric. 2011. “The Economic Growth Impact of Hurricanes: Evidence from U.S. Coastal Counties.” *Review of Economics and Statistics* 93(2): 575-589.
Strobl, E. 2012. “The Economic Growth Impact of Natural Disasters in Developing Countries: Evidence from Hurricane Strikes in the Central American and Caribbean Regions.” *Journal of Development Economics* 97(1):130–141.
Thorburn, C. 2009. “Livelihood Recovery in the Wake of the Tsunami in Aceh.” *Bulletin of Indonesian Economic Studies* 45(1):85-105.
Vorhies, F. 2012. “The Economics of Investing in Disaster Risk Reduction.” Geneva, Switzerland: UN International Strategy for Disaster Reduction. https://www.preventionweb.net/posthfa/documents/drreconomicsworkingpaperfinal.pdf.
Walker, T., and N. Jodha. 1986. “How Small Farm Households Adapt to Risk.” In *Crop Insurance for Agricultural Development*, edited by P. Hazell, C. Pomareda, and A. Valdes. Baltimore and London: The Johns Hopkins University Press.
Walker, T., and J. Ryan. 1990. *Village and Household Economies in India's Semi-Arid Tropics*. Baltimore: John Hopkins University Press.
World Risk Report. 2017. Relief Web. https://reliefweb.int/report/world/world-risk-report-2017
Yang, Dean. 2008. “Coping with Disaster: The Impact of Hurricanes on International Financial Flows, 1970-2002.” *Advances in Economic Analysis & Policy* 8(1):1903–1903.

Appendix Tables

Table A1a. Frequency of shocks by long-term precautionary measures.

	All hydro-meteorological hazards	**Typhoons**	**Floods**	**Landslide**	**Big waves**
Build resilient housing units	3.156	3.250	3.121	3.000	1.727
	(4.131)	(3.964)	(3.483)	(2.541)	(1.650)
Invest in stronger public facilities	3.931	4.073	3.394	2.533	1.727
	(3.356)	(2.972)	(3.296)	(2.677)	(1.650)
Build dams, dikes, embankments	4.574	4.596	3.512	2.286	2.500
	(2.457)	(2.329)	(3.111)	(2.781)	(1.286)
Upgrade power and water lines	4.050	4.193	4.121	6.333	1.000
	(3.488)	(3.300)	(3.114)	(2.075)	(1.808)
Major road repairs	3.769	3.927	3.676	3.882	1.875
	(3.541)	(3.169)	(3.051)	(1.897)	(1.609)
Identify relocation areas	4.208	3.890	4.347	3.941	2.063
	(2.976)	(3.179)	(2.373)	(1.862)	(1.267)
Rezoning and land-use regulations	4.398	4.163	3.788	2.765	2.154
	(3.030)	(3.092)	(2.975)	(2.552)	(1.333)
Build drainage	3.800	3.620	3.247	3.722	1.700
	(3.435)	(3.576)	(3.468)	(1.929)	(1.667)
Others	4.811	3.906	4.407	4.875	2.429
	(3.388)	(3.533)	(3.204)	(2.158)	(1.458)

Note: Mean of ‘yes’ outside parenthesis, mean of ‘no’ inside parenthesis

Table A1b. Frequency of shocks by mid-term precautionary measures.

	All hydro-meteorological hazards	Typhoons	Floods	Landslide	Big waves
Assess safety of public buildings	3.859	3.631	3.804	3.450	2.154
	(3.085)	(3.514)	(2.440)	(2.000)	(1.333)
Strengthen embankments	3.934	3.685	3.755	2.222	2.333
	(3.179)	(3.458)	(2.51)	(2.893)	(1.263)
Clean sewers and canals	4.149	4.074	3.681	3.238	1.727
	(1.543)	(1.548)	(2.065)	(2.120)	(1.650)
Conduct road assessment/repairs	3.642	3.458	4.070	3.120	1.833
	(3.731)	(3.980)	(1.787)	(2.048)	(1.579)
Repair/rehabilitate classrooms	4.173	3.897	3.494	3.706	1.750
	(2.629)	(2.920)	(3.103)	(2.000)	(1.632)
Others	2.450	2.611	3.778	5.250	1.167
	(3.811)	(3.725)	(3.312)	(2.381)	(1.800)

Note: Mean of 'yes' outside parenthesis, mean of 'no' inside parenthesis

Table A1c. Frequency of shocks by short-term precautionary measures.

	All hydro-meteorological hazards	Typhoons	Floods	Landslide	Big waves
Class suspension	3.715	3.601	3.061	3.304	1.600
	(3.176)	(3.643)	(4.344)	(1.957)	(1.818)
Gale warning	4.292	4.410	2.561	1.545	2.200
	(2.867)	(2.403)	(3.975)	(2.971)	(1.188)
Road closures	3.970	3.466	3.542	3.765	2.750
	(3.500)	(3.679)	(3.242)	(1.966)	(1.519)
Others	4.125	2.714	4.833	11.250	n/a
	(3.573)	(3.784)	(3.132)	(1.81)	(1.677)

Note: Mean of 'yes' outside parenthesis, mean of 'no' inside parenthesis

Table A2. Indices of risk management activities, precautionary measures, response, recovery, rehabilitation, and rebuilding block.

No.	Index	Description
1	**Long-Term Precautionary Measures Index (LTPMI)**	Product of type of long-term precautionary measures conducted by a city/ municipality before the shock occurred and its length of implementation
2	**Mid-term Precautionary Measures Index (MTPMI)**	Product of type of mid-term precautionary measures conducted by a city/ municipality before the shock occurred and its frequency of implementation
3	**Short-Term Precautionary Measures Index (STPMI)**	Two components: (1) unweighted average of product of type of short-term precautionary measures conducted by a city/ municipality before the shock occurred and time of implementation and (2) unweighted average of product of type of short-term precautionary measures conducted by a city/ municipality before the shock occurred and its length of implementation
4	**Warning Index (WI)**	Three indices: (1) Source of Warnings Index (SWI), (2) Preparatory Checks Index (PCI), and (3) Warning Issued Index (WII)
5	**Evacuation Index (EI)**	Three indices: (1) Evacuation Order Index (EOI), (2) Evacuation Center Index (ECI), and (3) Evacuation Center Facilities Index (ECFI)
6	**Search and Rescue Index (SRI)**	Product of the indicator variable if the city/ municipality conducted search & rescue and the ordinal variable for number of people rescued
7	**Shock Effects to Constituents Index (SECI)**	Product of the indicator variable if the shock resulted in death, illness, or injury of the constituents and the types of effects
8	**Quick Response Fund Index (QRFI)**	Two indices: (1) Quick Response Fund Uses Index (QRFUI) and (2) Quick Response Fund Monetary Assistance Index (QRF-MAI)
9	**National Disaster Fund Index (NDFI)**	Two indices: (1) National Disaster Fund Sources & Uses Index (NDFSUI) and (2) National Disaster Fund Monetary Assistance Index (NDF-MAI)
10	**Relief Index (RI)**	Two indices: (1) Relief Assistance Index (RAI) and (2) Relief Goods Index (RGI)
11	**Cleanup Operations Index (COI)**	Two components: (1) product of the indicator variable if the city/ municipality has undertaken cleanup operations and when it started and (2) product of the indicator variable if the city/ municipality has undertaken cleanup operations and duration

No.	Index	Description
12	**Employment Index (EI)**	Product of two components: (1) product of the indicator variable if the city/ municipality has a cash-for-work program for the shock and the daily wage rate and (2) product of the indicator variable if the city/ municipality has a food-for-work program for the shock and the value of food for a day's work
13	**Response & Assistance from Others Index (RAOI)**	Two indices: (1) Response from Others Index (ROI) and (2) Assistance from Others Index (AOI)
14	**Service Interruption Index (SII)**	Product of the indicator variable if the city/ municipality had any service interruption during the shock and the types of service interruption
15	**Type of Service Interruption Index (TSII)**	Three indices: (1) Water Supply Interruption Index (WSII), (2) Telecommunication Interruption Index (TII), and (3) Electricity Interruption Index (EII)
16	**Infrastructure Index (II)**	Two indices: (1) Infrastructure Breakdown Index (IBI) and (2) Infrastructure Repair Index (IRI)
17	**Housing Program Index (HPI)**	Product of the indicator variable if the city/ municipality has any housing programs in response to the shock and when it was started
18	**Trainings Index (TI)**	Two indices: (1) Training Given Index (TGI) and (2) Training Received Index (TRI)
19	**Assets Index (AI)**	Seven indices: (1) Asset Vehicle Index (AVI), (2) Asset Emergency Shelter Index (AESI), (3) Asset Facilities and Resources Index (AFRI), (4) Asset Search and Rescue Index (ASRI), (5) Asset Information Index (AII), (6) Asset Relief Goods Index (ARGI), and (7) Asset Medical Supplies Index (AMSI)

Table 19. Summary statistics.

Explanatory variable	Obs	Mean	Min	Max
Recovery				
Full Recovery from [SHOCK]	189	0.672	0	1
Shock severity				
Severity of [SHOCK]	189	0.614	0	1
Indices of ex ante risk management activities				
Long-Term Precautionary Measures Index	193	0.231	0	0.997
Mid-term Precautionary Measures Index	193	0.367	0	1
Short-Term Precautionary Measures Index	193	0.348	0	0.903
Warnings Index	193	0.449	0	1
DRRM Training Index	193	0.334	0	0.913
DRRM Asset Index	193	0.585	0	0.986
Indices of ex post risk management activities				
Evacuation Order and Center Index	193	0.506	0	0.989
Search and Rescue Index	193	0.126	0	0.989
Shock Effects to Constituents Index	193	0.206	0	1
Quick Response Fund Index	193	0.128	0	0.989
National Disaster Fund Index	193	0.043	0	0.989
Relief Index	193	0.545	0	0.952
Relief and Assistance from Others Index	193	0.387	0	0.94
Cleanup Operations Index	193	0.610	0	1
Employment Index	193	0.095	0	0.626
Service Interruption Index	193	0.509	0	1
Types of Service Interruption Index	193	0.097	0	0.631
Infrastructure Index	193	0.256	0	0.67
Housing Program Index	193	0.079	0	1
Control variables				
Dynasty Share 2013	177	0.452	0.167	0.623
Dynasty Largest 2013	177	0.022	0.009	0.062
Dynasty Sum of Squares 2013	177	0.003	0.001	0.009
Human Development Index 2009	177	0.555	0.353	0.849
Log of Poverty Threshold 2012	177	9.837	9.674	9.994
Log of Poverty Incidence 2012	177	3.016	0.938	4.015
Log of Poverty Magnitude 2012	177	10.790	8.541	12.130
Education of DRRM Officer	193	3.254	2	4
Log of Population	193	11.550	9.409	14.89
Poverty Index	193	20.570	0.28	60.21
Disaster Risk Classification	193	1.482	1	2

Log of DRRM Funding	193	2.474	0.827	5.193
Log of Total Local Revenues	193	4.230	0.296	9.758
Log of Total Non-tax Revenues	193	3.298	-0.849	7.369

Table A3a. What influences recovery (full model).

	W/ interaction w/o dynasty		**W/ interaction w/ dynasty**	
Explanatory variable	**Coefficient**	**Margin**	**Coefficient**	**Margin**
Shock severity				
Severity of [SHOCK]	-1.215	-0.191	-1.595	-0.255
	-1.022	(0.161)	(1.083)	(0.173)
Indices of ex ante risk management activities				
Long-Term Precautionary Measures Index	1.294	0.204	1.315	0.210
	(0.944)	(0.146)	(1.032)	(0.165)
Mid-term Precautionary Measures Index	-0.089	-0.014	0.363	0.058
	(1.075)	(0.169)	(1.29)	(0.206)
Short-Term Precautionary Measures Index	0.629	0.099	0.730	0.117
	(1.255)	(0.196)	(1.416)	(0.226)
Warnings Index	-0.775	-0.122	-0.739	-0.118
	(0.789)	(0.123)	(0.932)	(0.148)
DRRM Training Index	0.288	0.045	0.470	0.075
	(1.507)	(0.238)	(1.552)	(0.25)
DRRM Asset Index	0.144	0.023	0.249	0.040
	(0.683)	(0.108)	(0.731)	(0.117)
Indices of ex post risk management activities				
Evacuation Order and Center Index	-2.623	-0.413	-3.299	-0.528
	(1.473)*	(0.236)*	(1.783)*	(0.284)*
Interaction of Evacuation Index and Severity	0.956	0.151	1.190	0.191
	(1.663)	(0.265)	(1.88)	(0.303)
Search and Rescue Index	-0.558	-0.088	-1.420	-0.227
	(0.996)	(0.157)	(1.1)	(0.176)
Shock Effects to Constituents Index	-0.211	-0.033	0.055	0.009
	(0.807)	(0.127)	(0.879)	(0.141)
Quick Response Fund Index	0.313	0.049	0.271	0.043
	(0.869)	(0.138)	(0.898)	(0.144)
National Disaster Fund Index	1.463	0.230	1.954	0.313
	(1.431)	(0.227)	(1.792)	(0.288)
Relief Index	-1.795	-0.283	-2.589	-0.414
	(1.803)	(0.28)	(1.933)	(0.306)
Interaction of Relief Index and Severity	-0.445	-0.070	-0.608	-0.097
	(1.867)	(0.294)	(2.03)	(0.326)
Relief and Assistance from Others Index	2.065	0.325	2.281	0.365

	(1.15)*	(0.174)*	(1.155)**	(0.178)**
Cleanup Operations Index	2.071	0.326	2.546	0.407
	(1.026)**	(0.16)**	(1.071)**	(0.167)**
Employment Index	-1.721	-0.271	-2.052	-0.328
	(1.382)	(0.216)	(1.4)	(0.224)
Service Interruption Index	-0.845	-0.133	-0.982	-0.157
	(1.094)	(0.171)	(1.168)	(0.185)
Types of Service Interruption Index	-1.317	-0.208	-1.688	-0.270
	(1.567)	(0.245)	(1.659)	(0.263)
Infrastructure Index	1.574	0.248	2.367	0.379
	(1.127)	(0.173)	(1.168)**	(0.181)**
Housing Program Index	-0.954	-0.150	-1.430	-0.229
	(1.005)	(0.16)	(1.173)	(0.188)
Control variables				
Dynasty Share 2013			-1.735	-0.278
			(4.001)	(0.639)
Dynasty Largest 2013			30.640	4.903
			(43.33)	(6.886)
Dynasty Sum of Squares 2013			-317.300	-50.780
			(327.8)	(51.88)
Human Development Index 2009			1.257	0.201
			(4.485)	(0.721)
Log of Poverty Threshold 2012			5.687	0.910
			(4.386)	(0.706)
Log of Poverty Incidence 2012			1.464	0.234
			(0.866)*	(0.139)*
Log of Poverty Magnitude 2012			-0.376	-0.060
			(0.553)	(0.088)
Education of DRRM Officer	0.530	0.084	0.325	0.052
	(0.442)	(0.069)	(0.471)	(0.075)
Log of Population	-0.033	-0.005	0.501	0.080
	(0.709)	(0.112)	(0.834)	(0.134)
Poverty Index	0.021	0.003	-0.010	-0.002
	(0.0191)	(0.003)	(0.0244)	(0.004)
Disaster Risk Classification	0.182	0.029	0.234	0.038
	(0.377)	(0.059)	(0.395)	(0.063)
Log of DRRM Funding	-0.287	-0.045	-0.467	-0.075
	(0.614)	(0.097)	(0.64)	(0.102)
Log of Total Local Revenues	0.563	0.089	0.656	0.105
	(0.509)	(0.079)	(0.513)	(0.080)
Log of Total Non-tax Revenues	0.107	0.017	-0.206	-0.033
	(0.486)	(0.077)	(0.5)	(0.080)
Number of Observations	189		177	
Log pseudo-likelihood	-90.6140		-85.3270	
p-value	0.0027		0.0017	
McFadden R-square =	0.2423		0.2556	