DISASTER, MITIGATION AND HOUSEHOLD WELFARE IN INDONESIA

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Abstract

Households in the world as well as in Indonesia have become more exposed to a wide variety of vulnerabilities and risks due to the recent increase in the intensity and scope of global natural disasters. This study aims to comprehensively examine the impact of natural disasters on Indonesian's household welfare (consumption and poverty) using the Indonesian Family Life Survey (IFLS). This study finds that households in rural areas are the most vulnerable to natural disasters; the average asset losses and medical/funeral costs from natural disasters are roughly USD 2,190/household. Our econometric models confirm that earthquakes are the most destructive disaster to affect household welfare, whereas droughts, forest fires, floods, and other disasters appear to have only moderate effects. Disaster-mitigation preparedness plays a significant role in reducing the devastating impacts of disasters and in lessening households' vulnerability to becoming impoverished.

JEL Classification: Q54; I31; I32

Keywords

Natural Disaster — Welfare — Vulnerability

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1. INTRODUCTION

Households throughout the world face a wide variety of risks from natural disasters including floods, droughts, and earthquakes. According to the Emergency Events Database (EM-DAT), the number of natural disasters appears to be increasing globally—from fewer than 100 per year in the mid-1970s to approximately 400 per year during the 2000s. Thus, the magnitude of the social and economic consequences of recent natural events in the world has reinforced the need to place hazard-related concerns at the top of the global poverty and development agenda.

As a consequence of natural disasters, households in low-income developing countries are particularly vulnerable to disaster ([1]), mainly because their initial welfare levels are already close to the poverty line and because they lack early-warning systems or institutional arrangements for coping with disasters. The impact of such disasters could result in an immediate increase in poverty and deprivation, with permanent effects over time ([2]). One such example may be found in [3]'s study. They find that floods and drought significantly worsened social indicators in Mexico; they posited that better natural-disaster vigilance would have reduced the vulnerability of the nation's low-income groups.

The link between natural disasters and living standards is complex, however, and causality is difficult to capture empirically due to lack of relevant studies in the literature ([4]). The two-way relationship between vulnerability to natural disasters and poverty means that disasters increase poverty, while increase in poverty make disaster outcomes much more severe. Several studies such as [5], [6], and [7] have assessed impacts of disasters on economic and welfare,

but they used aggregate macroeconomic data that might not perfectly capture the household's welfare in responding to disasters. The economics literature on the impact of natural disasters on household level is still relatively scarce and in the nascent stage ([4]; [8]; [9]). Another reason for the scarcity of information is that many national standard household surveys do not generally collect data and information that is relevant to natural disasters. For this reason, many researchers have encountered difficulties in empirically examining the links between poverty and natural disasters.

In the case of Indonesia, according to a dataset from the National Agency for Disaster Management (*BNPB-Badan Nasional Penanggulangan Bencana*), the intensity of natural disasters and the number of human victims of natural disasters have both increased significantly in the recent years. During the period 2000–2015, for example, the number of people who died from disasters increased almost seventeen fold compared to the period of 1986–1999. The 2004 Aceh tsunami was the largest contributor to the increase in the death during the period of 2000–2015. The number of evacuated disaster victims also jumped from 95.6 thousands (1986–1999) to 9.3 million (2000–2015), almost half of the increase during that period was from flooding. Not only human victims are affected, natural disasters also damage infrastructures and economic activities. During the period 1990–2015, natural disasters such as floods and drought destroyed nearly 3.4 million hectares of crops, while natural disasters such as floods and earthquakes destroyed roughly 96 thousand kilometer of roads.

The damage that occurs can significantly decrease households' welfare as well as their poverty status. For instance, crop losses result in in losses to farmer's income and in some extreme cases, may led to famine. The property damages (to housing, productive assets, and public facilities), crop losses, injured and killed family members, and disabilities caused by disasters all lead to direct economic losses that can reduce household welfare and expose households to the vulnerability of becoming poor. The death of family members—especially of income earners—can easily thrust previously non-poor households into conditions of poverty. Prolonged sickness and death occasionally force households to sell land in exchange for medical treatment, which may lead to poverty in the near future.

This paper then examines the extent to which natural disasters influence household welfare and poverty in Indonesia. Although the consequences of disasters on household welfare are a critical issue in Indonesia, the subject remains a peripheral topic of research; empirical studies on disasters' impact on both household welfare and poverty (either in Indonesia or elsewhere) remain relatively scarce. [10] persuasively outline the policy relevance of studying the welfare impacts of natural disasters. According to them, policy makers must first understand the impacts of natural shocks to poor households so that the forthcoming disaster assistance will be more effective; second, specific population groups should be identified as being more vulnerable to natural hazards than others in order to plan a useful *ex-ante* response so that any long-term negative consequences on people's welfare may be minimized.

The outline of this paper is as follows. This study begins by first explaining the framework and literature review of the linkages between natural disasters, coping strategies/disaster preparedness, and household welfare (in terms of consumption and poverty). Sections 3 reviews several factors of disaster exposure, damages/losses, and household welfare/poverty at the national, village, and household levels. The information provides a comprehensive picture of how disasters may influence household welfare. Section 4 discusses the research method, while section 5 discusses the estimation results. This study includes an analysis of the impacts of natural disaster (such as earthquakes, floods, forest fires, and drought) as well as the impact of disaster preparedness on household consumption and poverty status. The paper then concludes with several important findings and policy suggestions.

2. LITERATURE REVIEW: DISASTER AND POVERTY

2.1 The Link between Natural Disaster and Poverty

While a natural hazard is defined as a natural event that threatens both life and property (e.g., earthquakes, typhoons, flooding, volcanic eruptions, and drought), disaster is generally described as the consequence of a natural hazard to individuals, societies, and the economy at large[1]. The effect of natural hazards on a disaster's physical impacts will depend on the hazard-mitigation practices and disaster-preparedness practices that are in place.

Natural hazards such as earthquakes, tsunamis, and typhoons may result in numerous adverse physical impacts, depending on the hazard's intensity, scope, duration of impact, and probability of occurrence. The physical impacts of disasters include casualties (both killed and injured) as well as property and infrastructural damage at the village/regional level. [10] found that low-income countries suffered approximately 3,000 deaths per disaster, whereas the corresponding figure for high-income countries was approximately 500. Having proper hazard-mitigation practices and disaster-preparedness practices in place represent two ways to reduce the physical impacts of a disaster.

Hazard-mitigation practices are pre-impact actions that protect in a passive way against casualties and damage at the time of a hazard's impact. These actions include community-protection work, land-use practices, and building-construction practices ([11]). Disaster-preparedness practices are also pre-impact actions; they provide the human and material resources that are required to support active responses at the time of the hazard's impact. These actions include being prepared with early-warning systems, evacuation routes, information centers, and shelters.

The social impacts of disasters include socioeconomic impacts (in the form of decreased welfare and poverty), psychosocial impacts, socio-demographic impacts, and political impacts. The socioeconomic impacts of disasters may be minimized by providing government assistance and community support to households that have experienced adverse impacts of disasters. Government assistance such as insurance,

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[1]The adverse impacts of disasters on the economy or of a society may be categorized into two definitions: damages to stock (including physical and human capital) and loss of flows due to business interruptions, such as production and/or consumption losses.

social safety nets, and reconstruction programs can minimize these socioeconomic impacts. For instance, the use of health insurance can protect households from losing productive assets to pay for medical treatment, while reconstruction programs can provide temporary jobs. Community-recovery resources in the form of community support such as gathering groups and praying groups (*arisan* and *pengajian*, respectively, in Indonesian), family assistance, and food sharing can also reduce the hardships that result from disasters. Both community support and government assistance can minimize the socioeconomic impacts of disasters and can support households in expediting the disaster-recovery process. In addition, the socioeconomic impacts of natural hazards are also dependent upon socio-demographic and economic factors, such as household education level, assets ownership, and marital status. Asset-holding households can more successfully speed the disaster-recovery process than non-asset-holding households due to the former's improved availability of resources.

2.2 Natural Disasters and Household Coping Strategies

Households generally try to actively manage risks/shocks by choosing *ex-ante* strategies and/or *ex-post* strategies. While *ex-ante* strategies are used to prevent households from risks/shocks before events occur, *ex-post* strategies are used to reduce the adverse impacts after events occur. *Ex-post* strategies for coping with risky events include the use of informal credit, family labor adjustments, savings withdrawals, and the sale of assets. *Ex-ante* strategies, in contrast, include organizing disaster preparedness, constructing resilient buildings, and buying insurance. In choosing which strategy to apply, households' choices will generally depend on their asset ownership, labor endowment, access to loans, and family assistance and structure.

[12] describe four types of coping behavior when responding to shocks: reactive, anticipatory, preventive, and proactive/precautionary. These behaviors can be defined as follows. *First*, reactive coping is an effort to deal with an ongoing crisis or one that has already happened; such coping efforts aim to either compensate for loss or alleviate harm. *Second*, anticipatory coping is an effort to cope with an imminent threat. *Third*, preventive coping is an effort to build more resilient resources that will be less susceptible to damage in the future. *Fourth*, proactive/precautionary coping is an effort to build general resources that will facilitate the promotion of challenging goals.

[13] also define four types of coping strategies that are commonly applied in response to natural hazards—behavioral, structural, technological, and financial—all of which may be categorized as *ex-ante* strategies. *Behavioral* strategies include preparing the means of evacuation, moving properties to safer places, and storing food and safe drinking water; these types of strategies can minimize the adverse impacts of natural disasters. Preparing evacuation routes can also assist people in finding safe places during natural hazards. *Structural* strategies include, for instance, building second floors to anticipate flooding and building earthquake-resilient houses. *Technological* strategies include installing early-warning systems that can alert the population when natural hazards occur so that they can

seek safety. Finally, *financial* strategies include the buying of disaster insurance or life insurance, both of which can ensure financial security if the worst happens. People can thus financially recover more quickly from the impacts of disasters, since insurance companies will pay for some of the recovery process, such as by rebuilding houses.

2.3 Studies on Natural Disasters and Poverty

Risks and shocks (such as natural disasters) that result in lost human, physical, and social capital can reduce access to profitable opportunities in the future, either temporarily or permanently ([14]). Two ways in which risks and shocks may cause poverty are by leading households to give in to fate (i.e., the *ex-post* impact of shocks) and fear (i.e., the behavioral impact of shocks). Natural disasters may result in fear—a traumatic condition that is significant enough for people to quit their jobs or leave potential business opportunities located in the disaster area—or to giving up in the face of fate, such as by leaving casualties and abandoning damaged physical structures. Both fate and fear may plunge many households into poverty.

The actual relationship between natural disasters and welfare/poverty can be a two-way process: not only do natural disasters increase the incidence of poverty, but poverty can in turn increase households' exposure to natural hazards. A household's vulnerability to natural shocks is determined by several factors ([15]): economic structure, local development stage, social and economic conditions, the availability of coping mechanisms, risk exposure, and the frequency and intensity of disasters. Wealthy and poor people will have different responses to exposure to natural hazards depending on their availability of resources, including physical, financial, and community resources and households' socio-demographic conditions. Wealthy households have better opportunities to mobilize resources during times of hazards (i.e., by constructing disaster-resilient houses) and therefore have lower risks and suffer fewer damages from hazard exposure.

In the case of floods in Pakistan, [1] find that 1) households that initially had fewer assets and experienced greater flood damage experienced more difficulties while recovering from the disaster, and 2) aid recipients did not show higher or lower levels of recovery than non-recipients, especially in terms of housing damage. [3], cited in [16], found a significant increase in poverty in disaster-affected municipalities in Mexico. [17] was unable to find any direct evidence of disaster-induced "poverty traps" in Nicaragua, although this finding does not mean that all households necessarily recovered in a similar manner.

[18] suggest that flood-afflicted zones fare the worst among different disaster-prone areas in terms of food shortages, the incidence of extreme poverty, insufficient incomes, illiteracy, and high concentrations of wage laborers. [19] found a complex, two-way relationship between disasters and economic and social well-being in Fiji. While they found that disasters increased poverty and reduced national economic growth, they found increases in poverty from disaster outcomes to be much more severe; the authors argued that a complex set of factors further influenced the depth and breadth of these relationships. [20] found that the poor in the United States were more vulnerable to natural disasters

than their wealthier counterparts due to factors such as type and place of residence, building construction, and social exclusion. These studies together recommend that while hazards can never be fully eliminated, improved disaster preparedness, response, and recovery efforts can significantly reduce disasters' devastating impacts on vulnerable communities.

Two studies—by [21] and [22]—both show that short-term constraints on recovery can cause poverty traps that then result in the reduction of long-term macroeconomic growth rates. [23] explain the somewhat counterintuitive findings of their own study by suggesting that disasters may hasten the Schumpeterian "creative destruction" process by replacing old technologies with new ones and by necessitating upgrades to equipment, infrastructure, and production processes. [5] suggests that access to reconstruction resources, as well as the capacity to utilize those resources effectively, are both important in determining the speed and success of recovery efforts.

In the case of Indonesia, [24] found that natural-disaster risk disproportionately affected consumption-constrained households and increased projected poverty rates; the authors also found that economic development factors (such as income, urbanization, and institutional strength) determined natural-disaster losses. Using the Indonesian Family Life Survey (IFLS) dataset, [25] found that households with a high degree of exposure to smoke from fires were more vulnerable in terms of total consumption than households with lower exposure rates. [26] suggest that the quality of village infrastructure and the existence of an industrial "cluster" system both provide necessary support for companies' recovery efforts, whereas aid distribution that is undertaken as early as possible will speed companies' recovery processes. [13] state that some of the adaptation strategies that households have implemented in response to extreme climate events in Indonesia have included evacuating and moving properties to safer places, repairing houses by using more resilient structures, installing pumping machines, diversifying income sources, and borrowing money. None of the households in their study, however, had chosen disaster insurance as an adaptation strategy.

3. OVERVIEW OF DISASTER, DAMAGE AND LOSSES IN INDONESIA

3.1 Disaster, Damage and Losses at Macro Level

Indonesia has become more vulnerable in the last two decades; the intensity and scope of disasters and the number of disaster victims both increased significantly. As Table 1 illustrates, nearly forty times as many people were affected by disaster during the period 2000–2015 compared to the period 1985–1999. This jump in numbers is mainly due to increases intensity and scope of disasters as well as improvements in recording measures and database. Earthquakes and their accompanying tsunamis are the deadliest types of disaster to afflict Indonesia, whereas flooding leads to mass evacuations. Because flooding may be predicted, however, the government of Indonesia could minimize the impact of disasters, especially of floods, by taking preventive actions such as river and reservoir normalization, reforestation, and spatial planning.

Table 1. Number of Human Victims Caused by Natural Disasters in Indonesia 1969–2015

Disaster	1969–1985					1986–1999					2000–2015				
	Deaths	Injured	Missing	Affected	Evacuated	Deaths	Injured	Missing	Affected	Evacuated	Deaths	Injured	Missing	Affected	Evacuated
Earthquake	975	866	1.000	47.547	5.434	3.925	10.838	436	366.083	91.750	8.527	57.934	64	194.757	2.680.747
Earthquake and Tsunami	571	273	1.940	-	171	2.497	-	1.017	381	-	167.780	3.988	6.333	4.326.687	462.339
Eruption	415	113	3	-	14.161	69	12	-	5.452	-	427	3.478	4	54.674	330.849
Floods	575	2.520	239	32.677	14.780	845	1.910	192	228.163	1.600	2.156	190.588	668	15.374.281	5.116.347
Floods and Landslide	702	48	5.001	3.000	496	317	103	65	4.432	-	3.737	43.165	520	646.379	585.777
Drought	-	-	-	-	-	-	-	-	-	-	2	-	-	2.858.889	-
Forest Fire	7	-	-	-	-	-	-	-	-	-	37	13.485	-	443.267	2.739
Strong Wind	506	9	-	-	625	11	13	-	2.616	2.278	328	2.752	41	248.797	25.619
Others	-	-	-	-	-	3.788	-	-	302.573	-	6.464	87.398	2.522	39.395	109.713
Total	3.751	3.829	8.183	83.224	35.667	11.452	12.876	1.710	909.700	95.628	189.458	402.788	10.152	24.187.126	9.314.130

Source: Author's compilation based on the BNPB data (available at http://dibi.bnpb.go.id, accessed per 24 January 2016)

Table 2. Economic Damages Caused by Natural Disasters in Indonesia 1990–2015

Damages	Heavily Damaged Houses	Moderately aged Houses	Damaged Lightly Houses	Prayer Facilities	Education Facilities	Health Facilities	Roads (km)	Damaged Soil (Ha)
Floods	83,168	6,691	164,012	2,398	6,102	2,063	61,238	1,470,702
Landslides	11,515	1,756	10,727	152	97	20	1,458	68,409
Floods & landslides	12,869	1,344	25,621	269	1,025	262	1,179	291,408
Abrasions	3,457	414	3,859	19	25	6	411	297
Earthquakes	242,125	6,87	356,706	9,109	20,246	1,873	2,037	1,993
Earthquakes & tsunamis	325,157	-	97,403	29	1,262	254	34,904	58,087
Forest fires	106	5	12	1	2	-	-	414
Drought	-	-	-	-	-	-	-	1,715,360
Volcanic eruptions	14,888	158	9,585	41	375	26	6	52,682
Waterspouts (strong winds)	34,29	19,083	105,521	412	551	82	134	16,754
Total	727,575	36,321	773,446	12,43	29,685	4,586	101,368	3,676,106

Source: Author's compilation based on the BNPB data (available at http://dibi.bnpb.go.id, accessed 28 July 2016)

Table 2 shows recorded economic damages caused by natural disasters. Flooding and droughts destroyed nearly 90% of the total crops in Indonesia during the period 1990–2015. Households in rural areas and/or those working in the agriculture sector were the most vulnerable or the most exposed to disasters during that period. Thus, the encouragement of community initiatives such as food buffers (*lumbung desa* in *Bahasa Indonesia*) may effectively protect agriculture-based households from the hardships that come from flooding and droughts. Road and bridge damages may also have a significant impact on both the general economy and on household welfare. Flooding causes most road damage, whereas earthquakes cause most bridge damage. These damages affect households' accessibility and disrupt the flow of goods and services as well as disaster relief. Emergency responses that help to reconstruct bridges and roads can help to mitigate the adverse impacts of natural disasters.

Various studies have demonstrated that negative shocks such as death and missing family members can easily impoverish previously non-poor households ([27]; [28]). In addition, deaths preceded by prolonged or severe sickness often impose strains on a household's economy. These households are sometimes forced to sell land for medical treatment, which might impoverish the household in the near future. In contrast, the numbers of injured, evacuated, and otherwise affected people as a result of disasters are not significantly correlated with the provincial poverty rate. Suffering minor injury or being evacuated from one's home are temporary conditions and thus do not cause poverty. Based on this correlation, the impact of natural disasters on household welfare and poverty appears to depend on the level of damage and loss that has occurred.

3.2 Disaster, Damage, and Loses at Village and Household Level

While the BNPB dataset is generally used to analyze the national-level relationship between natural disasters and household welfare/poverty, this study uses the 2007 version of the Indonesian Family Life Survey (henceforth "IFLS4") to analyze natural disasters, damages, and losses at the village and household levels[2]. The IFLS is a longitudinal survey of thirteen major provinces whose residents account for approximately 83% of the country's population[3]. The IFLS survey collects data on individual respondents and their households as well as community facilities and activities. IFLS4 interviewed 13,535 households, consisting of 6,596 original IFLS1 households, 3,366 older "split-off" households, and 3,573 newer split-off households ([29]). Compared to IFLS1, 2, and 3, IFLS4 comprehensively and deeply recorded the impacts of natural disasters on households and villages (313 villages), damages and losses, disaster mitigation, and preparedness at the village level.

At the village level, the survey reported that 28.12% of villages experienced floods and fires. The proportion of villages that experienced earthquakes and landslides was

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[2]One potential dataset for exploring the issue of natural disasters is the Village Potential database (PODES), which records any natural disasters that occur throughout all villages in Indonesia; however, this dataset does not record the socioeconomic impacts of disasters at the household level.

[3]The thirteen provinces are North, West, and South Sumatera; West, Central, and East Java; DKI Jakarta; DI Yogyakarta; Bali; West Nusa Tenggara; South Kalimantan; and South Sulawesi.

18.85% and 9.58%, respectively; drought, a source of disaster particularly for farmers, affected 8.63% of villages. Combined, disasters damaged village infrastructures and facilities such as housing (42.11%), roads (33.33%), schools (16.37%), places of worship (13.45%), business centers (8.19%), and health facilities (7.6%) (see Table 3). Damage to roads and bridges disrupted villages' connectivity, which then impeded the flow of goods and services as well as aid to the afflicted villages. Damages to business centers generally hamper the disaster-recovery process due to slowed economic activities. The collapse of schools from disasters exacerbates psychological trauma for children due to their loss of places to play, learn, and socialize, while damage to health facilities increases the number of casualties due to the lack of places to stage emergency responses and administer first aid.

Figure 1 shows the composition of households that have been affected by disasters. At the individual level, only 24% of households had experience with disasters: 12.9% had experienced earthquakes, whereas 6.85% had experienced flooding. Not all households that experienced disasters suffered severe impacts; IFLS4 shows only 26% of households that experienced disasters were severely affected by them. The welfare of a household with disaster experience but no severe impact from that disaster may not necessarily decrease afterward.

According to the IFLS, 4,331 households reported that natural disasters had damaged the value of their business assets by 1.73 million Indonesian rupiah (IDR; approximately USD 173) on average, whereas 777 households reported that natural disasters had damaged the value of non-business assets by IDR 10.4 million (USD 1,040) on average. Among 821 households, the out-of-pocket medical costs and/or funeral costs caused by natural disasters was on average IDR 11 million (USD 1,100). The asset losses and out-of-pocket costs were around IDR 21.9 million (around USD 2,190)[4]. Losing assets and money due to medical/funeral costs may result in a lowering of household welfare. Non-poor households may become impoverished following a large loss from disaster and the subsequently incurred medical costs. Other households might be forced to sell their assets (such as land and livestock) during the recovery process or for medical treatment. The loss of productive assets can easily lead to poverty for such households.

Table 4 shows a cross-tabulation between households that have experienced disaster and household poverty status in 2007. The table does not completely portray whether or not disaster can impoverish households, however, because the proportions of poor households and non-poor households that have experienced natural disasters are quite similar. The exception is only to be found in the case of earthquakes, where there is a 3% difference between the proportion of poor and non-poor households that have experienced disasters. Two factors could explain the seemingly vague correlation between disaster experience and poverty status in 2007. *First*, only one-fourth of households that had experienced disasters were severely affected; and *second*, one-third of those severely affected households were better off, since their disaster compensation was higher than the

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[4]The exchange rate in 2006–2007 was around USD 1= IDR 10,200

Table 3. Damage Facilities at Village Level Caused by Natural Disaster

Damage of Facilities	Proportion of Village (%)	
	Yes	No
Roads	33,33	66,67
Bridges	11,70	88,3
Ports	1,17	98,83
Railways	0,58	99,42
Schools	16,37	83,63
Health Center Facilities	7,60	92,4
Housing	42,11	57,89
Village Office	13,45	86,55
Worship Place	17,54	82,46
Business Center	8,19	91,81
Other Public Facilities	4,68	95,32
Number of Village	171	

Source: Author's calculation based on IFLS 4

original costs stemming from the disaster.

3.3 Disaster Preparedness

Although natural hazards cannot be eliminated, improving disaster preparedness and responses can reduce human casualties and the adverse effects of natural disasters. Village preparedness for disasters essentially includes training and briefing; training includes hazard-mitigation practices such as organizing food storage, volunteering, and shelters, whereas briefing provides instruction for early responses to natural hazards. As a country that is susceptible to disaster, hazard-mitigation preparedness in Indonesia should be prioritized to reduce the physical and social impacts of disaster. Only 36% of surveyed villages (113 of 313 villages) conducted both training and briefings, however, whereas 61 villages only conducted briefings without training and 12 villages only conducted training without briefings. Around 23% (23 out of 125 villages) of villages that conducted training allocated IDR 84.1 million (USD 8,400) on average for disaster preparedness.

Figure 2 illustrates the different types of disaster preparedness. As shown in the figure, food storage and volunteering are two well-known training activities for hazard-mitigation preparedness. Based on these figures, although natural hazards frequently occur in Indonesia, the nation's communities are not well prepared to respond to these hazards. The lack of hazard-mitigation preparedness will effectively increase the adverse impacts of disasters on Indonesian society.

4. RESEARCH METHODOLOGY

This study then proposes three econometric models to examine whether or not natural disasters and mitigations can affect households' consumption and poverty status. We estimate three econometric models in order to confirm the consistency and robustness of the estimation results vis-à-vis natural disasters' ability to reduce household welfare or change households' poverty status.

The first econometric model examines the relationship between households' natural-disaster experience during the last five year 2002–2007 and per-capita household consumption in 2007; the negative coefficient of disasters indicates a household's reduced welfare. The second econometric
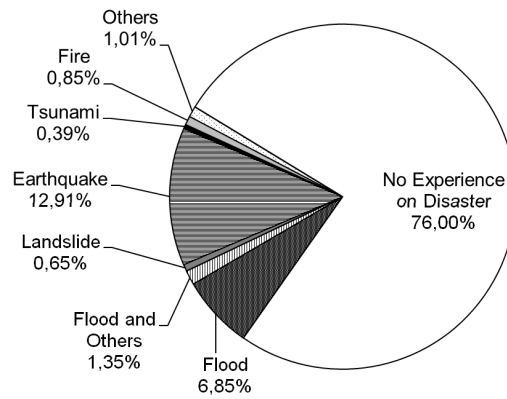
Figure 1. Household Experiences on Disaster (N=12,987)
Source: Author's calculation based on IFLS4

Table 4. Cross-tabulation between Disaster Experience and Poverty Status in 2007

	All Disaster		Flood		Flood & Others		Landslide		Earthquake		Tsunami		Fire		Others	
	No Exp.	Exp.	No Exp.	Exp.	No Exp.	Exp.	No Exp.	Exp.	No Exp.	Exp.	No Exp.	Exp.	No Exp.	Exp.	No Exp.	Exp.
Non Poor	75,96	24,04	93,16	6,84	98,59	1,41	99,36	0,64	87,01	12,99	99,6	0,4	99,23	0,77	99,02	0,98
Poor	71,99	28,01	93,2	6,8	98,58	1,42	99,37	0,63	84,02	15,98	100	0	98,26	1,74	98,58	1,42

Source: Author's calculation based on IFLS 4
Note: 1=experience disaster; 0=no experience disaster

model examines whether households' natural-disaster experience during the last five year (2002–2007) influences household poverty status in 2007. In this model, a household's decreased per-capita consumption does not necessary imply a household's changed poverty status: if household per-capita consumption decreases but the decrease does not place the household lower than the poverty line, then the household's poverty status is not considered to have changed. Though, two models are estimated using cross-sectional data of IFLS4, a significant relationship between the occurrence of disasters and low consumption still means the disasters cause poverty. This is because the IFLS-recorded disasters occurred within the last five years of when the survey was conducted, which means that these disasters occurred during the period 2002–2007.

The third econometric model examines the impact of natural disasters on changing households' poverty status within the two periods of 2000 and 2007. If the household poverty status changed from "non-poor" in 2002 to "poor" in 2007, then this implies that disasters had strongly affected household welfare. This study applies the expenditure-based poverty calculation, the official poverty line of 2000 and 2007, and the poverty measures of the "FGT" formula, named for the formula's authors ([30])[5]. This study only analyzes the "P0" (the head-count index) of the FGT poverty measurement.

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[5]The FGT classification of poverty follows this equation:

$$P_\alpha = \frac{1}{n} \sum_{i=1}^{q} \left(\frac{z - y_i}{z} \right)^\alpha$$

where P is the poverty index, n is the total population size, z is the poverty line, y_i is the income of the ith individual (or household), q represents the number of individuals just below or at the poverty line, and α is a parameter for the FGT class. The average national poverty line is IDR 103,904 (2000) and IDR 166,642 (2007). The present study, however, applies the provincial poverty line, which varies among provinces as well as among rural and urban areas.

The exploratory variables in this study are divided into two main groups: household-level exploratory variables and village-level exploratory variables. The exploratory variables included in the model consider the data available from IFLS3 and IFLS4 ([29]; [31]) as well as variables used in previous studies, including [5], [17], [25], [24], and [32]. The present study initially intended to also include coping strategies in responding to natural disasters, although this proved to be impossible due to the unavailability of data from IFLS 4. The econometric models are shown below.

$$y_i^1 = HHC_i\beta + HHDIS_i\delta + VILINF_i\chi + VILDIS_i\varphi + PREPA_i\pi + e_i \quad (1)$$

$$y_i^2 = HHC_i\beta + HHDIS_i\delta + VILINF_i\chi + VILDIS_i\varphi + PREPA_i\pi + e_i \quad (2)$$

$$y_i^3 = HHCCD_i\beta + HHSHODIS_i\delta + VILINF_i\chi + VILDIS_i\varphi + PREPA_i\pi + e_i \quad (3)$$

Where:

y_i^1 : per-capita consumption expenditure in 2007;
y_i^2 : poverty status in 2007: 0 = non-poor; 1 = poor;
y_i^3 : a changing household poverty status: 1 = chronic poor; 2 = transient poor (-); 3 = transient poor (+); 4 = never poor[6];
HHC_i : a vector of family characteristics in the initial year after a disaster has struck, including marital status, education attainment, number of household members, age, and livestock ownership;

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[6]The category of "chronic poor" means that households remained in the "poor" category during two periods of the sample (2000 and 2007). The "transient poor (-)" category means that households were non-poor in 2000 but had become poor by 2007, while "transient poor (+)" refers to households that were categorized as poor in 2000 but had become non-poor by 2007. The "never poor" category is assigned to those households that were always non-poor during both periods of the survey.
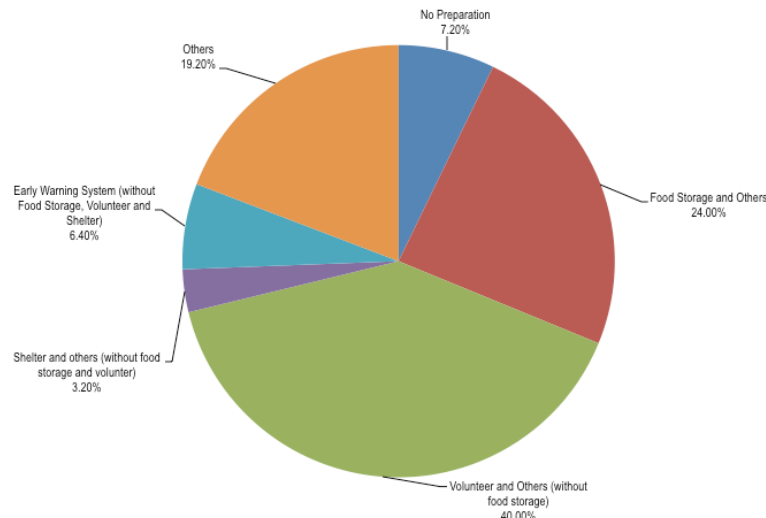
Figure 2. Types of Village Preparedness on Natural Disaster (N=125)
Source: Author's calculation based on IFLS4

$HHCCD_i$: a vector of family characteristics in the initial year, including marital status, change in marital status, education attainment, change in educational attainment, number of household members, change in size of household members, age, and livestock ownership;

$HHDIS_i$: a vector of disasters and damages that households experienced during the period 2002–2007, including flooding, earthquakes, and other disasters; costs of damage; and the ratio between costs of damage and assistance the households received;

$HHSHODIS_i$: a vector of shocks, disasters, and damages, including a vector of HHDIS and the shocks of death of family members and of being unemployed;

$VILINF_i$: a vector of village infrastructure availability, including the availability of formal credit institutions and medical facilities in a given village;

$VILDIS_i$: a vector of disasters and damages at the village level, including drought, forest fires, and damage to connectivity, business centers, and other facilities;

$PREPA_i$: a vector of village disaster preparedness and types of preparation, including disaster-mitigation preparedness, the availability of shelter, food-storage capabilities, and the use of an early-warning system;

e : error term; and

i : household-i, i = 1,..., n.

Model 1 is a linear model that is estimated using the ordinary least square (OLS), while models 2 and 3 are limited-dependent variable-of-logit (ordered logit) models that are estimated using maximum likelihoods. Each model is estimated twice: first using only household-level explanatory variables and second using both household-level and village-level explanatory variables. The double estimations are intended to check the consistency and robustness of the regression coefficient estimates when the regression specification is modified by adding explanatory variables.

5. THE IMPACT OF NATURAL DISASTERS ON HOUSEHOLD WELFARE

5.1 Disasters and Household Consumptions

OLS estimations of both model 1a and 1b confirm that only earthquakes consistently and significantly influenced per-capita consumption in 2007. Households that had experienced an earthquake during the period 2002–2007 tended to have lower per-capita consumption compared to households that had no earthquake experience. Households with disaster experience might have lost some of their productive assets, experienced housing damages, or may even have lost family members. Each of these losses will cause a household's welfare to decrease, as indicated by reduced per-capita consumption. Because the coefficient magnitudes of other disasters were found to be significant in model 1a but not in model 1b, we can say that this variable was not robust in terms of influence on per-capita consumption in 2007. The coefficient estimates of flooding are counterintuitive, since the coefficients in both model 1a and 1b were shown to be positive, which means that households that have experienced flooding tend to have increased per-capita consumption. Floods—mostly temporarily flooding—occur frequently every year in Indonesia and may not completely destroy many household properties; floods therefore may not have a significant effect on household consumption[7].

According to model 1b (shown in Table 5), drought and forest fires can significantly reduce per-capita consumption. Drought leads to crop failure, since droughts mean that there is not enough water for crops to grow; crop failure can occasionally lead to famine in some rural areas. Drought may also force some households to seek water sources for their daily needs that are located far from their residences. These households are thus forced to spend more time collecting water, which in turn reduces the time they can spend on income-earning activities. Reduced working times can shrink both household income and household consumption.

Similarly to drought, forest fires also significantly reduce per-capita consumption. Households in those villages that have experienced forest fires tend to have lower per-capita consumption. Forest fires spread smoke pollutants

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[7]Around 30% of households received disaster compensation that was more substantial than the costs from the original damage.

that can disrupt and hinder social activities, notably outdoor activities, since the smoke is often dangerous to breathe. Smoke can also cancel or delay flights due to low visibility and may disrupt educational and working activities due to the unhealthy conditions smoke creates. If this condition persists for a week or more, then economic activities may slow, eventually reducing both household income and consumption.

In terms of damages from disasters, not all the coefficient estimates of model 1b were as expected. Damage to business centers and other facilities was found to be negatively related to household per-capita consumption. Damage to a business center (such as a market in a village) interrupts the village's economic activities due to the inability of farmers and small-medium enterprises (SMEs) to sell their products; this condition will also decrease households' sources of income. The impairment of connectivity (such as via damage to roads and bridges) appears to be counterintuitive, since this type of damage does not appear to disrupt household consumption: in theory, this damage should decrease both household income and consumption, since connectivity is a necessary condition for expediting goods and services. One possible reason for this counterintuitive finding is that any connectivity impairments from disasters during the period 2002–2007 had been rebuilt by the time of the survey and therefore did not necessarily decrease household consumption in 2007.

Table 5 (model 1b) confirms that disaster-preparedness practices provide protection to households when disasters occur. Households in those villages that have undertaken disaster-preparedness practices tend to have higher per-capita consumption. Such practices can minimize the adverse impacts of disaster in such a way that households will still be able to maintain their welfare after a disaster has occurred. Model 1b also confirms that disaster preparedness in terms of shelter and food storage can ensure that households will preserve their levels of per-capita consumption after a disaster has struck. This finding is similar to that of [20]'s study; they found that improving disaster preparedness could significantly reduce the adverse impacts of disasters.

The estimated coefficients of other control variables (such as socio-demographic variables and village infrastructure variables) were as expected. For instance, households with more members tended to have lower per-capita consumption, while households with higher educational attainment tended to have higher per-capita consumption. This is because higher educational attainment is related to increased chances of earning a higher salary or income. The availability of village infrastructures (such as formal credit institutions and medical facilities) also positively correlates with per-capita consumption. Formal credit institutions may help households to smooth their consumption by providing credit when necessary.

5.2 Disasters and Household Poverty Status in 2007

The previous section analyzed whether or not disasters reduce household consumption; this section focuses on whether disasters could determine household poverty status during the period in question (2007). Compared to per-capita consumption, poverty status is a stronger indicator of welfare. Households that have experienced a decrease in their per-capita consumption do not necessarily fall into a state of poverty, because if per-capita consumption does not decrease beyond the poverty line, then the household will still be categorized as "non-poor."

Similarly to the finding of model 1, earthquakes are one type of disaster that consistently and significantly influence household poverty status. Households that have experienced an earthquake have a higher probability of being poor. The probability of being poor increased by 1.9% when an earthquake affected households during the period 2002–2007. Earthquakes may cause damages to physical assets as well as the sickness and even death of family members; both force households to spend a great deal of resources on the recovery process and medical treatment. These conditions might influence a household's 2007 poverty status. Other disasters, the costs of damages, and the ratio between costs of damage and assistance did not significantly influence household poverty status in 2007.

Model 2b confirms that forest fires significantly determined household poverty status in 2007. Households in villages that were affected by forest fires tended to have a higher probability of being poor (by approximately 3%). This finding is consistent with the same finding from model 1b, which showed that forest fires reduced per-capita consumption and thus could impoverish households. In the case of droughts, although they did not significantly determine poverty status in 2007, this type of disaster should be looked at more carefully, since households in villages that had experienced drought tended to be poor in 2007. Although damages to both business centers and other facilities were not statistically significant, they did increase the probability of being poor.

Model 2b confirms that disaster-preparation activities may effectively protect households from falling into hardship. Households in villages with disaster-preparation practices in place tended to be non-poor at the time when disasters occurred. Disaster-preparation practices such as using briefings, spreading information about disasters, and implementing early-response systems all encourage households to prepare disaster-mitigation practices; one such example is by constructing earthquake-resistant buildings. Doing this may lead to a decreased probability of massive destruction and wounded victims, thus reducing recovery costs. The types of preparation activities, however—such as the building shelters, the existence of adequate food storage, and the use of early-warning systems—did not significantly determine household-poverty status in 2007.

Model 2a and 2b confirm that socio-demographic variables such as size of household members, educational attainment, age of household head, and the ownership of livestock were important factors in determining household-poverty status in 2007. Households with more members tended to be poor, whereas households with higher educational attainment tended to be non-poor. Households also increased the probability of being poor by having more members: given a fixed income, an increase in the number of members forces households to reduce their per-capita consumption levels in order to support the additional member(s). Having a better education raises the probability of being non-poor, because a higher education level provides more opportunities to find

Table 5. The Impact of Disaster on Household's Consumption and Poverty in 2007

Variables	Consumption in 2007				Poverty Condition in 2007			
	Model 1a		Model 1b		Model 2a		Model 2b	
	Coef.	Robust SE	Coef.	Robust SE	Coef.	Robust SE	Coef.	Robust SE
Socio-demographic in 2007								
Marital Status (1=marriage; 0=others)	-0.131***	0.016	-0.047**	0.020	-0.102	0.126	-0.098	0.139
Size of Household Member	-0.139***	0.004	-0.127**	0.004	0.383***	0.021	0.383***	0.023
Educational Attainment (years of schooling)	0.056***	0.000	0.050***	0.002	-0.007**	0.003	-0.007*	0.004
Age of Household Head	0.0005***	0.001	0.002***	0.001	-0.141***	0.009	-0.125***	0.011
Livestock ownership	-0.050***	0.008	-0.012	0.009	-0.131**	0.056	-0.219***	0.063
Disaster and Damage at HH Level								
Flood (1=experience; 0=others)	0.112***	0.020	0.039	0.026	-0.104	0.163	0.257	0.179
Earthquake (1=experience; 0=others)	-0.047**	0.020	-0.087***	0.025	0.322**	0.133	0.376**	0.163
Other Disaster (1=experience; 0=others)	-0.188***	0.055	-0.085	0.067	-0.564*	0.318	-0.574	0.380
Log Average Costs of Damage (in IDR)	0.000	0.002	0.000	0.002	0.011	0.013	0.010	0.015
Ratio between Costs of Damage and Assistance	0.000	0.000	0.001**	0.001	0.000	0.002	0.001	0.004
Village Facilities								
Formal Credit Institution (1=available; 0=others)			0.056**	0.005			-0.058*	0.036
Medical Facilities (1=available; 0=others)			0.083*	0.051			0.147	0.399
Disaster and Damage at Village Level (during 2002–2007)								
Drought (1=experience; 0=others)			-0.065***	0.023			0.199	0.154
Forest Fire (1=experience; 0=others)			-0.140***	0.038			0.542**	0.232
Damages of Connectivity (roads-bridges) (1=experience; 0=others)			0.080***	0.018			-0.338***	0.131
Damages of Business Center (market) (1=experience; 0=others)			-0.023	0.041			0.142	0.283
Damages of Other Facilities (1=experience; 0=others)			-0.121***	0.030			0.179	0.198
Disaster Preparedness at Village Level (during 2002–2007)								
Training and Preparation for Disaster Mitigation (1=having preparation and training; 0=others)			0.042***	0.016			-0.294**	0.124
Shelter and others except food storage and volunteer (1=available; 0=others)			0.528***	0.100			-0.905	0.980
Food Storage and other preparations			0.133***	0.026			0.093	0.199
Early-warning System Only (1=available; 0=others)			-0.011	0.047			0.286	0.308
Constant	13.43***	0.059	12.92***	0.098	-2.66***	0.366	-2.58***	0.586
Numbers of Observation	11,902		8,134		11,902		8,134	
F-Statistic (Wald Chi-Square)	361.51		113.50		543.76		430.39	
R-Square (Pseudo R-Square)	0.264		0.247		0.106		0.103	

*, **, *** are significant at 10%, 5% and 1%
Source: Author's calculation

better jobs with higher incomes. The ownership of livestock also positively correlated with non-poor status in 2007, since the ownership of livestock is one common coping strategy during shocks such as disasters. When households experience shock, they can easily convert their livestock to cash, thus smoothing their consumption.

Model 2b also verifies that access to formal credit institutions is an important factor in helping households maintain their consumption levels and avoid becoming impoverished when shocks such as disasters occur. The probability of being non-poor for households in villages with formal credit institutions increased by around 0.3% during the period in question (2007).

5.3 Disasters and Poverty Dynamic during 2000–2007

Models 1 and 2 were used to check whether disasters affected household welfare in terms of per-capita consumption and poverty status in 2007. Model 3 further analyzed whether disasters that households have experienced during the period 2002–2007 can change a household's poverty status from "non-poor" in 2000 to "poor" in 2007. This study would have difficulty concluding that disasters could reduce household welfare if we used only the results from models 1 and 2, because both models are based on estimations of cross-sectional data[8].

The results of model 3, however, can provide stronger evidence of disasters' impacts on household welfare, because model 3 allows us to capture whether the change in household poverty status during the period 2000–2007 was influenced by households' experience with disasters that had occurred during the period 2002–2007. Model 3 also adds new exploratory variables to ensure the robustness of its estimations. These new exploratory variables include change in marital status, change in household size, change in educational attainment, shock from the death of a family member, and shock of becoming unemployed. Many previous studies—such as those of [32] and [33]—confirm that changes in socioeconomic status and shocks are highly correlated with the poverty dynamic (i.e., changes in poverty status).

Models 3a and 3b provide strong evidence that earthquakes and other disasters significantly affect household-poverty status as shown by the negative coefficient (see Table 6). Households that have been affected by earthquakes and other disasters tend to be among the "chronic poor" (i.e., they remain poor over the course of two periods) and "transient poor (-)" (i.e., they change from being non-poor to poor). In addition, for households that experienced an earthquake during the period 2002–2007, the probability of remaining poor during the two following periods (i.e., being among the "chronic poor") increased by 0.5%, while the probability of becoming impoverished (i.e., "transient poverty [-]") increased by 3.7%.

These figures imply that earthquakes can easily impoverish formerly non-poor households and can hinder house-

holds from escaping poverty. Earthquakes as well as other disasters may result in human victims and damages to certain physical assets. This will in turn create a significant financial burden on households that need to pay for medical treatment and the recovery process. This is why non-poor households typically become poor after earthquakes have struck. Furthermore, although the estimated coefficients of other negative shocks (such as the death of a family member or unemployment) are expected to increase the probability of households joining the chronic poor, these factors do not appear to be statistically significant. And finally, the average cost of disaster damage is not a significant factor in household-poverty status.

Similarly to earthquakes, droughts and forest fires are the most important factors to potentially change household-poverty status. Households in areas that have been affected by droughts and forest fires tend to be among the chronic poor and transient poor (-) categories. Similarly to the explanation for models 1 and 2, droughts and forest fires disrupt economic activities and lower household income, which in turn can easily plunge households into poverty if a village experiences drought and/or forest fire. Droughts and forest fires increase the probability of joining the chronic poor by 1% and 0.8%, respectively, whereas each disaster also increases the probability of joining the transient poor (-) group by 0.7% and 0.6%, respectively.

The destruction of business centers significantly changes household-poverty status, since this will reduce economic transactions; this in turn means less income for affected households, which can immediately become impoverished as a result. Model 3b also supports the findings of models 1b and 2b, which found that connectivity damages do not decrease household welfare, since these models showed that the affected households did not necessarily become impoverished. The reason for this is similar to the explanation for model 1b: the immediate reconstruction of previously damaged roads and bridges has prevented adverse impacts from having long-term effects that would otherwise influence household welfare in 2007. The consistent results from model 1b, 2b, and 3b also indicate that disasters may speed the Schumpeterian creative-destruction process by replacing old infrastructure.

Disaster-preparation practices can prevent households from becoming impoverished; this is evident in the finding that households in villages that have disaster-preparation practices in place tend to be non-poor. The probability of being non-poor for these households increased by around 2.6% during the period under consideration. Disaster-preparation practices might reduce the probability of massive destruction and/or casualties and thus will help to keep households from becoming impoverished. The types of preparation practices, however—such as the building of shelters, the existence of adequate food storage, and the use of early-warning systems—did not significantly determine changes in poverty status during the period 2000–2007. Although not statistically significant, the use of shelters and early-warning systems are two types of disaster-preparation practices that appear to be effective in preventing households from becoming impoverished.

The control variables of the socio-demographic variables we have examined (such as marital status, change in

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[8]The cross-sectional data could result in non-robust estimations due to the endogeneity problem as well as coincident outcomes, because explanatory variables of disasters represent past experience (i.e., conditions during the period 2002–2007), whereas per-capita consumption and poverty status represent current status.

Table 6. The Impact of Disaster on Changing Poverty Status during 2000–2007

Variables	Model 3a		Model 3b	
	Coef.	Robust SE	Coef.	Robust SE
Socio-demographic in 2000				
Marital Status (1=marriage; 0=others)	0.216**	0.090	0.233***	0.090
Change in Marital Status 2000-2007 (1=divorce; 0=others)	-0.198**	0.096	-0.204**	0.096
Size of Household Member	-0.301***	0.016	-0.301***	0.016
Change in Size of Household Member (1=increase; 0=others)	-0.406***	0.071	-0.403***	0.071
Educational Attainment (years of schooling)	0.149***	0.007	0.145***	0.008
Change in Educational Attainment (1=increase; 0=others)	0.371***	0.062	0.367***	0.062
Age of Household Head	0.008***	0.002	0.008***	0.002
Livestock ownership	0.118	0.152	0.221	0.156
Shocks, Disaster, and Damage at the HH Level (during 2002–2007)				
Shock of Death Family Member (1=experience; 0=others)	-0.081	0.118	-0.094	0.119
Shock of Being Unemployed (1=experience; 0=others)	-0.108	0.141	-0.157	0.141
Flood (1=experience; 0=others)	0.111	0.114	-0.103	0.119
Earthquake (1=experience; 0=others)	-0.182*	0.097	-0.243**	0.111
Other Disaster (1=experience; 0=others)	-1.094**	0.548	-1.001*	0.558
Log Average Costs of Damage (in IDR)	-0.002	0.010	-0.002	0.010
Ratio between Costs of Damage and Assistance	0.002	0.005	0.001	0.005
Village Facilities				
Formal Credit Institution (1=available; 0=others)			0.106*	0.060
Medical Facilities (1=available; 0=others)			0.546	0.602
Disaster and Damage at Village Level (during 2002–2007)				
Drought (1=experience; 0=others)			-0.317***	0.093
Forest Fire (1=experience; 0=others)			-0.257*	0.156
Damages of Connectivity (roads-bridges) (1=experience; 0=others)			0.444***	0.082
Damages of Business Center (market) (1=experience; 0=others)			-0.394**	0.175
Damages of Other Facilities (1=experience; 0=others)			0.038	0.136
Disaster Preparedness at Village Level				
Training and Preparation for Disaster Mitigation (1=having preparation and training; 0=others)			0.133*	0.070
Shelter and others except food storage and volunteer (1=available; 0=others)			0.052	0.392
Food Storage and other preparations (1=available; 0=others)			-0.124	0.124
Early-warning System Only (1=available; 0=others)			0.166	0.201
/cut1	-4.406	0.578	-3.724	0.845
/cut2	-3.862	0.575	-3.177	0.842
/cut3	-1.972	0.572	-1.257	0.838
Number of Observations	6,285		6,257	
Wald Chi-Square	656.57		723.0	
Pseudo R-Squared	0.070		0.075	

Source: Author's calculation

marital status, household size, change in household size, educational attainment, change in educational attainment, and age of household head) were found to be important factors in determining changed poverty status. These results also support the findings of [32]. Change in the demographic variable of marital status due to divorce often results in the loss of productive family members (either the wife or the husband). This change could reduce the household's ability in terms of economic capacity. In addition, an increase of one family member was found to be associated with becoming impoverished, since a given amount of resources now needs to be redistributed to support the new member. Changes in the educational attainment of the household head was found to be positively correlated to the probability of being in the "never poor" category. The inclusion of a household head who has attained more education increased the probability of being in the "never poor" group by 7.1%. Parallel to the findings of models 1b and 2b, model 3b has also confirmed that access to formal credit institutions is an important factor in household welfare. Formal credit institutions provide an alternative so that households may smooth their consumption with lower interest rates.

6. CONCLUSION

Indonesia has become vulnerable due to recent increases in the intensity and scope of disasters that have resulted in more victims than was the case during earlier periods. Nearly forty times as many people were affected by disaster during the period 2000–2015 compared to the period 1985–1999. After observing the national data and the household data from IFLS, this study found that households in rural areas and/or those that work in the agricultural sector are the most vulnerable or the most exposed to disaster, particularly drought and floods. At the household level, even though asset losses and out-of-pocket costs from natural disasters average around IDR 21.9 million (USD 2,190) per household, not all disasters lead to adverse impacts on society. Only one-fourth of those households that have experienced disasters feel severely affected by them.

Our three econometric models confirm that earthquakes are the most destructive disaster to affect household welfare. Earthquakes can cause formerly non-poor households to become poor households due to asset losses, damage costs, and casualties. Droughts and forest fires also significantly affect household welfare, particularly agricultural households and those in Sumatera and Kalimantan, both of which are vulnerable to forest fires. In contrast, flooding and other disasters have less of an effect on household welfare.

The government should also pay more heed to rebuilding damaged business centers (such as markets) to hasten the recovery process, since this study has shown that damages to business centers negatively affect households' welfare and poverty status. Moreover, households in those villages that have experienced damage to connectivity due to disasters often become better off, in the sense that their welfare (i.e., consumption) increases and their poverty status improves when the village experiences damages to roads and bridges (i.e., connectivity). One possible reason for this is that damaged roads and bridges will be rebuilt immediately after a disaster has struck, to be replaced by upgraded infrastructures.

Similarly to other studies, this study has found that the implementation of disaster-mitigation preparations such as trainings and briefings could reduce the impacts of disasters as well as households' vulnerability to becoming impoverished once disaster has struck. The government of Indonesia should actively encourage and support villages or other communities to engage in disaster-preparation practices such as distributing information about disasters, implementing early-response systems, and preparing shelters in order to reduce the probability of massive destruction and/or casualties. One important policy suggestion to protect households from negative shocks would be to expand household access to formal credit institutions, since such institutions can help households in smoothing their consumption when shocks occur by providing credit at lower interest rates.

7. ACKNOWLEDGEMENT

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