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Determinants of Flood Fatalities: Evidence from a Panel Data of 79 Countries

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ABSTRACT

There is available evidence from different parts of the world that floods and storm account for about 67 percent of the natural disasters. While, earthquake, landslides, drought, extreme temperature, wildfire and volcano eruptions contribute to the remaining 23 percent. In many developing countries, the frequent occurrences of natural disasters, particularly floods are not uncommon. Yearly recurrence of floods bring devastate economies. The objective of the present study is to investigate factors that can mitigate the impact of floods on human fatalities and damages. We use a panel of 79 countries for the period of 1981-2005 and employ the two-step system GMM estimator to show that the level of economic development, population, investment, openness and education impact flood fatalities, total people affected and total cost of damages.

Keywords: Natural disasters, floods, GMM, developing economies

INTRODUCTION

Natural disasters are common event. Drought, earthquake, extreme temperature, floods, cyclone, volcanic eruptions, wildfires and landslide are natural phenomenon that occur from time to time. For example, The Asian Disaster Reduction Center (ARDC, 2009) reports that 399 natural disasters occurred in 2009 worldwide, killing almost 16,000 people and affecting over 220 million people. The estimated amount of economic damage came close to US$50 billion. By geographical region, Asia is the highest in all four accounts: 35.8 percent of disaster occurrences; 52.1 percent of total number of people killed; 78.3 percent of total number of affected people; and 44.9 percent of amount of economic damages.

Within the Southeast Asian region, in 2009, Indonesia was impacted by 5 occurrences of earthquakes, 5 occurrences

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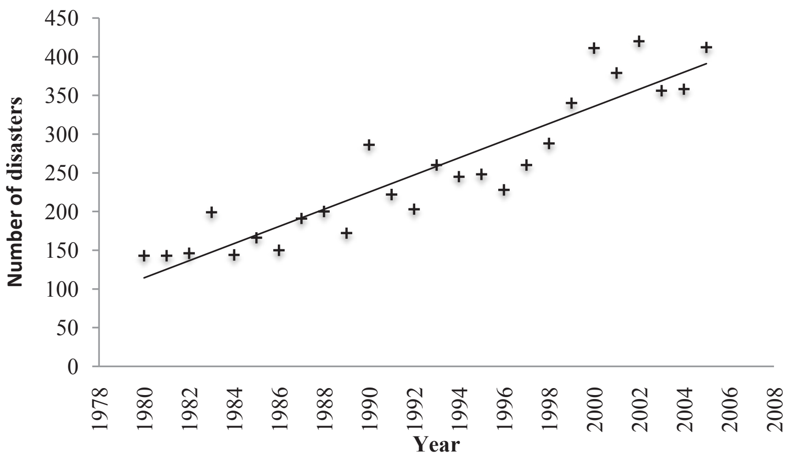
of floods and 2 occurences of landslides. The earthquake caused 1,330 deaths and affected more than 2.8 million people. The estimated cost of damages reached about US$2.8 billion. Floods has killed 126 people and affected more than 26,000 people. While, the landslides killed 29 people over the two occasions. On the other hand, the Philippines accounted for more three types of natural disasters that included earthquake, flood, landslide, storm and volcanic eruptions. Storm or cyclone accounted for most damages. In 2009, cyclone wrecked havoc in the Philippines 14 times that killed 1,242 people, affected more than 12 million people and causing more than US$900 million in damages. Eight occurrences of flood caused 55 deaths, affected more than 1 million people, and caused US$29 million in damages. In 2009, volcanic eruption affected more than 47 thousand people in the Philippines. However, Malaysia only experienced two occasions of floods in 2009. These two occasions of flood affected more than 10 thousand people.

There is available evidence from different parts of the world that there is a rising trend of natural disasters from 1978 to 2008 (see Fig.1). A total of 6,991 natural disasters occur during this period. Flood and storm accounted for about 67 percent of the natural disasters. While, earthquake, landslides, drought, extreme temperature, wildfire and volcano eruptions accounted for the remaining 23 percent (see Fig.2). Table 1 exhibits the 25 worst disasters based on number of people killed in Asia in 2009. It shows that flood has been the most frequent occurring natural disaster with 151 times of occurrences. The floods caused more than 3,000 deaths and 57.7 million people affected and damages reaching US$8 billion (ADRC, 2009). As shown in Table 1, flood also created havoc in other countries. India



Sources: EM-DAT: The OFDA/CRED International Disaster Database – www.emdat.be – Université Catholique de Louvain – Brussels – Belgium.

Fig.1: Number of Disaster from 1978-2008

TABLE 1
The 25 Worst Disasters in Asia by Number of People Killed, 2009

Disaster Type	Country	Date Started	Killed	Total Affected	Damages (US$ million)
Earthquake:	Indonesia:	2-September	128	339,792	160
		30-September	1,195	2,501,798	2,200
Flood:	India:	July	992	1,886,000	220
		25-September	300	2,000,000	2,150
		3-November	70	8	64
	Saudi Arabia	24-November	161	10,000	900
	China P. Rep.	1-July	90	39,372,000	1,000
	Nepal	4-October	87	257,786	60
	Indonesia	26-March	64	1,600	0
Storm:	Taiwan (China)	7-August	630	2,307,523	250
	Philippines:	7-May	77	401,007	30
		24-September	501	4,901,763	237
		29-September	512	4,478,491	585
	Bangladesh	25-May	190	3,935,341	270
	Vietnam:	28-September	182	2,477,315	785
		2-November	124	500,145	280
	India	25-May	96	5,100,000	0
	China P. Rep.	3-June	52	215	625
Epidemic:	Sri Lanka	January	346	35,007	0
	Nepal	1-May	314	58,874	0
	India	January	311	1,521	0
Extreme Temperature:	Bangladesh	15-December	135	50,000	0
	India	14-April	120	25	0
Mass Movement:	China P. Rep.:	5-June	65	0	0
		14-July	54	10,004	139

Source: ADRC Natural Disasters Data Book 2009.

had it in July, September and November, Saudi Arabia in November; China in July, Nepal in October and Indonesia in March. As a result, total death reached to 1,764 people, 43.5 million people affected and economic losses reached close to US$4.4 billion.

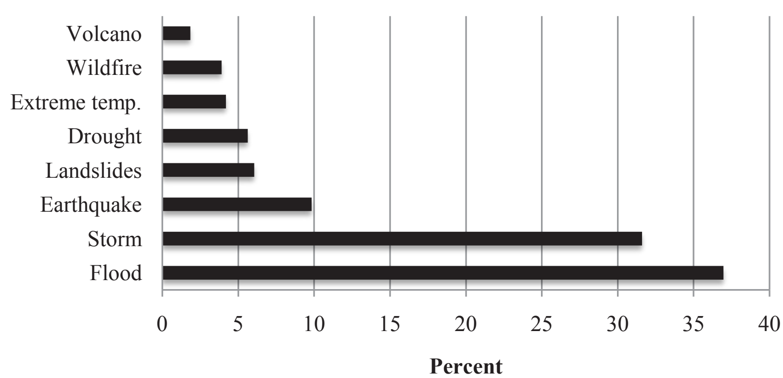
Obviously, natural disasters such as earthquakes, storms and floods have readily perceptible effects. At the same time, natural disaster has gradual impact or long lasting impact following the event. For instance, invasion of crop pests arriving in the wake of the disaster and shortages of essential products arising several months after the catastrophe. As a matter of fact, the effects of a natural disaster have been classified as follows:

a. direct damage - the effects on property;
b. indirect damage - the effects on goods and services production flows;
c. secondary effects - the effect on the behavior of the main macroeconomic aggregates.

The first effects more or less coincide with the disaster or occur within hours of the event. While, the others occur over a period of time. Based on the practical experiences, the period can as long as five years, depending on the magnitude of the disaster. For example, according to Tobin and Montz (1997), their study indicate that the residents of Linda and Olivehurst in California that have experienced the most severe flooding, see long lasting impacts on the house price. Following floods, some houses experience certain degree of damages causing the owners repainting, replacing all the appliances and carpets. As a consequent, the house prices have to be increased.

On the other hand, a study by Leiter *et al.* (2009) demonstrate that in the short-run, companies in regions hit by a flood show an average higher growth of total assets and higher employment compared to those firms in regions unaffected by flood. They also find that some part of the capital is less vulnerable to disasters. Companies with larger shares of intangible assets prevail with positive effect. Leiter *et al*. point out that after floods, firms with low fraction of tangible assets experience increase accumulation in physical capital. As a result, the negative effects on firm's productivity declines with an increasing share of intangible assets.

Alexander (1993) indicate that in developing countries floods have distinctive long-term effects. Floods affect human health including death, physical injury, disease transmission, malnutrition and loss



Sources: EM-DAT: The OFDA/CRED International Disaster Database – www.emdat.be – Université Catholique de Louvain – Brussels – Belgium.

Fig.2: The Percentage of Different Natural Disaster as a Percent of Total Number of Disasters During 1978-2008

of morale. Floods affect the agricultural sector by destroying crops, livelihood of the people, and also destroy homes and infrastructures. For example, during the two years of 1987 and 1988 flood in Bangladesh, flood waters has increased risk of cholera, dysentery and rapid growth in the incidence of malaria and yellow fever. Furthermore, the time duration the water remains on the land also affects the agricultural prospects (Gruntfest, 1995). The long-term disruption of livelihoods and the loss of land and other assets will increase the long-term vulnerability to flood and poverty.

In Malaysia, floods occur on an annual basis causing misery, damage to properties and loss of life (Chan, 1997; Chan & Parker, 1996). Flooding is the most significant natural hazard in terms of people affected, frequency, area extent, flood duration and social economic damages. Since 1920, Malaysia has experienced major floods in the years of 1926, 1963, 1965, 1967, 1969, 1971, 1983, 1993, 1998, 2005, 2006 and 2007. The flood that occurred in Johor during period of 2006-07 was due to abnormally heavy rainfall. The massive floods has caused a loss in damages amounting to RM1.5 billion. To-date, it has been considered as the most costly flood events in Malaysian history. The rapid urbanization in the state of Johor amplifies the cost of damage in infrastructures, bridges, roads, agriculture, private commercial and residential properties. During that period, 110,000 people have been evacuated and sheltered in relief centers. the reported death toll is 18 people (Ketua Pengarah, 2007). As shown in Table 2, from 1960 to 2009, flood has been the number one type of disaster that have devastated the Malaysian population with a total death of 607 people, affecting more than 1.2 million people and economic loss of about US$1.08 billion. Other disasters that have created havoc to the Malaysian people include storms (296 death, 57,946 people affected; US$53 million damages), epidemic (540 death; 32,047 people affected), landslide (152 death; 285 people affected), wildfire (3,000 people affected; US$302 million), drought (5,000 people affected) and tsunami (80 death; 5,063 people affected; US$500 million in damages).

The objective of this paper is to investigate factors affecting flood damages and fatalities in 79 selected countries. In this study we have identified several potential determinants of floods namely, the level of economic development, population, population density, unemployment, real investment, real government consumption, openess, education and corruption. These socio-economic and macroeconomic variables are found to have impacted natural disasters fatalities in numerous studies. The paper has been organized in such a way that the next section discusses some factors discovered to have imparted natural disaster's fatalities in the past. It is followed by a discussion on the estimating model used in the study in section Methodology. While, section Empirical Results shows the empirical results. Finally, the last section exhibits our conclusion.

Table 2
Type of Natural Disasters Occurrence in Malaysia, 1965-2009

Disaster Type	Sub Type	Name	Date Started	Killed	Total Affected	Damages US$ million
Flood			3/12/1965	6	300,000	1
Flood			00/01/1967	50	140,000	25.6
Flood			26/12/1970	61	243,000	37
Flood			00/12/1978		3,000	
Flood			00/12/1983	10	15,000	
Flood			28/11/1986	11	25,000	11.5
Flood			00/12/1987	3	2,576	
Flood	General flood		12/11/1988	27	60,000	
Flood	General flood		22/12/1993	30	25,000	
Flood	General flood		11/2/1996		418	
Flood			19/11/1998		2,500	
Flood	General flood		1/1/1999	1	2,000	
Flood	Flash flood		21/11/2000	12	8,000	1
Flood	Flash flood		19/08/2001		10,000	
Flood			00/10/2001		5,000	
Flood			30/10/2001		200	
Flood	General flood		22/12/2001	11	18,000	
Flood	Flash flood		29/11/2003	5	3,000	
Flood	General flood		17/12/2003		2,000	
Flood	General flood		3/10/2003	3	13,800	
Flood	General flood		24/01/2004	3	6,900	
Flood	General flood		8/3/2004		9,138	
Flood	General flood		10/12/2004	13	15,000	10
Flood	Flash flood		17/07/2005	4	600	
Flood	Flash flood		23/11/2005	9	30,000	
Flood	General flood		9/1/2006		1,112	
Flood	General flood		10/2/2006		4,906	
Flood	General flood		20/04/2006		500	
Flood	Flash flood		19/12/2006	6	100,000	22
Flood	General flood		11/1/2007	17	137,533	605
Flood	General flood		7/12/2007	29	29,000	363
Flood	General Flood		1/12/2008		2,000	
Flood	Flash Flood		28/12/2008		6,000	
Flood	General Flood		23/11/2009		1,793	
Flood	General Flood		20/11/2009		9,082	
Storm			7/1/1968	21	10,000	
Storm	Tropical cyclone	Greg	26/12/1996	270	4,176	52

Table 2 (continue)

Disaster Type	Sub Type	Name	Date Started	Killed	Total Affected	Damages US$ million
Storm	Tropical cyclone	Zita	23/08/1997	2	2,115	1
Storm			27/09/2000		500	
Storm	Local storm		30/03/2002	2	155	
Storm			16/07/2004		1,000	
Storm			6/11/2004	1	40,000	
Epidemic	Bacterial Infectious Diseases	Cholera	00/05/1968	2	5	
Epidemic	Bacterial Infectious Diseases	Typhoid	00/05/1977		50	
Epidemic	Viral Infectious Diseases	Dengue fever	00/00/1991	263	3,750	
Epidemic	Viral Infectious Diseases	Dengue/ dengue haemorrhagic fever	00/05/1996	13	4,800	
Epidemic	Bacterial Infectious Diseases	Cholera	11/5/1996		607	
Epidemic	Bacterial Infectious Diseases	Coxsackievirus	5/11/1997	17		
Epidemic	Viral Infectious Diseases	Dengue and dengue Haemorrhagic fever	00/01/1997	50	19,544	
Epidemic		Fatal myocarditis	13/04/1997	28	2,140	
Epidemic	Viral Infectious Diseases	Encephalitis	00/09/1998	105	160	
Epidemic			00/01/2000	2	480	
Epidemic	Viral Infectious Diseases	Hand foot and mouth disease	00/10/2000	2	508	
Epidemic	Viral Infectious Diseases	Acute respiratory syndrome (SARS)	14/03/2003	2	3	

Table 2 (continue)

Disaster Type	Sub Type	Name	Date Started	Killed	Total Affected	Damages US$ million
Epidemic	Viral Infectious Diseases	Dengue	00/07/2007	56		
Mass movement dry	Landslide		11/12/1993	72		
Mass movement wet	Landslide		30/06/1995	20	23	
Mass movement wet	Landslide		30/08/1996	50	262	
Mass movement wet	Landslide		31/01/2002	10		
Wildfire	Forest fire		3/5/1995		3,000	
Wildfire	Forest fire		21/08/1997			300
Wildfire	Forest fire		4/3/1998			2
Wildfire	Forest fire		9/8/2005			
Drought	Drought		00/03/1998		5,000	
Earthquake (seismic activity)	Tsunami		26/12/2004	80	5,063	500

Source: ARDC Natural Disasters Data Book, various issues

LITERATURE REVIEW

Empirical evidences suggest that natural disasters produce a devastating impact on macroeconomic conditions in the short run. They cause sudden collapsed in domestic production and more pronounced slowdown in national income. In line with the collateral damages, they trigger irreversible loss of human capital, affect the standard of living, increase level of poverty Eventually, it leads to a more chronic economic decay. In line with the increasing frequency of natural disasters in recent years, its impact on social, economic and physical heighten public awareness and bring the issue to the forefront of public attention worldwide.

According to Wildavsky (1988), safety is a natural product of a growing market economy. Since the demand for safety rises with income, a nation’s per capita income is a good first approximation of the degree of safety it enjoys. Furthermore, a rise in income provides general safety. Its protection can specifically be directed to mitigate the impact of natural disasters fatalities and damages (Horwich, 2000). Albala-Bertrand (1993) argue that the higher the level of economic development, the smaller the number of deaths, injuries, deprived and relative material losses. The level of economic development includes income per capita, income distribution, economic diversification and social inclusion, institutionalization, participations, education, health, choices and protections.

In fact, Kahn (2005) point out that the impact of natural disasters can be substantially different between richer and poor nations. According to Kahn, although richer nations experience natural disasters as much as the poorer nations, the former suffer lesser number of deaths from the events. It is due to richer nations' ability to provide self-protection through a number of strategies in mitigating their natural disaster risk exposures. Furthermore, the government of a richer nation can provide implicit disaster insurance through effective regulation, strategies and quality infrastructure. Kahn further argue that nations with stronger institutions, demonstrating democratic and low income inequality nations, suffer lower number of deaths resulting from disasters. Raschky (2008) support the idea that institutions play important roles where the institutional framework is a key socio-economic determinant of a nation's vulnerability against natural disasters.

On the other hand, Tol and Leek (1999) argue that the positive effect of GDP can be readily explained since natural disasters destroy the capital stock. While, the GDP measure focuses on the flow of new production. They emphasize the incentives for saving and investment mitigating and recovery efforts. Furthermore, should sufficient re-investment from designated reserves takes place, the loss of capital in longer term may have a positive impact,.

Haque (2003) investigate the impact of socio-economic and demographic factors on natural disaster fatalities. Empirical evidence shows that socio-economic and the demographic factors have a very significant relationship to disaster-related deaths and economic losses in East, South Asia and the Pacific islands. It is also argued that the emergency preparations and swift action in handling the dangerous situation in such disastrous events will lessen the severity of bad impact of each event. At the same time the studies also point out the importance of having special training programs such as disaster management program to the teachers, volunteers, public and social workers, local emergency agencies such as the police, fire department and etc. in order to minimize the risks and promote the awareness of the natural disasters.

Research by Skidmore and Toya (2007) focus on the degree to which human and economic losses resulted from natural disasters are reduced as economies developed. The sample includes annual data of every recorded natural disaster from 151 countries over the period range from 1960–2003. Empirical evidences show that higher income, higher educational attainment, greater openess, more complete financial systems and smaller government lead to fewer losses.

Raschky (2008) investigate the relationships between economic development and vulnerability against natural disasters. The sample consists of 2792 events where numbers of natural disaster victims and 1103 events with figures on economic losses are available. Empirical results show that countries with high quality of institutions experience less victims and lower economic losses from natural disasters. Raschky also discover that there is non-linear relationship between economic development and economic disaster losses. This contention is further supported by Kellenberg and Mobarak (2008) where disaster-related deaths increase with rising income. According to Kellenberg and Mobarak, the inverted-U non-linearities appear to be stronger for floods, landslides and windstorms compared to extreme temperature events or earthquakes.

On the one hand, Padli and Habibullah (2009) investigate the relationship between natural disaster fatalities with the level of economic development, years of schooling, land area and population for a panel of fifteen Asian countries from 1970 to 2005. They find that the relationship between natural disaster losses and the level of economic development is non-linear in nature. It suggests that at lower income level, a country is more natural disaster resilient; but, at higher income level, an economy become less natural disaster resistant. The level of education is another natural disaster determinant that suggests educational attainment reduces human fatalities as a result of natural disaster. In addition, larger population increases death tolls and larger land areas reduce natural disaster fatalities.

On the other hand, Padli *et al*. (2010) investigate the relationship among the impact of natural disaster such as number of death per capita, total affected and total damage/GDP and macroeconomic variables namely Gross Domestic Product per capita (as a proxy for the level of economic development), GDP per capita squared to identify the linearity or non-linear of the relationship, government consumption, ratio of M2 over GDP as a proxy for financial deepening, years of schooling attainment, land area and population as a dependent variable by using cross-sectional analysis. Three different point of time are regressed, namely 1985, 1995 and 2005 encompassing 73 countries. It is discovered that wealthy nations and their citizens are better prepared for natural disasters. Preparations may lessen the aftermath economic impact of natural disasters. The size of the government is also found significant and inversely related. It strengthens the understanding of government intervention and consumption on minimizing the impact of natural disaster.

Kahn (2005), Skidmore and Toya (2007), Raschky (2008), Noy (2009) have tested the idea that better institutions reduce the adverse effects of natural disasters. It is concluded that countries with higher-quality institutions suffer less death tolls and economic losses from natural disasters.

It has been argued that damages resulted from natural disasters are dependent on good governance. Studies on the impact of public sector corruption on fatalities are evident Anbarci *et al*. (2006), Escaleras *et al*. (2007) and Yamamura (2013). In their studies on traffic fatalities in 10 selected countries, Anbarci *et al.* (2006) discover that as public sector corruptions increase in these countries, traffic fatalities rise significantly. Escaleras *et al*. (2007), on the one hand, when analyzing 344 earthquakes from 42 countries occurring between 1977 and 2003, found that public sector corruption is positively related to earthquake deaths. Furthermore, Escaleras *et al.* (2007), discover that public sector corruption is positively related to earthquake deaths in the analyses of 344 earthquakes from 42 countries occurring between 1977 and 2003. On the other hand, Yamamura (2013) focus on the probability of the occurrence of disasters using panel data from 98 countries. It is discovered that the public sector corruption increases the probability of technological disasters in those countries.

METHODOLOGY

Based on the work of Kahn (2005), Skidmore and Toya (2007) and Raschky (2008), we specify the following general functions for the determinants of flood damages and fatalities:

$$FLOOD_j = f\{RGDPc, RGDPc^2, pop, pop\_dens, unemp, rinv, rgc, open, edu, corr\} \quad (1)$$

The following regression specifies Equation (1) in a log-log regression:

$$\begin{aligned} &\ln FLOOD_{ijt} \\ &= \beta_0 + \beta_1 \ln RGDPc_{it} + \beta_2 \ln RGDPc^2{}_{it} \\ &+ \beta_3 \ln pop_{it} + \beta_4 \ln pop\_dens_{it} \\ &+ \beta_5 \ln unemp_{it} + \beta_6 \ln rinv_{it} + \beta_7 \ln rgc_{it} \\ &+ \beta_8 \ln open_{it} + \beta_9 \ln edu_{it} + \beta_{10} corr_{it} + \varepsilon_{ijt} \end{aligned} \quad (2)$$

where i denotes country *1, 2, 3,……N*, j signifies type of flood fatalities and ε_{ijt} represents the error term. $FLOOD_j$ is the measurement for flood fatalities which consists of three measurements, namely total number of death (*TD*), total number of affected per capita (*TAFFc*) and total economic losses (*TC*) caused by floods. As for the regressors, $RGDPc_{it}$ is the real gross domestic product per capita. $RGDPc^2{}_{it}$ is the square of real gross domestic product per capita which measures for non-linear relationships. In addition, pop_{it} is the total population, pop_dens_{it} is the population density, $unemp_{it}$ is the unemployment rate, $rinv_{it}$ is the ratio of real investment to GDP, rgc_{it} is the ratio of real government consumption to GDP, $open_{it}$ is openness measured as (export+import) / GDP, edu_{it} is education level; that is based on number of students enrolled in higher education, primary and secondary school, and $corr_{it}$ is corruption index. Finally *ln* denotes natural logarithm of the variables used in the study.

From Equation (1), we would expect that GDP per capita is negatively related to *TD*, *TAFFc* and *TC*. Economists have discovered that safety is generally a normal or luxury good. As people become wealthier and secure the necessities of life, they start focusing on reducing risks of premature deaths. However, based on past literatures, the relationship between GDP per capita and natural disasters show mixed results. It has negative or positive impact on natural disaster fatalities. We expect the results on population and population density to have positive impact on natural disaster fatalities due to urbanization. The unemployment rate is also expected to have mixed results. There are positive impact on total deaths and negative impact on total affected and economic losses due to limited or no income and wealth or resources. We expect negative relationship between sign of real investment and openness on damages and fatalities. As there is more investment, there is more research and development activities, more avenue to absorb new idea in natural hazard preparedness and finally will reduce the impact of natural disaster fatalities. The more investment channeled, the more research and development activities are designed. They functioned as avenues absorbing and generating new ideas in natural hazard preparations. Consequently, it reduces the impact of natural disaster fatalities. Similarly, from the aspect of government consumption, we expect a negative relationship on human fatalities and positive impact on economic losses. In addition, education attainment is also expected to have a negative relationship on losses due to natural disaster. As people become more educated and knowledgeable, they are more aware, alert and more prepared for any natural disaster events. Finally, corruption as a measurement of institutional factor is expected to show positive impact on disaster damages and fatalities. Natural disasters are the direct outcome of deviant political and economic decisions and actions by institutional participants.

To add dynamic to the panel data analysis, we include lagged one period of the dependent variable in each of equation for *TD, TAFFc* and *TC*. The general way to deal with dynamic panel data is to apply first-differenced General Method of Moment (GMM) estimators using the levels of the series lagged two periods or more as instrumental variables. However, when the number of time series observations is small, the first-differenced GMM may behave quite poorly It is due to lagged levels of the variables being weak instruments for subsequent first-differences (Bond *et al*., 2001). This problem may be alleviated by introducing the system GMM estimator suggested by Arellano and Bover (1995) and Blundell and Bond (1998). The assumption used is that first-differences are not correlated with country specific effects. The basic idea of system GMM is to combine both equations in first-differences, taking the lagged level variables as instruments, with equations in levels with lagged first-differences as instruments.

To establish the validity of instrumental variables, specification test are conducted using the Hansen test. Based on the Hansen test, the null hypothesis is that there is no correlation between instruments and errors, and failure to reject the null can be viewed as evidence in favor of using valid instruments. The next test is for the errors that are not serially correlated in first-differenced equation. By construction, the differenced error term may be first-order serially correlated even if the original error term is not (Carkovic & Levine, 2002). Thus, if the null hypothesis of no serial correlation of AR(2) model cannot be rejected, it can be viewed as evidence supporting the validity of instruments used.

Descriptions and Sources of Data

The data set consists of a panel of observation for 79 countries, including developed and developing countries, for the period 1981 – 2005. The data used in the analysis are five years averages: 1981-1985, 1986-1990, 1991-1995, 1996-2000 and 2001-2005. The list of countries used is shown in Table 3. Data on the impact of flood such as the number of deaths, number of affected per capita, and cost of damages are taken from the OFDA/CRED Centre for Research on the Epidemiology of Disasters. CRED has maintained the Emergency Events Database (EM-DAT) since 1988. It is accessible at http://www.emdat.be. Other regressors are obtained from various sources which are summarized in Table 4. All variables, except corruption (corr), are transformed into natural logarithm before estimation.

THE EMPIRICAL RESULTS

Table 5 shows the results of the two-step system GMM illustrating the estimated coefficients, sign and significance of several economic factors affecting flood fatalities and damages. In Total Death equation, the only variable that contributes to changes

TABLE 3
Lists of Countries included in the Study

Algeria	Italy	Thailand
Australia	Jamaica	Trinidad & Tobago
Austria	Japan	Turkey
Bangladesh	Kenya	Uganda
Belgium	Korea Rep	United Kingdom
Bolivia	Luxembourg	United State
Brazil	Madagascar	Uruguay
Bulgaria	Malawi	Venezuela
Cameroon	Malaysia	Vietnam
Canada	Mexico	Yemen
Chile	Mozambique	Zimbabwe
China P Rep	Netherlands	
Colombia	New Zealand	
Costa Rica	Nicaragua	
Czech Rep	Pakistan	
Dominican Rep	Panama	
Ecuador	Papua New Guinea	
Egypt	Paraguay	
El Salvador	Peru	
France	Philippines	
Germany	Poland	
Ghana	Portugal	
Greece	Romania	
Guatemala	Russia	
Haiti	Senegal	
Honduras	Slovakia	
Hong Kong	Slovenia	
Hungary	South Africa	
Iceland	Spain	
India	Sri Lanka	
Indonesia	Sudan	
Iran Islam Rep	Sweden	
Ireland	Switzerland	
Israel	Tanzania	

TABLE 4
Description of Variables and Sources of Data Used in the Study

Variables	Brief Description	Sources of Data
Number of death	Persons confirmed as dead and persons missing and presumed dead	EM-DAT
Number of total affected per capita	Sum of injured, homeless, and affected	EM-DAT/ Penn World
Total damage cost	Estimates include both direct costs (such as damage to property, infrastructure, and crops) and the indirect losses due to reductions in economic activity.	EM-DAT
Income per capita	Real Gross Domestic Product per capita	WDI/IMF
Population	Total population	Penn World
Population Density	Total population divide by land area sq/km	Penn World / WDI
Unemployment	The rate of unemployment	WDI
Investment	Real investment percentage of GDP	WDI
Openness	Export plus import divided by GDP	Penn world
Government Consumption	Real government Expenditure percentage of GDP	WDI/IFS
Education	Number of schooling attainment	Barro and Lee (2010)
Corruption	The extent to which public power is exercised for private gain, including petty and grand forms of corruption, as well as "capture" of the state by elites and private interests	ICRG (International Country Risk Guide)

in total deaths is openness. The inverse relationship between openness and total deaths suggest that by opening the economy to the outside world. For example, it is implemented through liberalizing trade or foreign direct investment. It promotes knowledge absorbing, technology transfer, effective regulation and planning as well as quality infrastructure. Consequently, total deaths may be reduced during floods.

In the aspect of the Total Number of Affected per Capita, our results suggest that the level of economic development, population, investment and openness are statistically significant different from zero, at least, at 5 percent level. On the other hand, economic development, population, investment and education are important determinants for the Total Economic Loss (Damages) Equation. An increase in the level of economic development, measured by income per capita, reduces both total affected and total damages due to floods. It can be observed that a 1 percent increase in the level of economic development can contribute to a more than 5 percent in total economic losses or damages. Opening the economy coupled with increase in investment and population, most likely, lead to migration from rural to urban areas. It enhances rapid urbanization. As a result, these activities lead to increase in the number

TABLE 5
Results of Dynamic Panel Data Two-Step System GMM Estimations

Variable	Total Death $LnTD_t$	Total Affected per Capita $LnTAFFc_t$	Total Economic Losses $LnTC_t$
$LnTD_{t-1}$	0.143 (1.31)		
$LnTAFFc_{t-1}$		-0.051 (-0.71)	
$LnTC_{t-1}$			-0.020 (-0.25)
$LnRGDPc_t$	-0.055 (-0.16)	-1.074*** (-3.72)	-5.418*** (-2.58)
$Lnpop_t$	-	0.770*** (3.01)	1.752*** (3.06)
$Lnrinv_t$	0.226 (0.99)	-	-
$Lnrinv\_pc_t$	-	0.223*** (3.65)	5.472*** (1.570)
$Lnopen_t$	-1.688** (-2.33)	2.557*** (2.99)	-
$Lnedu_t$	1.370 (1.53)	-	-2.080* (-1.64)
Observation	295	295	294
No. of Countries	79	79	79
Dummy	Yes	No	No
AR(1) *p*-value	0.021**	0.002***	0.006***
AR(2) *p*-value	0.464	0.169	0.335
Hansen test *p*-value	0.862	0.518	0.635

Notes: Figures in parenthesis are *t* -statistics. Asterisks (***), (**), (*) denote statistically significant at the 1%, 5%, 10% level, respectively. Other variables that are not statistically significant different from zero were dropped from the final estimated models.

of people affected by floods and also increase in total damages considering buildings and infrastructures are more concentrated in urban areas. Lastly, education level plays a role in affecting losses due to floods. More people those are well informed and knowledgeable about the consequences of flood contribute to reducing damage costs as a result of flood. The extent of information and knowledge people comprehend about the consequences of flood contributes to reducing damage costs.

CONCLUSION

The purpose of this study is to investigate factors that contribute to the mitigation of flood fatalities and damages using a panel of data from 79 countries. We have identified several economic variables that may affect flood fatalities and damages. These variables include: income per capita, total population, investment, openness and education.

Generally, our study suggests that among others, enhancing economic development can help in reducing the impact of flood on human fatalities or total people affected and economic losses. Countries with higher income are more prepared to face future devastation due to floods. The investment on flood relief centers, preparation programs on flood, early warning systems, enforcement of building regulation to flood prone areas etc, lessen the impact of flood on the public and damages on the infrastructures. Furthermore, higher investment and expanded public education lead to reduction in human fatalities. Well informed citizen are more sensitive to preparations against any ill-effect as a result of floods. For example, they buy homes located in areas that are less prone to floods or take extra precautions to face future disasters.

One important policy implication is that programs and policies focussing on increasing people income level should be given priorities. Indirectly, in the long run, it may work positively in mitigating and reducing the damages, losses and fatalities resulting from natural disasters. Furthermore, the expenditure and consumption of the government also need to be carefully planned and cautiously implemented. It is supported by this study that has proven government consumption is an important tool. If it is used wisely and vigilantly, it mitigates the losses and reduces the negative impact of natural disasters. The government also needs to allocate a big proportion of its budget on mitigating factors and facilities such as retainable wall or establishing adequate forest reserves to act as cushions to prevent or minimize the damages.

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