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# Mitigating Fatalities and Damages Due to Natural Disasters: Do Human Development and Corruption Matters?

*(Pengurangan Kematian dan Kemusnahan Akibat Bencana Alam Semula Jadi: Adakah Pembangunan Insan dan Korupsi Penting?)*

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*ABSTRACT*

*Studies have shown that natural disasters could pose a spectrum of challenges to human development, especially in developing countries. United Nations Development Programme (UNDP, 2004)) estimates that low human development countries accounted for more than half of reported casualties due to natural disasters for the last two decades. The study also estimates that nearly 85 percent of the people exposed to natural disasters live in either medium or low human development countries. Other related studies have shown that corrupted officials in poor countries would increase the vulnerability of these countries to natural disasters. Thus, the purpose of the present study is to investigate the impact of human development indicators, such as income per capita and human capital development (education level), as well as corruption (a measure of governance) on fatalities and damages due to natural disasters in selected 77 developing countries. By employing the two-step system GMM estimators, we identified several economic variables that are significantly related to fatalities and property damages due to natural disasters, such as flood, storm, earthquake, landslides, drought, extreme temperature, wildfire, and volcanic eruption. By exploring the impact of economic development, population density, unemployment rate, investment, government consumption expenditure, education, openness, and corruption, on disaster preparedness, it would be useful for both government and international disaster risk reduction and mitigation agencies to re-evaluate their approach towards target recipients in the future.*

*Keywords: Natural disasters; human development; education; GMM*

*ABSTRAK*

*Kajian lepas telah menunjukkan bahawa bencana alam semula jadi boleh menimbulkan cabaran kepada pembangunan insan, khasnya di negara-negara membangun. Program Pembangunan Bangsa-bangsa Bersatu (UNDP 2004) menganggarkan negara yang memiliki tahap pembangunan insan yang rendah menanggung lebih separuh daripada keseluruhan kes kesan bencana alam dalam tempoh dua dekad kebelakangan ini. Kajian tersebut juga menganggarkan hampir 85 peratus daripada mereka yang terdedah kepada bencana alam semula jadi tinggal di negara yang memiliki tahap pembangunan insan yang sederhana atau rendah. Kajian juga menunjukkan bahawa negara miskin yang mempunyai pegawai-pegawai yang korup telah meningkatkan risiko terdedah kepada kesan yang lebih buruk akibat bencana alam. Matlamat kajian ini adalah untuk mengkaji impak indikator pembangunan insan seperti pendapatan per kapita dan pembangunan modal insan (tahap pendidikan) serta tahap korupsi (ukuran tadbir urus) terhadap kemalangan jiwa dan kemusnahan harta benda akibat bencana alam semula jadi seperti banjir, ribut, gempa bumi, tanah runtuh, suhu melampau, kebakaran dan letusan gunung berapi. Dengan mengkaji kesan pembangunan ekonomi, kepadatan penduduk, kadar pengangguran, pelaburan, perbelanjaan penggunaan kerajaan, pendidikan, keterbukaan, dan juga korupsi terhadap persediaan menghadapi bencana, dapatan kajian adalah bermanfaat kepada pihak kerajaan dan agensi pengurangan risiko bencana antarabangsa bagi menilai semula pendekatan yang digunakan terhadap penerima sasaran pada masa hadapan.*

*Kata kunci: Bencana alam; pembangunan manusia; pendidikan; GMM*

## INTRODUCTION

Natural disasters are not an uncommon event, whereby droughts, earthquakes, extreme temperature, floods, cyclones, volcanic eruptions, wildfires, and landslides are common natural phenomenon all around the world. The Asian Disaster Reduction Center (ADRC 2009) reported that 399 natural disasters occurred in 2009 alone worldwide, killing almost 16,000 people and affecting over 220 million people. The estimated amount of economic damage came close to USD50 billion. By geographical region, Asia recorded the highest numbers in all four accounts: 35.8 percent of disaster occurrences; 52.1 percent of the total number of people killed; 78.3 percent of the total number of affected people; and 44.9 percent of the total economic damages.

In the Southeast Asian region, Indonesia was impacted by five earthquakes, five floods, and two landslides. The earthquakes caused 1,330 deaths and affected more than 2.8 million people. The estimated cost of damages reached USD2.8 billion. The floods killed 126 people and affected more than 26,000 people; while the landslides killed 29 people. The Philippines recorded more than three types of natural disasters, namely; earthquake, flood, landslide, storm and volcanic eruption. Storm or cyclone accounted for most damages. In 2009, 14 cyclones crashed into the Philippines, killing 1,242 people; affecting more than 12 million people and causing more than USD900 million in damages. Eight floods caused 55 deaths, affecting more than 1 million people and causing USD29 million in damages. In 2009, volcanic eruptions affected more than 47,000 people in the Philippines. Meanwhile, Malaysia experienced two floods where more than 10,000 peoples were affected.

Sustaining a long-term growth of real gross domestic product (real GDP) is crucial for a nation to maintain the standard of living in the long run. Countries must increase their average output per person over time. It has been recognized that factors determining economic growth include the growth rate of stocks of both physical and human capital, as well as the rate of technological change. Therefore, the investment in plant, equipment, technology, and the accumulation of skill and education (human capital) are important for long-term economic growth.

The importance of human capital in enhancing economic growth has been discussed by Barro (1991), Becker et al. (1990), Lucas (1988) and Nelson and Phelps (1966). Nelson and Phelps (1966) demonstrated that the innovation of new ideas and products as a result of the larger stock of human capital accumulation positively affect the growth of an economy. Lucas (1988) and Becker et al. (1990) argued that increasing human capital leads to a higher rate of human and physical capital investment as well as economic growth. As human capital rises, it raises productivity in an economy, reduces fertility rates and increases economic growth. According to Barro (1991), the rate of technological progress depends on the initial stocks of human capital by assuming that human capital acts as a primary input in R&D.

Numerous studies have shown that natural disasters could pose a great challenge to human development, particularly in developing countries. According to the ADRC (2007), the human development level is a measure of factors that express a country's level of development, including its literacy rates, gross school enrolment rate (human capital), per capita income, and life expectancy. The United Nations Development Programme (UNDP 2004) estimated that low human development countries accounted for more than half of all reported casualties due to natural disasters in the last two decades, even though they represented only a tenth of those exposed to natural disasters. The study also estimated that nearly 85 percent of the people exposed to natural disasters live in medium and low human development countries. Rodriguez-Oreggia et al. (2008) studied the impact of natural disasters on human development and poverty at the municipal level in Mexico and found that the impact of natural disasters is significantly higher in municipalities with lower social indicators (lower HDI and poor communities). In the aftermath of a disaster, the poor communities could be losing access to some basic services, experiencing a reduction in the accumulation of physical and human capital and an increase in child labour and criminal activities.

Corruption has also become an important issue during the recovery from natural disasters. Corruption is widespread in the global society and considered particularly disruptive in the developing nations (Soliman & Cable 2011). Escaleras et al. (2007), Ambraseys and Bilham (2011) and Escaleras and Register (2016) suggested that, at the national level, the degree of corruption has a very strong correlation with the incidence and seriousness of disasters, particularly in earthquake catastrophes, where weak enforcement and application of safety standards lead to a widespread collapse, with further damage and casualties.

The purpose of the present study is to investigate the impact of human development indicators such as income per capita and human capital (education level), and the institutional transparency factors such as corruption, on natural disaster fatalities in selected 77 countries. On various accounts, ARDC has reported that countries with higher human development level experience easier disaster mitigation, preparedness planning, disaster reduction and management strategies, and follow-up activities in post-disaster periods. Improving the level of human development, such as improving a country's literacy rate, life expectancy, education level and income per capita, could contribute immensely to reducing the impact of natural disasters. It is expected that a higher education level and income per capita will lead to a reduction in fatalities due to natural disasters. Finally, better enforcement and low corruption will reduce the fatalities and damages due to natural disasters.

The paper is organized as follows. The next section discusses the related literature on the topic. Models, method of analysis and sources of data are presented in Section 3. The interpretation of empirical results is discussed in Section 4. The final section is our conclusion.

## LITERATURE REVIEW

Empirical evidence suggests that natural disasters produce a devastating impact on macroeconomic conditions in the short run, resulting in a sudden collapse in domestic production and a more pronounced slowdown in national income (Okon 2018; Padli et al. 2010; 2013). Together with the collateral damage, they cause such irreversible losses of human capital, affecting not only on the standard of living but also increasing the poverty level, resulting in a more chronic economic decay. With the increasing frequency of natural disasters in recent years, the social, economic and physical impact has heightened public awareness and brought 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 will provide not only general safety but at high enough income levels, protection can be directed to specifically mitigate the impact of natural disaster fatalities and damages (Horwich 2000). A higher level of economic development can lead to a smaller number of deaths, injuries, deprivation and relative material losses (Albala-Bertrand 1993). The level of economic development includes income per capita and income distribution, economic diversification and social inclusion, institutionalization and participation, education and health, choice and protection.

Natural disasters could cause significant economic and physical losses, which effect could spread beyond the immediate locality (Loayza et al. 2012). They also found that the impact on economic growth is not always negative and the developing countries are more vulnerable as more sectors are affected. The World Bank and the United Nations (2010) suggested that economies in underdeveloped regions rarely grow after the occurrence of a natural disaster, and the negative effect depends on the structure of the economy. Regions with low social capital might also have weak economic structures, thus experience difficulties in securing adequate resources after the damage from natural disasters.

Noy's (2009) found that macroeconomic costs are much higher in developing nations than in developed nations. He also concluded that a higher level of literacy, better institutional qualities, higher per capita income, higher government spending, more open economies, and better financial conditions, are likely to contribute to countries' macroeconomic performances after a natural disaster. Meanwhile, Tol and Leek (1999) also argued that the positive effect of GDP can be explained since the GDP measure focuses on the flow of new production, and they emphasize the incentives for saving and investing during the mitigating and recovery efforts after the capital stock is destroyed by the natural disaster. Furthermore, the loss of capital may have a positive impact in the long term, provided that sufficient re-investment from designated reserves takes place.

Disasters can affect human development by causing substantial damages, including death and destruction to human and physical assets (Baez et al. 2010). It could dramatically reduce nutrition, education, health, and many income-generating processes. Destruction to schools and other infrastructures, and casualties among teachers subsequently affect the supply of education in the aftermath of a natural disaster. On the other hand, for children who lose a parent tend to have a lower investment in human capital as a result of losing their source of income to attain their education level (Cuaresma 2010). Disasters could also lead to a reduced children's nutrient intake, leading to malnutrition and therefore lowering the formation of biological human capital in early childhood (see Hoddinott & Kinsey 2001; Del Ninno & Lundberg 2005). A recent study by Yamauchi et al. (2009) on the children of Bangladesh, Ethiopia and Malawi, found that children with more biological human capital (health and nutritional status) are less affected by the adverse effect of the flood, and the rate of investment in intellectual human capital (schooling and cognitive skills) increases with the initial human capital stock achieving a faster recovery after the natural disaster.

According to Freitas et al. (2012) and the International Federation of Red Cross and Red Crescent Societies (IFRC) (2003, 2010), natural disasters have a comparatively greater effect on the poorest countries, which lead to them having to deal with more serious consequences. Most less-developed nations experience the degradation of health (Datar et al. 2013) due to diseases and poor sanitary conditions (Takahashi et al. 2012). Jaramillo (2007) concluded that both short-term and long-term effects of a natural disaster are determined by the type of disaster, and a country's income level and population.

Empirical evidence shows that socio-economic and demographic factors have a significant relationship to disaster fatalities and economic losses in East Asia, South Asia and the Pacific Islands (Haque 2003). He further argued that emergency preparedness and fast action in handling dangerous situations during a disaster would lessen the severity of its impact. He also highlighted the importance of providing special training programs, such as disaster management programs for teachers, volunteers, public and social workers, as well as local emergency agencies, such as the police, fire department and others to minimize the risk and increase the awareness in preparing for surviving a natural disaster.

Economic development allows a country to better manage and mitigate the risk from disasters (Anbarci et al. 2005; Kahn 2005; Skidmore & Toya 2007). Macro-level policies in managing the human and economic risks from natural disaster will allow countries to develop, and reduce the risk of damage due to a natural disaster. Hoke (2005) and Okonski (2004) argued that the best way to avoid high levels of damage from disasters is for poor countries to develop at a faster pace.

According to Kahn (2005), who performed tests on several hypotheses concerning natural disaster mitigation by using annual deaths from natural disasters in 73 nations from 1980 to 2002, the empirical results showed that the hypothesis of richer nations experience fewer shocks or are lucky enough to experience weaker natural disaster shocks than those experienced by poorer nations is rejected. In the face of an equal quantity and quality of shocks to those in poorer nations, richer nations suffer fewer deaths from natural disasters. He also found that geography and institutions also play a role in shielding a nation from a higher number of deaths.

Further research by Skidmore and Toya (2007) focused on the degree to which the human and economic losses from natural disasters are reduced as economies developed. Based on the annual data for every recorded natural disaster from 151 countries over the 1960–2003, empirical evidence showed that losses are reduced with higher income, higher educational attainment, greater openness, a more complete financial system, and a smaller sized government.

Raschky (2008) investigated the relationship between economic development and the vulnerability against natural disasters. The sample consists of 2792 events where the numbers of natural disaster victims are available and 1103 events with data on economic losses. Empirical results showed that countries with high quality of institutions recorded fewer victims and fewer economic losses from natural disasters, and there is a nonlinear relationship between economic development and economic disaster losses. Raschky (2008) further concluded that the institutional framework is a key socio-economic determinant of a nation's vulnerability against natural disasters. Nations with a higher GDP, with a more educated population, more social and political freedom and a more comprehensive financial system, will suffer fewer losses during extreme natural disasters (Oxley 2013).

Studies also showed that richer countries appear to be less corrupted (Melissa et al. 2012), while better and more transparent institutions are also believed to reduce the impact of natural disasters. Empirical works by Escaleras et al. (2007); Ambraseys and Bilham (2011); Escaleras and Register (2016) suggested that, at the national level, the degree of corruption has a very strong correlation with the incidence and seriousness of natural disasters, particularly earthquake catastrophes. It is believed that the degree of corruption is one of the factors that cause a natural disaster (Oliver-Smith et al. 2016). Corruption is a major factor that weakens the efforts to prepare for natural disasters, as well as to manage and bring the problem under control (Alexander 2017). The solution is to ensure that the disaster-related transactions and policies are transparent, justifiable, and in line with what the affected population wants and needs.

To lessen the damages due to natural disasters, Sorensen (2014) advised that states and local level executives must include laws, rules, and punishment to address the increased opportunity for fraud and corruption. Besides, corruption is an important factor that hinders both preparation and response to natural disasters (Cordis & Milyo 2013; Thura 2013). Further research by Yamamura (2014) revealed that natural disasters which cause substantial damage increase public sector corruption in both developing and developed countries, with a greater impact on public sector corruption in developed countries than in developing countries. Natural disaster frequency was also found to have a significant impact on the level of corruption in developed countries. Hence, foreseeable disasters increase corruption in general. In developed countries, an incentive to live in a disaster-prone area may be attributed to the potential disaster compensation payout.

Padli and Habibullah (2009) investigated the relationship between natural disaster fatalities with the level of economic development, years of schooling, land area and population for a panel of 15 Asian countries from 1970 to 2005. They found that the relationship between natural disaster losses and the level of economic development is nonlinear in nature, suggesting that a country is more resilient to natural disasters at a lower income level, but would become less resilient to natural disasters at a higher income level. Another natural disaster determinant is the level of education, which suggests that educational attainment reduces human fatalities due to a natural disaster. Meanwhile, a larger population increases the number of fatalities and a larger land area reduces natural disaster fatalities.

Padli et al. (2010) investigated the relationship between the impact of natural disasters, such as the number of deaths per capita, total people affected, total damage/GDP, and macroeconomic variables such as GDP 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 in a cross-sectional analysis. The analysis of 73 countries was done at three different points of time, namely 1985, 1995 and 2005. They found that wealthy nations and their citizens are better prepared for natural disasters and could lessen the aftermath economic impact of a natural disaster. The size of the government is also found to be significant and inversely related, which strengthened the understanding of government intervention and consumption on minimizing the impact of a natural disaster.

The review of existing literature reveals that very few academic works have been done to explore the potential effect of human development and corruption on disaster preparedness and also by types of disaster. Most of the previous studies focused on the political economy and the social impact of a natural disaster. Therefore, we believe that it is important to explore a possible relationship between poor governance, economic development, population, unemployment, investment, consumption, education and disaster vulnerability by types of disaster.

## METHODOLOGY

Based on the previous literature, such as (Barro 1991; Cuaresma 2010; Freitas et al. 2012), we propose an equation in a log-linear regression as follows,

$$\ln ND_{jit} = \beta_0 + \beta_1 \ln ND_{ji(t-1)} + \beta_2 \ln RGDPc_{it} + \beta_3 \ln RINV_{it} + \beta_4 \ln EDU_{it} + \beta_5 \ln UNEMP_{it} + \beta_6 \ln OPEN_{it} + \beta_7 \ln RGC_{it} + \beta_8 \ln POP\_DEN_{it} + \beta_9 \ln COR_{it} + \varepsilon_{it} \quad (1)$$

Where $j$ denotes types of natural disasters, $i$ denotes country 1, 2, 3 …n, $t$ is time series and $\varepsilon_{it}$ is the error term. ND is the measurement for natural disaster fatalities, as proxied by the total number of fatalities (TF), total people affected (TA) and total damages (TD) caused by eight types of natural disasters, namely drought, earthquake, extreme temperature, flood, storm, volcano eruption, wildfire, and landslide. As for the regressors, RGDPc is real gross domestic product per capita; RINV is the ratio of real investment to GDP, EDU is education level (number of students enrolled in higher education, primary and secondary school), UNEMP is unemployment rate, OPEN is openness, RGC is real government consumption as a percentage of GDP, POP_DEN is the population density, and COR is corruption. Finally, ln denotes the natural logarithm of the variables used in the study. Our variables of interest are RGDPc and EDU in Equation (1) that represent the human development indicators, and COR that represents the institutional factor.

From Equation (1), it is expected that both human development indicator variables, *RGDPc* and EDU are negatively related to *ND*. Economists have found that safety is generally considered a normal or luxury good: as people become wealthier and secure the necessities of life, and they look to reduce risks of premature death (Kem 2010). However, the relationship between real GDP per capita and ND is ambiguous (Barro 1991; Cuaresma 2010; Freitas et al. 2012). Furthermore, an educated population is better prepared in the event of natural disasters and would be able to reduce fatalities, numbers of the affected as well as damages. Education attainment is also expected to have a negative relationship to losses due to a natural disaster. As people become more educated and knowledgeable, they are more aware, alert and better prepared for any natural disaster. The unemployment rate is expected to have a mixed result; a positive impact on total deaths and a negative impact on total people affected and economic losses due to limited or no income and wealth (resources) available. As for the real investment and openness, we expect to find a negative relationship to disaster impact on damages and fatalities. More investment, research, and development activities provide more avenues to absorb new ideas in preparing for natural disasters and reduce the number of fatalities. Similarly, for government consumption, we expect a negative relationship to human fatalities and a positive impact on economic losses. As for population density, we expect the result to show a positive impact on natural disaster fatalities due to urbanization. More crowded area leads to more fatalities and damages if the area is struck by a natural disaster. Finally, corruption as a measure of institutional factor is expected to show a positive impact on disaster damages and fatalities, where 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 have included one lagged period for the dependent variable in Equation (1). If lagged dependent variables also appear in explanatory variables, then the condition of strict exogeneity of the regressors no longer holds. The general method of moment (GMM) estimators are known to be consistent, asymptotically normal and efficient among all estimators that do not use any additional information aside from that contained in the moment conditions.

The general way to deal with a dynamic panel data is to apply first-differenced 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 poorly because lagged levels of the variables are only weak instruments for subsequent first differences (Bond et al. 2001). Moreover, there could be situations where the difference GMM model might not be able to perform as a good estimator. When a model error is heteroscedastic, we need a two-step GMM estimator that is robust under heteroscedasticity. However, their standard errors are downwardly biased. Windmeijer (2005) proposed a solution using a correction for the two-step GMM estimators. Meanwhile, Blundell and Bond (1998) proposed an alternative method where in addition to differentiating the model equation and using lagged level of as instruments of they worked with the 'original' model and used the difference as instruments of . The estimators obtained in this way are called system GMM estimators.

Once the difference or system GMM estimators are obtained, the validity of the model must be checked. To establish the validity of the instrumental variables used in the analysis, specification tests are conducted using 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 supporting the validity of the instruments. The second test is to test for the errors that are not serially correlated in the first difference equations. By construction, the differenced error terms might be first-order serially correlated even if the original error terms are not serially correlated (Carkovic & Levine 2002). Thus, if the null hypothesis no serial correlation of the AR(2) model cannot be rejected: it also can be viewed as evidence supporting the validity of the instruments.

## DESCRIPTION AND SOURCE OF DATA

The data set consists of a panel observation for 77 selected developing countries for the period 1984 – 2016. Annual data are used in the analysis. The list of countries is provided in Table 1. Data for the impact of natural disasters such as number of fatalities, number of affected per capita, cost of damage is taken from the Office of Foreign Disaster Assistance (OFDA) and the Centre for Research on the Epidemiology of Disaster (CRED). Since 1988, CRED has maintained the Emergency Events Database EM-DAT, accessible at http://www.emdat.be. Other regressors are obtained from various sources as summarized in Table 1. All variables except corruption (corr) are transformed into natural logarithm before estimation.

## THE EMPIRICAL RESULTS

Based on the results of the two-step system GMM, Table 2 shows the estimated coefficients, signs and significance of several economic factors affecting natural disasters fatalities (TF), affected people (TA) and damages (TD). The Hansen test indicates that valid instrumental variables are used in the analysis. The AR (2) test results suggest that there is no serial correlation in the first difference equations. Our discussion is based on our variables of interest, which are the human development indicators – per capita income; human capital – the level of education and institutional indicator – corruption. The results are presented in Table 2 for total people affected *(TA)*, Table 3 for total deaths *(TF)* and Table 4 for total economic damages *(TD)*. Our results suggest that the level of economic development, as proxies by real income per capita *(RGDPc)*, exhibits a significant and positive relationship with total people affected due to drought, landslide, volcano eruption, wildfire and extreme temperature; a significant and positive relationship with total deaths due to drought, earthquake, extreme temperature and landslide, and a significant and positive relationship with total damages due to drought, earthquake, landslide and wildfire. These variables are found to be statistically significant at a five percent level. It shows that economic development and the prosperity of a country increases the probability of severe damage due to natural disasters.

Our second variable of interest is the human capital as proxied by *edu* in our model. *EDU* is mostly statistically

TABLE 1. Description of variables and source of data

| Variable | Brief Description | Source of Data |
|---|---|---|
| Number of fatalities *(TF)* | Persons confirmed as dead and persons missing and presumed dead | Emergency events database (Centre for Research on the Epidemiology of Disaster (CRED) 2000 |
| Number of total people affected *(TA)* | Sum of injured, homeless and affected | CRED. (2000)/ Heston, Summers, & Aten (2009) |
| Total damages *(TD)* | Estimates include both direct costs (such as damage to property, infrastructure, and crops) and the indirect losses due to a reduction in economic activities | CRED. (2000) |
| Income per capita (RGDPc) | Real gross domestic product (GDP) per capita | World Development Indicator (WDI) (2008) |
| Investment (RINV) | Investment percentage of GDP | World Development Indicator (WDI) (2008) |
| Education (EDU) | Number of schooling attainment | Barro and Lee (2013) |
| Unemployment (UNEMP) | The rate of unemployment | World Development Indicator (WDI) (2008) |
| Openness (OPEN) | Export plus import divided by GDP | Heston et al. (2009) |
| Government consumption (RGC) | Government expenditure percentage of GDP. | WDI. (2008)/ International Monetary Fund (IMF) (2008) |
| Population density (POP_ DEN) | Total population divided by land area ($km^2$) | Heston et al. (2009)/WDI.(2008) |
| Corruption (COR) | 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 | Political Risk Service & International Country Risk Guide (ICRG) (2006) |

significant and displays a negative sign for all types of natural disasters, where education helps to mitigate the losses with better preparedness in the event of a natural disaster. More aggressive campaigns should be made by the local and state authorities in creating public awareness for any type of disaster. Through education, people can learn to reduce risk and prepare to manage the impact of natural disasters. Nelson and Phelps (1966) pointed out that a nation with larger stocks of human capital may absorb new ideas and products that have been developed abroad more easily, which could generate a feedback effect between growth and human capital. According to Barro (1991) and Romer (1990), human capital is considered as a primary input, where the approach of technological progress depends on the stock of human capital. Cuaresma et al. (2008) argued that overall catastrophic risk tends to increase knowledge spillovers, the effect of geologic disasters tends to be observable in the medium run only, and climatic disaster risk systematically increases the size of the R&D spillovers in the long run.

Finally, our third variable of interest, corruption, is shown to lead a higher total number of people affected, total deaths and also losses from damages. A higher level of corruption increases total people affected and losses from damages due to drought, earthquake, extreme temperature, flood, landslide, storm, volcano eruption, and wildfire. However, the total deaths due to extreme temperature and flood decrease with a higher level of corruption. The governance, which is the provision of

TABLE 2. Results total people affected due to natural disaster: system gmm two-step –developing countries analysis

| Variables | Drought | Earthquake | Temperature | Flood | Landslide | Storm | Volcano | Wildfire |
|---|---|---|---|---|---|---|---|---|
| L.Total People | 0.512*** | -0.031*** | -0.005*** | -0.035 | -0.029*** | 0.025 | 0.030*** | -0.058*** |
| Affected | (0.006) | (0.006) | (0.001) | (0.039) | (0.004) | (0.026) | (0.006) | (0.001) |
| lgdpc | 1.315*** | 1.082*** | 0.190*** | 3.682*** | -0.124* | 1.514* | 0.345** | 0.150*** |
| | (0.261) | (0.167) | (0.051) | (1.385) | (0.066) | (0.888) | (0.141) | (0.031) |
| linvest | -0.111 | -0.993*** | -0.015 | -2.513 | 0.037 | -1.581** | 0.131 | 0.040 |
| | (0.159) | (0.161) | (0.076) | (1.933) | (0.085) | (0.766) | (0.157) | (0.033) |
| ledu | -4.727*** | -2.354*** | 0.522*** | -7.006** | 0.444*** | -2.317 | -0.810*** | -0.071 |
| | (0.552) | (0.493) | (0.120) | (2.803) | (0.165) | (2.162) | (0.300) | (0.081) |
| lunemp | 0.747*** | 0.225 | -0.320*** | 0.529 | 0.013 | 1.749** | 0.246** | 0.180*** |
| | (0.245) | (0.204) | (0.075) | (0.769) | (0.066) | (0.741) | (0.103) | (0.032) |
| lopen | 0.318 | -1.239*** | -0.551*** | -2.131*** | -0.523*** | 0.062 | -0.080 | -0.042 |
| | (0.208) | (0.220) | (0.100) | (0.684) | (0.068) | (0.646) | (0.138) | (0.048) |
| lgc | 0.628*** | -0.244 | -0.211 | -1.486** | -0.197** | -1.836** | -0.517*** | -0.300*** |
| | (0.237) | (0.263) | (0.138) | (0.585) | (0.091) | (0.731) | (0.164) | (0.057) |
| lpden | 0.418*** | 0.345*** | -0.037 | 1.279*** | 0.042 | 1.216*** | 0.061 | -0.026 |
| | (0.105) | (0.123) | (0.043) | (0.250) | (0.035) | (0.393) | (0.057) | (0.023) |
| lcor | 0.667*** | 0.492** | -0.069 | 0.932** | 0.157** | 0.748 | 0.153 | 0.076*** |
| | (0.259) | (0.224) | (0.055) | (0.431) | (0.064) | (3.649) | (0.098) | (0.023) |
| cons | 4.941*** | 9.237*** | 0.625 | 21.575*** | 1.774*** | 0.975 | 1.322 | -0.174 |
| | (1.889) | (2.111) | (0.635) | (4.597) | (0.503) | (3.649) | (0.924) | (0.228) |
| Obs. | 1244 | 1244 | 1244 | 1244 | 1244 | 1244 | 1244 | 1244 |
| N | 77 | 77 | 77 | 77 | 77 | 77 | 77 | 77 |
| AR1 | 0.000 | 0.000 | 0.001 | 0.000 | 0.007 | 0.000 | 0.004 | 0.003 |
| AR2 | 0.819 | 0.587 | 0.491 | 0.611 | 0.299 | 0.182 | 0.971 | 0.341 |
| Instrument | 55 | 55 | 50 | 15 | 45 | 30 | 35 | 45 |
| Hansen J-test | 0.275 | 0.562 | 0.371 | 0.965 | 0.267 | 0.522 | 0.443 | 0.507 |
| Dif-in-Hansen Test | 0.309 | 0.506 | 0.197 | 0.927 | 0.154 | 0.340 | 0.909 | 0.474 |

*Notes:* Base sample is an unbalanced panel spanning from 1984–2016 data from 77 selected developing countries. Standard errors are in parentheses, p-values are reported for AR1, AR2, Hansen J-test and Dif-in-Hansen Test. In the case of two-step GMM, the Windmeijer (2005) finite sample correction for standard errors is employed. Asterisks ***,**,* denote significance at the 1%, 5% and 10%-level, respectively. The row for the Hansen J-test reports the p-values for the null hypothesis of instrument validity. Instruments are combined into smaller sets by collapsing the block of the instruments' matrix. This technique was used by previous researchers, including Calderon et al. (2002), Beck and Levine (2004), Azman-Saini et al. (2010), Karim and Azman-Saini (2013), Karim (2012), Karim and Zaidi (2015), among others. The values reported for the Diff-in-Hansen test are the p-values for the validity of the additional moment restriction necessary for system GMM. The values reported for AR(1) and AR(2) are the p-values for first and second order auto regressive of the disturbances in the first differences equations.

"due process," are checks, balances, accountability, and transparent decision-making, and may be weak in the world's poorer countries (Alexander 2011). Furthermore, Klein (2008) argued instead that companies, particularly multinational corporations, have a powerful opportunity to exploit disasters for their benefit. During the disaster, people, governance, democracy, and livelihood are weakened and leave them vulnerable to exploitation.

Corruption is a very serious and pervasive issue that affects all countries. It is a major factor in weakening the efforts to manage natural disasters. For example, buildings are not built following the safety codes but obtained legal approval by excessive political influences. Even during a disaster relief windfall, public employees are accused of soliciting bribes from relief-funded contractors and overbilling the government (Leeson & Sobel 2008). By ensuring that transactions related to disasters are transparent, ethically justifiable, and in line with the needs of the affected people, it may reduce the impact of corruption on natural disaster.

Other variables that have impacted total people affected, total deaths and economics damages include population density, investment, unemployment, openness, and government consumption. Based on the results in Table 2 to 4 respectively, high populated areas have a higher number of total people affected, total deaths and total economic damages due to flood, earthquake, and storm. Urbanization, population growth, and migration are human-induced demand factors that increase pressure on the environment, and these trends will impact the

TABLE 3. Results of total deaths due to natural disaster: system gmm two-step – developing countries analysis

| Variables | Drought | Earthquake | Temperature | Flood | Landslide | Storm | Volcano | Wildfire |
|---|---|---|---|---|---|---|---|---|
| L. Total Deaths | 0.043*** | -0.007 | -0.007 | 0.047 | 0.111** | 0.008 | -0.071*** | 0.066*** |
| | (0.003) | (0.005) | (0.011) | (0.029) | (0.050) | (0.033) | (0.001) | (0.001) |
| lgdpc | 0.440*** | 0.372*** | -0.215*** | 0.645** | 0.201 | 0.798** | 0.074** | -0.049** |
| | (0.096) | (0.121) | (0.080) | (0.292) | (0.171) | (0.340) | (0.031) | (0.019) |
| linvest | -0.387*** | -0.086 | 0.344*** | -0.333 | -0.052 | -0.224 | -0.068* | 0.070** |
| | (0.063) | (0.189) | (0.101) | (0.326) | (0.167) | (0.304) | (0.038) | (0.032) |
| ledu | -0.954*** | -0.070 | 0.480** | -1.240 | -0.445 | -1.763** | -0.170** | 0.090* |
| | (0.259) | (0.449) | (0.198) | (0.796) | (0.375) | (0.792) | (0.082) | (0.046) |
| lunemp | 0.614*** | 2.443*** | 0.060 | -0.237 | 0.025 | 0.682*** | 0.038 | 0.026 |
| | (0.179) | (0.273) | (0.079) | (0.369) | (0.069) | (0.203) | (0.023) | (0.022) |
| lopen | 0.182** | -0.127 | -0.402*** | -1.088*** | -0.323*** | 0.183 | 0.032 | -0.047* |
| | (0.089) | (0.254) | (0.114) | (0.294) | (0.124) | (0.243) | (0.025) | (0.025) |
| lgc | -0.413*** | -1.128*** | -0.031 | -0.443 | -0.196 | -0.548** | -0.081** | 0.020 |
| | (0.087) | (0.247) | (0.131) | (0.313) | (0.141) | (0.277) | (0.036) | (0.025) |
| lpden | 0.040 | 0.308** | 0.038 | 0.296* | 0.058 | 0.401*** | 0.010 | -0.008 |
| | (0.066) | (0.129) | (0.040) | (0.157) | (0.041) | (0.115) | (0.013) | (0.007) |
| lcor | 0.150** | 0.333** | -0.059 | 0.148 | 0.051 | 0.272 | 0.064*** | 0.025 |
| | (0.063) | (0.149) | (0.069) | (0.222) | (0.113) | (0.183) | (0.019) | (0.132) |
| cons | 0.578 | -4.453*** | 0.367 | 7.374*** | 2.212*** | -0.116 | 0.279 | -0.072 |
| | (0.675) | (1.650) | (0,396) | (1.940) | (0.635) | (1.104) | (0.232) | (0.132) |
| Obs. | 1244 | 1244 | 1244 | 1244 | 1244 | 1244 | 1244 | 1244 |
| N | 77 | 77 | 77 | 77 | 77 | 77 | 77 | 77 |
| AR1 | 0.022 | 0.001 | 0.001 | 0.000 | 0.000 | 0.000 | 0.068 | 0.002 |
| AR2 | 0.719 | 0.817 | 0.463 | 0.801 | 0.135 | 0.979 | 0.886 | 0.224 |
| Instrument | 45 | 50 | 35 | 40 | 30 | 30 | 25 | 35 |
| Hansen J-test | 0.881 | 0.901 | 0.854 | 0.269 | 0.568 | 0.559 | 0.183 | 0.727 |
| Dif-in-Hansen Test | 0.595 | 0.702 | 0.516 | 0.224 | 0.386 | 0.189 | 0.721 | 0.628 |

*Notes:* Base sample is an unbalanced panel spanning from 1984–2016 data from 77 selected developing countries. Standard errors are in parentheses, p-values are reported for AR1, AR2, Hansen J-test and Dif-in-Hansen Test. In the case of two-step GMM, the Windmeijer (2005) finite sample correction for standard errors is employed. Asterisks ***,**,* denote significance at the 1%, 5% and 10%-level, respectively. The row for the Hansen J-test reports the p-values for the null hypothesis of instrument validity. Instruments are combined into smaller sets by collapsing the block of the instruments' matrix. This technique was used by previous researchers, including Calderon et al. (2002), Beck and Levine (2004), Azman-Saini et al. (2010), Karim and Azman-Saini (2013), Karim (2012), Karim and Zaidi (2015), among others. The values reported for the Diff-in-Hansen test are the p-values for the validity of the additional moment restriction necessary for system GMM. The values reported for AR(1) and AR(2) are the p-values for first and second order auto regressive of the disturbances in the first differences equations.

vulnerability of the urban centers to natural disasters (Brauch 2001; 2002).

Real investment does have a negative relationship with total people affected, total deaths and total economic damages for all types of natural disaster in our model. This implies that older equipment is more exposed to damages when a disaster hits the capital stock, and thus the replacement of facilities would constitute a positive productivity shock, which may have permanent consequences in the growth rate of the whole economy (Okuyama 2003). Skidmore and Toya (2002) also concluded that update in technology and/or factor composition will positively influence long-run growth. For urbanization to take place, a huge investment in building infrastructures and services is needed. Besides, since urban areas have higher income population and higher investment in infrastructures than the rural areas, it is expected that higher fatalities and damages will occur in the event of a natural disaster.

Openness and government expenditure also contribute to an increase in total deaths. Openness as a proxy of transfer knowledge or technology from abroad can reduce natural disaster fatalities. A country with a steady-state of the financial sector may reduce the destruction of natural disasters because a more efficient financial system is less likely to finance projects in essentially risky locations (Skidmore & Toya 2002). Cuaresma et al. (2008) argued that natural catastrophic

TABLE 4. Results of total economic damages due to natural disaster: system gmm two-step – developing countries analysis

| Variables | Drought | Earthquake | Temperature | Flood | Landslide | Storm | Volcano | Wildfire |
|---|---|---|---|---|---|---|---|---|
| L. Total damages | -0.068*** | 0.010*** | 0.003*** | 0.089*** | 0.053*** | -0.036*** | 0.098*** | 0.185*** |
| | (0.001) | (0.003) | (0.001) | (0.013) | (0.002) | (0.005) | (0.001) | (0.006) |
| lgdpc | 0.343** | 1.001*** | -1.170*** | 0.528 | -0.458*** | 0.866*** | 0.102*** | -0.692*** |
| | (0.140) | (0.338) | (0.029) | (0.633) | (0.169) | (0.225) | (0.020) | (0.127) |
| linvest | 0.022 | -0.589 | 0.338*** | 1.594*** | 0.962*** | -0.159 | 0.040 | 0.308*** |
| | (0.179) | (0.500) | (0.028) | (0.571) | (0.195) | (0.452) | (0.034) | (0.093) |
| ledu | -1.489*** | -1.809** | 0.638*** | -0.073 | 0.317 | -1.640** | -0.214*** | 1.601*** |
| | (0.379) | (0.859) | (0.117) | (1.472) | (0.436) | (0.685) | (0.049) | (0.360) |
| lunemp | 0.198 | 0.602** | -0.178*** | 1.180 | 0.525*** | 0.431 | 0.058** | 0.110 |
| | (0.149) | (0.297) | (0.045) | (0.861) | (0.176) | (0.427) | (0.023) | (0.120) |
| lopen | -0.440** | -0.346 | -0.405*** | -2.846*** | -0.334*** | -0.998*** | 0.092*** | 0.027 |
| | (0.178) | (0.244) | (0.033) | (0.510) | (0.126) | (0.313) | (0.029) | (0.140) |
| lgc | 0.314 | -0.792** | 0.235*** | -0.540 | 0.064 | -0.021 | -0.198*** | -0.295* |
| | (0.209) | (0.342) | (0.023) | (0.482) | (0.180) | (0.403) | (0.041) | (0.160) |
| lpden | 0.294*** | 0.410** | -0.033* | 0.651* | 0.128 | 1.114*** | 0.025** | -0.185*** |
| | (0.104) | (0.178) | (0.17) | (0.338) | (0.084) | (0.140) | (0.010) | (0.060) |
| lcor | 0.016 | 0.251 | 0.123*** | 0.146 | 0.533*** | 0.552** | 0.125*** | 0.034 |
| | (0.158)) | (0.256) | (0.022) | (0.361) | (0.096) | (0.275) | (0.021) | (0.075) |
| cons | 3.262*** | 2.934 | -0.628*** | 3.090 | -0.486 | 1.018 | -0.166 | -0.939 |
| | (1.057) | (2.375) | (0.221) | (3.325) | (1.299) | (2.428) | (0.198) | (0.970) |
| Obs. | 1244 | 1244 | 1244 | 1244 | 1244 | 1244 | 1244 | 1244 |
| N | 77 | 77 | 77 | 77 | 77 | 77 | 77 | 77 |
| AR1 | 0.001 | 0.001 | 0.006 | 0.000 | 0.030 | 0.000 | 0.052 | 0.009 |
| AR2 | 0.754 | 0.913 | 0.321 | 0.107 | 0.100 | 0.538 | 0.283 | 0.722 |
| Instrument | 50 | 50 | 50 | 60 | 40 | 50 | 30 | 35 |
| Hansen J-test | 0.749 | 0.814 | 0.776 | 0.467 | 0.637 | 0.443 | 0.123 | 0.663 |
| Dif-in-Hansen Test | 0.476 | 0.742 | 0.684 | 0.461 | 0.113 | 0145 | 0.975 | 0.363 |

*Notes:* Base sample is an unbalanced panel spanning from 1984–2016 data from 77 selected developing countries. Standard errors are in parentheses, p-values are reported for AR1, AR2, Hansen J-test and Dif-in-Hansen Test. In the case of two-step GMM, the Windmeijer (2005) finite sample correction for standard errors is employed. Asterisks ***,**,* denote significance at the 1%, 5% and 10%-level, respectively. The row for the Hansen J-test reports the p-values for the null hypothesis of instrument validity. Instruments are combined into smaller sets by collapsing the block of the instruments' matrix. This technique was used by previous researchers, including Calderon et al. (2002), Beck and Levine (2004), Azman-Saini et al. (2010), Karim and Azman-Saini (2013), Karim (2012), Karim and Zaidi (2015), among others. The values reported for the Diff-in-Hansen test are the p-values for the validity of the additional moment restriction necessary for system GMM. The values reported for AR(1) and AR(2) are the p-values for first and second order auto regressive of the disturbances in the first differences equations.

risk is positively related to the extent of technology transfer between developed and developing countries. The extent of catastrophic risk attached to climatic disasters is a significant determinant of both medium-run and long-run patterns of technological transfer and is positively related to the size of the spillover, the results for geologic disasters are only significant and very sizeable in the medium-run recovery following the occurrence of a disaster. Gassebner et al. (2010) also found a negative relationship between the occurrence of natural disasters and a nation's trade volume.

## CONCLUSIONS

Natural disasters are not uncommon, though they are very unpredictable. Based on Disaster Reduction Center (ADRC 2009), 399 natural disasters occurred worldwide in 2009, killing almost 16,000 people and affecting over 220 million people. The estimated amount of economic damage came close to US$50 billion.

Most of the previous studies focused on the political economy and social impacts of a natural disaster. However, only several empirical works have been done to explore the potential effect of human development and corruption on disaster preparedness. Therefore, this study chooses to explore a possible relationship between several economic variables, such as population density, investment, government consumption, unemployment and openness that may affect total deaths, total people affected and damages caused by natural disasters. This study examines two important human development indicators; income per capita and education attainment, and other institutional factors; corruption and poor governance, by using a panel data from 77 countries. From the results, it is identified that, among others, enhancing economic development can help in reducing the impact of natural disasters on human fatalities. Countries with a higher income will be able to be more prepared to mitigate future damages due to natural disasters. By spending more on natural disaster relief centers, preparedness programs, early warning system, good governance and increasing transparency with better enforcement such as building regulation in a disaster-prone area, can reduce the impact of a natural disaster. Furthermore, human fatalities can be reduced with higher investment and educating the public. As a well-informed citizen, people would be more willing to prepare themselves against any ill-effect as a result of natural disasters, for example, by buying or building homes that are less prone to natural disasters or take extra precaution to face future disasters.

Such study is useful for both government and international disaster risk reduction and mitigation agencies to re-evaluate their approach towards target recipients. Such programs and policies centering around the aim of increasing the income level of the people should be given priorities because it indirectly works positively in the long run in mitigating and reducing the damages and losses as well as the fatalities due to natural disasters. Government expenditure and consumption also need to be carefully planned and cautiously executed, as this study has also shown that government consumption is an important tool that could mitigate the losses and reduce the negative impact of natural disasters. The government also needs to allocate a big portion of its budget in mitigating factors and facilities, such as a retainable wall, or to ensure adequate forest reserve are protected to prevent or lessen the damages.

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