Environmental Science and Pollution Research (2019) 26:14287–14299
https://doi.org/10.1007/s11356-019-04755-5

RESEARCH ARTICLE

Natural disasters and economic losses: controlling external migration, energy and environmental resources, water demand, and financial development for global prosperity

Khawar Abbas Khan[1] · Khalid Zaman[1] · Alaa Mohamd Shoukry[2,3] · Abdelwahab Sharkawy[2] · Showkat Gani[4] · Sasmoko[5] · Jamilah Ahmad[6] · Aqeel Khan[6] · Sanil S. Hishan[7]

Received: 12 December 2018 / Accepted: 4 March 2019 / Published online: 12 March 2019

Abstract

The objective of the study is to examine the impact of natural disasters on external migration, price level, poverty incidence, health expenditures, energy and environmental resources, water demand, financial development, and economic growth in a panel of selected Asian countries for a period of 2005–2017. The results confirm that natural disasters in the form of storm and flood largely increase migration, price level, and poverty incidence, which negatively influenced country's economic resources, including enlarge healthcare expenditures, high energy demand, and low economic growth. The study further presented the following results: i) natural resource depletion increases external migration, ii) FDI inflows increase price level, iii) increase healthcare spending and energy demand decreases poverty headcount, iv) poverty incidence and mortality rate negatively influenced healthcare expenditures, v) industrialization increases energy demand, and vi) agriculture value added, fertilizer, and cereal yields required more water supply to produce greater yield. The study emphasized the need to magnify the intensity of natural disasters and create natural disaster mitigation unit to access the human and infrastructure cost and attempt quick recovery for global prosperity.

Keywords Natural disasters · Economic losses · Health expenditures · Energy demand · Environmental resources · Poverty · Migration · Asian countries

Responsible editor: Muhammad Shahbaz

✉ Khalid Zaman
Khalid_zaman786@yahoo.com

[1] Department of Economics, University of Wah, Quaid Avenue, Wah Cantt, Pakistan

[2] Arriyadh Community College, King Saud University, Riyadh, Saudi Arabia

[3] KSA Workers University, El Mansoura, Egypt

[4] College of Business Administration, King Saud University, Muzahimiyah, Saudi Arabia

[5] Faculty of Humanities and Research Interest Group in Educational Technology, Bina Nusantara University, Jakarta, Indonesia

[6] School of Education, Faculty of Social Sciences and Humanities, Universiti Teknologi Malaysia, 81310 Skudai, Johor, Malaysia

[7] Azman Hashim International Business School, Universiti Teknologi Malaysia, 81310 Skudai, Johor, Malaysia

Introduction

It is the real fact that the natural disasters have put a serious threat to the economies of the world especially developing countries in terms of economic losses and physical damages. The main task for disasters mitigating agencies is to control the devastating impacts of such vulnerable disasters all across the globe. In the past, we see a lot of devastating disasters but the severity of these disasters rose dramatically since 1970s. In the recent years, Typhoon Haiyan in Philippines is considered one of the strongest storms ever. A common typology of disaster impacts distinguished between direct and indirect impacts (The Guardian 2013). Direct impacts include the destruction of fixed assets, raw material, mineral resources, high-yielding crops, and loss of precious lives (which of course cannot be compensated by any means). Indirect impacts which are often termed as economic losses concerned with economic activities, specifically the goods and services sector that does not come into effect instantly after the disaster.

The disasters differ to each other in terms of severity. The impact of one super severe disaster is much adverse than that of an average disaster. The poverty rate is also high in super severe disaster areas due to high level of damages created. The migration rate is also larger in numbers from highly affected areas. When these migrants come into other areas then they also face the problem of shelter and other basic needs of life, which affects the quality of life of the migrants (Boustan et al. 2017). Natural disasters intensity and its magnitude sharply increase over a period of time and since 1970s, around more than 7000 major disasters that caused around more than US$2 trillion have been reported (Shabnam 2014).

Natural disasters are commonly attached with the substantial economic losses. Since the last three decades, natural disasters episodes substantially increase worldwide, which caused an intimidating impact on the different economies of the world specifically the developing countries. The developing countries bear the much worst impact on economic losses than that of developed countries. It is on the record that between 1970 and 2002, a total of 6436 natural disasters have occurred and 77% disasters hit the developing countries. It shows that due to lack of resources, developing countries are unable to counter these deadly disasters (Kellenberg and Mobarak 2008).

One of the major disasters in the history is the tsunami of December 2004, which caused a high level of destruction with an earthquake of magnitude 9.0 effecting more than 18 countries from Southeast Asia to Southern Africa. The tsunami killed about 250,000 people in a single day and destroyed the large number of houses, which results in more than one million homeless people, and also posed a negative impact on economic activity causing millions of dollars loss by affecting tourist and fishing industries (Cavallo et al. 2014). In October 8, 2005, Pakistan faced severe intensity earthquake that Richter scale shows its magnitude of 7.6, which largely hit the Northern region Himalayan region and Kashmir. The epicenter of this earthquake was located almost 9 km northeast of the city of Muzaffarabad, which is known as the capital of Azad Jammu Kashmir (AJK). The death toll provided by the government's official on November 2005 was 87,350 approximately. The number of injured people was 38,000 and 3.5 million people estimated to be homeless. As per government figures, the number of innocent children found dead by this dreadful disaster was counts of 19,000. Most of them lost their life in the collapse of school buildings. More than 500,000 families had been affected by the earthquake and almost 250,000 farm animals died. More than 78,000 buildings were either damaged or destroyed, which includes approximately 17,000 school buildings and hospitals (Earthquake Engineering Research Institute 2006).

The cyclone Nargis in 2008 hit the northern Indian Ocean, which made a devastation in Myanmar by landfall and also affected the Ayeyarwady Delta region alongside with its 37 townships for nearly 2 days. The government officials released the figures showing that 84,500 people were killed along with 53,800 missing. The cyclone resulted in a massive destruction for this region. This cyclone was equal to a category 3 or 4 hurricane on the scale of Saffir-Simpson, led to a huge disaster in a form of storm and flood. The cost of damages was estimated around US$10 billion and also this cyclone was the second deadliest in the recorded history after Typhoon Nina in 1975 (Mercene 2017). The Sumatra-Andaman earthquake along the shores of Thailand, Indonesia, Sri Lanka, and South India happened on December 26, 2004 with the magnitude of 9.15 Richter scale created a severe impact in these areas. The duration of the earthquake was so minimal that lasts for only 10 s but caused a lot of devastation in a form of Tsunami, killing 200,000 to 310,000 people.

India is the country which experienced the 14 high-scale earthquakes between 1982 and 2002 that caused a high level of destruction. It is estimated by the concerned authorities that these earthquakes killed a total of 32,117 people. On contrary, the USA in this time span experienced almost 18 major earthquakes that killed 143 people that show a high difference in earthquakes killing between India and the USA. The difference in the proportion of deaths is showing a significance impact of infrastructure between both the countries. The report by the intergovernmental panel on climate change revealed that 65% of deaths in the world by these natural disasters between 1985 and 1999 occurred in the nations whose incomes were under US$760 per capita (Kahn 2005).

Flood is the form of natural disaster, poses a huge impact on the economy. The businesses in the affected areas of the flood shut down on temporary basis and shackling potential GDP growth posing significant impact in their value chains; further, it caused substantial amount of capital stock reduction, electricity disruption, and closing of roadways, which create more challenges for country's development (Haddad and Teixeira 2015). It is the dilemma of many nations in the present situation not to understand the broader perspective of disaster management. It is the dire need of the time to promote awareness among the people and decision-makers to combat these externalities with effective policies and approaches. The different strategies are required for different countries to handle disasters according to their geographical location. There are multi dimensions in historical courses, sociocultural attributes, and economic structures of different regions. The same institutional framework for different countries seems unachievable and inappropriate. Therefore, it is the basic principle of knowledge sharing to make policies based on the current situation of that region to improve the understanding of disaster mitigation under the shadow of sustainable development concerning with global widespread issues (Haque 2003).

The above discussion confirmed the undeniable losses from large-scale natural disasters, which affect all across the globe. The present study strives hard to access vulnerability possess due to natural disasters in Asian region to device sound policy inferences to minimize economic and human losses. The more specific objectives are as follows:

i) to examine the impact of natural disasters on external migration, inflation, and poverty incidence across Asian countries,
ii) to analyze natural disaster's impact on energy demand, water supply, healthcare infrastructure, and wealth of the countries, and
iii) to investigate the impact of natural disasters on natural resource capital across countries.

These objectives required in-depth survey to device robust policy inferences to mitigate climate change and minimize economic losses by catastrophic hazards across countries.

Literature review

The relationship between natural disasters and economic losses is widely evident all across the globe. The number of studies provoked the need of disaster mitigating strategies to reduce human and economic sufferings. Smith and McCarty (1996) assessed the Hurricane Andrew vulnerability both in terms of infrastructure cost and human cost in Dade county, Florida. The results show that almost more than half of the houses in Dade County were damaged and around 353,000 people were moved to other places, while around 40,000 people forced to migrate abroad on permanent basis. Gray and Mueller (2012) showed the consequences of environmental changes that forced people to migrate towards a safer place. The study used a longitudinal survey data from 1700 Bangladeshi households to estimate the effects of vulnerable floods on crop failures that create a huge impact on local population mobility and migration in faraway areas. The results show that flooding has meek effects on women and the poorer mobility. Beine and Parsons (2015) examined the impact of natural disasters on international migration and conclude that climatic factors have no direct impact on international migration through the entire sample; however, epidemics and miscellaneous incidents have a chief factor of international migration in urban setting. Drabo and Mbaye (2015) assessed the effect of natural disasters on migration rates in developing countries. The results show that natural disasters are positively related with the emigration rates; however, it varies from geographical location and education. Phifer et al. (1988) concluded that flood caused a modest health declines. The persistence of health effects was directly related to the intensity of flood. Ivers and Ryan (2006) studied the risk of different kinds of vulnerable diseases, which were caused by weather hardships and flood-related natural disasters. The study concludes that unpredictable weather changes and natural disasters led to increased risk of infectious diseases across countries. Loayza et al. (2012) investigated the impact of natural tragedies on development distinctly through disaster in economic segment and found that flood disasters can have a constructive development effect in certain areas, simple disasters do not, which need fair examination in the study area. Skidmore and Toya (2002) investigated the long-run relationships between natural disasters, capital growth, total factor productivity, and economic development. The results reveal that natural disasters mitigation is connected with higher rates of human capital accumulation, rises in total factor productivity plus economic development, while it negatively effects on rate of return to physical capital. The study concludes that disasters deliver the stimulus to modernize the capital stock to approve fresh knowledge, foremost to developments in total factor productivity. Rajapaksa et al. (2017) examined the relationship between natural disaster and economic losses in a panel of 108 countries by using a last 25-year data set and found that there is an upturned "U" shaped for small-to-medium level disasters in which natural assets depletion is greater than ever. Correspondingly, trade, FDI, and economic growth are the significant determinants of natural capital. Ji and Chen (2017) concluded that high growth of urban population is the main challenge that need to maintain energy supply and demand in China. Chou et al. (2019) showed the disaster vulnerabilities in the form of drought and floods in China and estimated the economic losses regionally, and found that Northeastern China suffered with high episodes of drought disasters that damaged area around 6.44 million hectares while Central China affected with high episodic floods that damaged area about 3.97 million hectares. The study concluded that droughts and extreme temperature shifted from north to south and south to north respectively that damaged the natural flora of the country. Awan et al. (2018) concluded that industrialization impacts on the quality of human life and damages the natural environment, which could be considered as one of the chief factor for global warming and natural disasters. Botzen et al. (2019) initiated the call for the policy makers to integrate economic and environmental policies in a way to combat disaster episodes with climate-friendly policies. Seraphin (2019) argued that natural disasters affect country's economic growth through damaging the natural herbage, which culminated the tourism industry. The need of effective disaster management adaptation policies to manage tourist's destinations is high need for supporting international tourism across countries. Helderop and Grubesic (2019) concluded that storm disaster caused significant human and infrastructure damages that need fair policies related with climate and disaster adaptation policies for long-term sustained growth. Table 1 shows few more recent studies on natural disaster and economic losses across countries.

Table 1 Current debate on natural disaster and economic losses

Authors	Findings	Policy actions
Mal et al. (2018)	Natural disasters largely damaged country's economic system and increase poverty, hunger, health diseases, and ecosystem destruction. Climate change is one of the destructive factors that causes natural disasters globally.	Climate change mitigation and adaptation policies would be helpful to reduce the intensity of economic and human sufferings that need global sustainable policies for economic prosperity.
Nandi et al. (2018)	Natural disasters not only effect socio-economic and environmental factors while it negatively influenced on demographic factors that causes changes in birth rates, birth spacing, and child sex ratio.	Awareness, knowledge transformation, and disasters alert substantially will be helpful to reduce the intensity of natural disasters while healthcare planning is deem desirable for mitigating natural disaster episodes.
Keerthiratne and Tol (2018)	Natural disasters affect income disparity between the rich and poor, as non-poor households have a non-agriculture income that severally affected by natural disasters episodes while poor households have a greater share in agriculture income that less affected as compared to business activities.	For economic prosperity, natural disaster mitigation strategies are imperative to reduce the negative externalities of natural disaster both in terms of management of agriculture and non-agriculture activities.
Zhou et al. (2018)	Global warming led to an increase in the occurrence of natural disasters and destruction of sustainable development agenda.	To build disaster mitigation unit and emergency decision-making unit for improving the capability of disasters respond on time.
Bondonio and Greenbaum (2018)	Dynamic propensity score matching is used for knowing the disaster intensity and its vulnerability, and provide relief assistance to the affected place accordingly.	The matching score could be used to prevent it from future disasters episodes and invest in physical infrastructure.
Wu et al. (2018)	Economic development supports natural disaster mitigation programs, which is imperative for future disaster prevention planning globally.	Economic and human cost modeling due to climate-related natural disasters could be substituted by better planning and infrastructure development.
Xie et al. (2018)	Infrastructure development and increase reconstruction investment levels give more quick recovery from natural disaster episodes.	Investment in safe infrastructure development is imperative for mitigating natural disasters externalities.
Bangalore et al. (2016)	Climate vulnerabilities pose serious threat to the economy and human sufferings in the form of increase flood episodes and poverty incidence.	Climate change mitigation policies should be adopted for lessening socio-economic and environmental hazards globally.

The motivation of the study is to amalgamate different socio-economic and environmental factors affected by natural disasters, to analyze economic losses of a country. The previous studies largely provoked the nexus between natural disasters and economic growth that just represent the one side of the story. The real contributory factors largely ignored due to lack of qualitative data, which overcome over a period of time. The study has a novel contribution in the existing research by exploring the unexplored factors, including the impact of natural disasters on migrant stocks, price level, water resources, energy demand, resource depletion, and financial development across countries. These factors are largely unnoticed in previous studies and just received a slight attention by the scholars, which is imperative for long-term sustained growth by mitigating natural disaster episodes across the globe. South Asia is considered one of the most vulnerable regions that severely get affected by natural disasters due to low adaptation policies. Thus, this study is one of the initiatives to explore this unexplored research area for conclusive findings.

The stated studies confirmed the damaging effects of natural disasters on socio-economic and environmental factors in different economic settings, while this study accessed vulnerabilities of Asian countries account of high natural disaster episodes to proposed sound economic policies to reduce its intensity and damages with quick recovery team for preventing high economic and human losses.

Data and methodology

The data is taken from EM-DAT (2017) and World Bank (2017) for selected seven Asian countries, namely India, Pakistan, China, Vietnam, Bangladesh, Philippines, and Japan for a period of 2005–2017. The following variables are used in the study, including international migrant stock in numbers, consumer price index in annual %, poverty headcount in percentage, GDP per capita in constant 2010 US$, health expenditures as % of GDP, energy demand in kg of oil equivalent per capita, water supply as % of population access, broad money supply as % of GDP, the number of people affected by flood and storm, mineral depletion as % of GNI, FDI inflows as % of GDP, trade openness as % of GDP, industrialization as % of GDP, agriculture value added as % of GDP, fertilizer as Kg per hectare of arable land, cereal yield as Kg per hectare, real interest rate in %, mortality rate per 100 live birth, and carbon dioxide emissions as metric tons per capita.

Natural disasters have different types but there are two main categories of it. First is a climatic disaster, which results from atmospheric phenomena. Floods, droughts, and hurricanes are considered to be major climatic disasters that pose a huge impact on countries. The reason behind floods is heavy rainfall or melting of snow on mountains that result in the overflow of rivers on their banks and inundate the nearby areas. Hurricanes are another climatic disaster, which consist of large storms and occur in tropical or sub-tropical areas. Interestingly, hurricanes take place in areas where the constant supply of warm water is available which is very important to keep its intensity. Any kind of interaction with land or colder water affects it and ultimately weakens hurricanes. Hurricanes pose different impact in different areas consisting upon the geological position but strongest impact near coastlines, in mountainous areas, and on islands. The main proponents of rural areas are agricultural crops and livestock and they do not hit crops and livestock in large numbers, but buildings are the main target struck by earthquakes (Abbott, 2004).

It is a bitter reality that disasters pose a negative impact on the progress of an economy and also affect human capability of doing work due to the loss of lives of their dear ones. It is an international goodwill of different nations and people that in the days of disasters they arrange fund raising rallies and private gatherings to get donations for the affecters' in terms of money, clothes, tents, etc. The economy also gets disturbed by these vulnerable disasters. The momentum of the economy is affected by these shocks as the land for cultivation is ruined and infrastructure is destroyed. Therefore, political stability and proper functioning of important institutions are necessary to manage such vulnerable situations efficiently. The strong structure of government is the utmost need to overcome all these disasters with efficient strategies. A better performance of the government will cause a better outcome under different scenarios (Shahzad 2014).

The study used the following regression equations in evaluating the natural disaster's impact on country's economic losses:

Model-1: impact of natural disasters on international migration

$$MIG_{i,t} = \alpha_0 + \alpha_1 FLOOD_{i,t} + \alpha_2 STORM + \alpha_3 HEXP_{i,t} + \alpha_4 FDEP_{i,t} + \alpha_5 MDEP_{i,t} + \alpha_6 GDPPC_{i,t} + \varepsilon_{i,t} \quad (1)$$

It is expected that natural disasters, i.e., flood and storm, will largely influenced the decision of international migrant about to stay or leave the place where the natural disasters could happen, while health expenditures may increase along with the increase migrant stock across countries. Resource factors including forest depletion and mineral depletion may impact negatively on international migrant to stay the vulnerable place. The country's per capita income will be expected to retain the international migrant stock, if and only if, the country's income spent on international migrant if natural disaster could happen in the form of either infrastructure development, reconstruction of houses, or, giving alternative place to live when disaster would occur.

Model-11: impact of natural disasters on price level

$$CPI_{i,t} = \alpha_0 + \alpha_1 FLOOD_{i,t} + \alpha_2 STORM + \alpha_3 HEXP_{i,t} + \alpha_4 ENRG_{i,t} + \alpha_5 FDI_{i,t} + \alpha_6 TOP_{i,t} + \varepsilon_{i,t} \quad (2)$$

It is expected that higher natural disaster episodes bring greater change in the existing price level, especially food inflation that could increase larger time due to shortage of food stuff in the vulnerable places, while government spending on health expenditures is pre-requisite to mitigate healthcare issues in the disaster areas; however, it will put a burden on healthcare cost. Energy demand, FDI inflows, and trade openness will likely to increase price level due to foreign competition that threaten the domestic industries to meet the quality standards to compete the firms in globalized competitive era.

Model-111: impact of natural disasters on poverty incidence

$$POV_{i,t} = \alpha_0 + \alpha_1 FLOOD_{i,t} + \alpha_2 STORM + \alpha_3 HEXP_{i,t} + \alpha_4 ENRG_{i,t} + \alpha_5 FDI_{i,t} + \alpha_6 GDPPC_{i,t} + \varepsilon_{i,t} \quad (3)$$

It is expected that natural disasters episodes may largely increase poverty incidence due to demolished economic infrastructure that gives equal benefit to the poor to sustained their lives, while inadequate health spending, energy crisis, pro-rich foreign investment, and imbalance growth all would likely to increase poverty incidence across countries.

Model-IV: impact of natural disasters on country's economic growth

$$GDPPC_{i,t} = a_0 + a_1 FLOOD_{i,t} + a_2 STORM + a_3 TOP_{i,t} + a_4 CPI_{i,t} + a_5 FDI_{i,t} + \varepsilon_{i,t} \quad (4)$$

The impact of natural disaster on country's economic growth is complex in relationship, as high episodes of natural disaster lead to decrease economic losses, while on the other hand, it gives an opportunity to restructure the economy by foreign aid to re-stabilize their economy with disaster mitigating strategies. Thus, both the positive and/or negative impact could be observed in a given scenario. The trade liberalization policies, price level, and FDI inflows may get maximum payoff in the form of spending on development purpose, which sustained the country's growth through bilateral and multilateral trade negations, capital foreign investment, and optimize price charges.

Model-V: impact of natural disasters on health expenditures

$$HEXP_{i,t} = \alpha_0 + \alpha_1 FLOOD_{i,t} + \alpha_2 STORM + \alpha_3 POV_{i,t} + \alpha_4 CO2_{i,t} + \alpha_5 MR_{i,t} + \alpha_6 GDPPC_{i,t} + \varepsilon_{i,t} \quad (5)$$

The impact of natural disasters on health expenditures is expected to be positive, as disasters episode get drain economic resources on the cost of resource depletion, which ultimately increases healthcare costs across countries. The high poverty incidence, high mass carbon emissions, and increase mortality rate will be burdened on healthcare infrastructure in the form of communicable and non-communicable diseases, which need fair income to resolve healthcare issues.

Model-VI: impact of natural disasters on energy resources

$$ENRG_{i,t} = a_0 + a_1 FLOOD_{i,t} + a_2 STORM + a_3 INDST_{i,t} + a_4 TOP_{i,t} + a_5 FDI_{i,t} + \varepsilon_{i,t} \quad (6)$$

It is expected that natural disasters negatively affect energy resources as account of energy breakdown, while industrialization, trade openness, and FDI inflows required high energy resources in order to produce economic products across countries.

Model-VII: impact of natural disasters on water supply

$$WS_{i,t} = a_0 + a_1 FLOOD_{i,t} + a_2 STORM + a_3 AGR_{i,t} + a_4 FRT_{i,t} + a_5 CY_{i,t} + \varepsilon_{i,t}. \quad (7)$$

It is likelihood that natural disasters negatively affect on water resource supply, while agriculture value added, fertilizer, and cereal production required massive water supply in order to meet the food challenges across countries.

Model-VIII: impact of natural disaster on financial development

$$M2_{i,t} = a_0 + a_1 FLOOD_{i,t} + a_2 STORM + a_3 CPI_{i,t} + a_4 RI_{i,t} + a_5 GDPPC_{i,t} + \varepsilon_{i,t} \quad (8)$$

Finally, it is expected that natural disasters negatively impact on country's financial resources in account of fall down bonds and share markets, while inflation would increase money supply and real interest rate decreases money supply, both negatively influenced country's economic growth.

Where, MIG shows migrant stock, CPI shows consumer price index, GDPPC shows gross domestic product per capita, POV shows poverty incidence, HEXP shows health expenditures, ENRG shows the energy resources, WS shows water supply level, M2 shows broad money supply, TOP shows trade openness, FDI shows foreign direct investment, CO2 shows carbon emissions, AGR shows agriculture sector, CY shows cereal yields, RI shows real rate of interest, FRT shows fertilizer, INDST shows industrial sector, and MDEP shows mineral depletion.

The study employed panel unit root test for assessing stationary series of the candidate variables. Panel cointegration further checked for long-run and cointegrated relationship between the variables, while panel random effect model is used to absorb country-specific and time variant shocks. The following basic model is used to described the random effect:

$$Y_{it} = \mathbf{X_{it}}\boldsymbol{\beta} + (\alpha + u_i) + \varepsilon_{it} \quad (9)$$

where "Y" is regress and, "X" is the set of regressors, and α shows constant term.

Results and discussion

Table 2 shows the descriptive statistics of the studied variables for ready reference. The minimum value of AGR is 1.060% of GDP and maximum value is 26.0246% of GDP with a mean value of 14.642% of GDP. The variable has a negatively skewed distribution and high kurtosis value. The minimum value of CO2 is 0.2754 metric tons per capita and maximum value is 9.7829 metric tons per capita with a mean value of 3.0461 metric tons per capita. The CO2 is positively skewed distribution with high kurtosis. CPI has an average value of 5.5896%. The minimum value of CY is 2411.6 kg per hectare

Table 2 Descriptive statistics

Variables	Mean	Maximum	Minimum	Standard deviation	Skewness	Kurtosis
AGR (% of GDP)	14.642	26.024	1.060	7.283	− 0.556	2.336
CO2 (metric tons per capita)	3.046	9.782	0.275	3.312	1.110	2.511
CPI (%)	5.589	23.116	− 1.352	4.510702	1.225	5.533
CY (kg per hectare)	4290.952	6262.4	2411.6	1266.789	0.062	1.466
ENRG (kg of oil equivalent per capita)	1137.906	4062.979	158.918	1185.278	1.406	3.490
FDI (% of GDP)	2.239	9.663	− 0.052	2.002	1.480	5.058
FLOOD (number of people killed and affected)	18,873,477	9.34E+08	900	99,173,152	8.795	81.366
FRT (kg)	260.704	567.260	104.973	134.721	0.834	2.406
GDPPC (constant US%)	8206.412	47,623.27	598.617	15,409.64	2.010	5.114
HEXP (% of GDP)	5.088	10.247	2.613	2.199	1.056	3.244
INDST (% of GDP)	6.123	15.050	− 14.863	4.666	− 1.587	7.521
M2 (% of GDP)	109.124	242.829	47.421	63.0187	0.869	2.229
MCPT (% of GDP)	51.290	151.451	4.751	31.696	0.549	2.759
MDEP (% of GNI)	0.425	2.348	0	0.590	1.561	4.620
MIG (Stock)	1,945,036	5,923,642	51,768	1,873,251	0.887	2.524
MR (per 100 live birth)	30.286	80.3	2	22.093	0.708	2.561
NFDEP (% of GNI)	0.167	0.501	0	0.132	0.0750	2.030
POV (%)	12.336	31.1	0.3	9.150	0.305	2.120
RI (%)	3.119	8.164	− 6.774	3.191	− 1.164	4.387
STORM (number of people killed and affected)	3,766,519	55,337,820	0	8,468,595	3.888	20.645
TOP (% of GDP)	61.902	184.686	24.490	42.908	1.712	4.650
WS (% of population access)	91.406	100	79.8	5.073	0.089	2.574

and maximum value is 6262.4 kg per hectare with a mean value of 4290.952 kg per hectare. The minimum value of ENRG is 158.9185 kg of oil equivalent per capita and maximum value 4062.979 kg of oil equivalent per capita with a mean value of 1137.906 kg of oil equivalent per capita. The average value of FDI inflows is about 2.2397% of GDP. The average intensity of flood and storm affected number of peoples is about 18,873,477 and 37,66,519 respectively. The average value of FRT is 260.704 kg, GDP per capita is about 8206.412$, HEXP is about 5.088% of GDP, INDST is 6.123% of GDP, and M2 is 109.124% of GDP.

The minimum value of MCPT is 4.751% of GDP and maximum value is 151.451% of GDP having mean equal to 51.290% of GDP. The MCPT has positively skewed distribution with kurtosis 2.759. The average value of MDEP is about to reach 0.425% of GNI, MIG is 19,45,036 stock, MR is 30.284 per hundred live birth, NFDEP is o.167% of GNI, POV is reached up to 12.336%. The minimum value of RI is − 6.774% and maximum value is 8.164% with mean value of 3.119%. The RI is negatively skewed with kurtosis 4.387. The minimum value of TOP is 24.490% of GDP and maximum value is 184.686% of GDP, having mean value of 61.902% of GDP. The distribution has positively skewed distribution with high kurtosis. The average value of WS is 91.406% of population. Table 3 shows the panel unit root estimates for ready reference.

The result of panel unit root test shows that CPI is level stationary as per the estimates of LLC and PP panel unit root test; however, it is insignificant for the remaining two panel unit root estimates, i.e., IPS and ADF test. The CPI is differenced stationary for all the prescribed unit root tests; hence, we find the mixture of order of integration by different unit root tests. The result of panel unit root test shows that flood is level stationary for all the prescribed panel unit root tests, i.e., LLC, PP, IPS, and ADF. The result clearly illustrates that storm is level stationary as per the estimates of all the panel unit root tests. The result points out that GDPPC is not level stationary as per all the mentioned panel unit root tests but differenced stationary at PP, IPS, and ADF test; however, it is not significant for LLC test, as a result, we find mixture order of integration by different unit root tests. The variable POV is level stationary according to LLC panel unit root test; however, it is insignificant for the IPS, PP, and ADF test. The variable POV is differenced stationary for LLC, IPS, PP panel unit root tests but insignificant for ADF test; therefore, we get the mixture order of integration by different unit root test. The results show that ENRG, HEXP, TOP, DI, and FERT are differenced stationary for the prescribed panel of unit root test and level stationary for only LLC panel of unit root test. The result shows that AGR, MDEP, and M2 are differenced stationary for the LLC, IPS, IDF, and PP panel of unit root test. The results signify that MCPT, NFDEP, CY, and CO2 are

Table 3 Panel unit root estimates

Test	Level							
	CPI	FLOOD	STORM	GDPPC	POV	MIG	HEXP	ENRG
LLC	− 2.02015	− 3.2539	− 2.3208	0.17425	− 2.4997	− 1.0233	−2.3926	−3.8731
	(0.0217)	(0.0006)	(0.0101)	(0.5692)	(0.0062)	(0.1531)	(0.0084)	(0.0001)
IPS	− 1.06969	− 2.07495	− 2.7159	3.58426	0.2124	1.20968	0.29954	−0.3138
	(0.1424)	(0.019)	(0.0033)	(0.9998)	(0.5841)	(0.8868)	(0.6177)	(0.3768)
ADF	19.0588	25.2575	30.7363	1.70213	8.13594	5.69959	9.18259	14.443
	(0.1627)	(0.0321)	(0.006)	(1)	(0.7744)	(0.9735)	(0.8192)	(0.4173)
PP	29.3829	51.6687	62.6539	2.54253	7.47118	4.72429	6.46899	16.0637
	(0.0093)	(0)	(0)	(0.9996)	(0.825)	(0.9893)	(0.9533)	(0.3095)
First difference								
LLC	− 10.114	− 6.74718	− 8.2379	0.66325	− 1.6544	49.544	−4.4692	−4.59625
	(0)	(0)	(0)	(0.7464)	(0.049)	(1)	(0)	(0)
IPS	− 6.59067	− 4.59344	− 6.4702	− 1.9545	− 1.4459	− 6.386	−3.7577	−2.33836
	(0)	(0)	(0)	(0.0253)	(0.0741)	(0)	(0.0001)	0.0097
ADF	105.746	46.4138	61.3607	24.838	15.9419	57.141	39.8001	31.6454
	(0)	(0)	(0)	(0.0362)	(0.1013)	(0)	(0.0003)	(0.0045)
PP	62.4071	124.326	121.613	23.0746	38.2579	116.259	64.0433	47.3028
	(0)	(0)	(0)	(0.0591)	(0)	(0)	(0)	(0)
Test	Level							
	M2	MCPT	NFDEP	MDEP	TOP	INDST	AGR	CY
LLC	− 1.052	− 2.8399	− 1.684	− 1.047	− 2.639	− 3.079	0.359	−4.3464
	(0.146)	(0.002)	(0.046)	(0.147)	(0.004)	(0.001)	(0.640)	(0)
IPS	0.970	− 1.226	− 0.967	− 0.5423	0.01127	− 1.529	1.78623	−0.3418
	(0.834)	(0.11)	(0.166)	(0.2938)	(0.5045)	(0.0631)	(0.963)	(0.3662)
ADF	10.303	19.506	16.497	13.9401	14.7731	21.726	6.82573	15.2866
	(0.739)	(0.146)	(0.169)	(0.3045)	(0.3938)	(0.084)	(0.9412)	(0.3588)
PP	15.608	27.7748	20.914	17.6589	19.27	50.523	18.4758	25.8153
	(0.337)	(0.015)	(0.051)	(0.1264)	(0.1549)	(0)	(0.186)	(0.0273)
First difference								
LLC	− 5.1228	− 12.635	− 4.7932	− 5.3353	− 4.3226	− 10.202	−4.3959	−3.6415
	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0.0001)
IPS	− 3.4298	− 7.5112	− 3.1312	− 3.6252	− 2.7497	− 6.9717	−3.3897	−2.3547
	(0.0003)	(0)	(0.0009)	(0.0001)	(0.003)	(0)	(0.0003)	(0.0093)
ADF	36.7802	67.1401	30.9301	35.1702	31.0807	65.3507	36.1162	27.5974
	(0.0008)	(0)	(0.002)	(0.0004)	(0.0054)	(0)	(0.001)	(0.0161)
PP	50.0288	106.162	57.645	69.9279	61.1275	124.698	80.3023	62.0367
	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
Test	Level							
	FDI	MR	CO2		RI	FRT	WS	
LLC	− 1.700	− 1.940	− 3.000		− 0.747	− 2.753	− 4.284	
	(0.044)	(0.026)	(0.001)		(0.222)	(0.002)	(0)	
IPC	− 0.815	0.884	− 0.388		− 0.462	− 0.708	− 0.490	
	(0.207)	(0.811)	(0.348)		(0.322)	(0.239)	(0.311)	
ADF	18.127	13.318	12.741		14.196	16.205	11.066	
	(0.201)	(0.501)	(0.547)		(0.435)	(0.301)	(0.523)	
PP	15.208	53.221	21.226		33.531	20.25	28.048	
	(0.364)	(0)	(0.096)		(0.002)	(0.122)	(0.005)	
First difference								
LLC	− 5.582	5.070	− 9.551		− 8.494	− 6.219	5.458	
	(0)	(1)	(0)		(0)	(0)	(1)	
IPC	− 3.393	2.479	− 4.043		− 6.175	− 3.778	2.194	
	(0.003)	(0.993)	(0)		(0)	(0.001)	(0.985)	
ADF	36.322	8.053	41.943		59.0503	39.801	5.189	
	(0.009)	(0.886)	(0.001)		(0)	(0.0003)	(0.951)	
PP	67.494	6.201	44.938		109.716	80.469	1.313	
	(0)	(0.961)	(0)		(0)	(0)	(0.999)	

Note: small bracket shows probability values

level stationary as per the estimates of LLC and PP panel of unit root test and differenced stationary for all the prescribed panel of unit root test. Hence, we find the mixture order of integration by different unit root test. The result illustrates that WS and MR are level stationary as per the findings of LLC and PP unit root test and insignificant for the others. The RI is level stationary for only LLC unit root test and differenced stationary for all LLC, IPS, ADF, PP panel of unit root test.

MIG is differenced stationary for all prescribed tests instead LLC. Table 4 shows the panel cointegration estimates for Model-1 to Model-8 for ready reference.

The results show that Model-1, Model-2, Model-3, Model-5, and Model-8 tend to show a significant statistic at 5% level of confidence either significant in panel statistics or group statistics, or both, which confirmed the cointegrated relationship exhibit between the variables in the given models, while the remaining models, i.e., Model-4, Model-6, and Model-7, do not confirmed any significant association among the variables in a given model; thus, it accepts the null hypothesis of no cointegration between the variables. Table 5 shows the panel random effect estimates for Model-1 to Model-8.

The results show that flood has a significant and positive association with the migrant stocks, which implies that higher natural disaster episodes substantially increase the individual behaviors towards migration to other countries where the disaster episodes are considerably low. The results further confirmed the vulnerability of storm that enlarges the migrants stocks from a panel of selected countries. The results are supported with the previous studies of Gray and Mueller (2012), Saldaña-Zorrilla and Sandberg (2009) etc., as these studies confirmed the vulnerability of disaster episodes across the globe. The impact of health expenditures on migrants stock is negative which confirmed that along with higher health expenditures in Asian countries, the individual decisions of migration are limited, as higher health spending gives more healthcare facilities that a person required for its well-being; hence, the impact is quite favorable in the panel of selected countries. The results supported with the previous studies of Pond and McPake (2006) and Connell et al. (2007), which confined that health expenditure, reduced the migrants stocks across countries. The impact of natural resources on migration is positive, as higher the net forest depletion and mineral depletion resources, higher is the intensity to leave the people to other countries, which provoked the importance of natural resources in economic agenda. The result is in line with the previous studies of Lubere (2016) and Kliot (2004), which confirmed the importance of natural resources in economic policies. Finally, the result is positive in between per capita income and migrant stock, as higher per capita income increases the migrant stock, which linked with the size of labor force that grew the economy size and reap the economic benefits. The result is supported with the previous work of Taylor et al. (2003), Pedersen et al. (2008), etc.

The results show that storm has a positive relation with consumer price index, as an increase in the vulnerable storms causes an increase in the CPI of the economy due to shortage of food stuff in the affected areas. The results are confirmed with the previous studies of Collier and Goderis (2008), Ramsay (2011), etc. The impact of foreign direct investment is positive with consumer price index which shows that an increase in foreign direct investment resulting in increase in the general price level in Asian countries. As higher the productivity of the economy causes to rise in price level. The results are confirmed by the previous studies of Reinhart and Rogoff (2003), Sayek (2009), etc. The result clearly shows that there is a positive relation between storm and poverty as increase in the storms results in rise in the poverty level, which tends to show that storms cause destruction in the infrastructure of the society including industrial zones and agriculture sector that lowers the income level across countries. The results are confirmed by the previous studies of Bui et al. (2014), Carter et al. (2007), Rodriguez-Oreggia et al. (2013), etc. The energy has a negative impact on the poverty level, which illustrates that an increase in the energy level decreases the poverty in Asian countries. This relation highlights that with an increase in the energy level causes a development in multiple sectors of the economy results in high standard of living in Asian countries with less poverty. The results are confirmed by the studies of Jaber and Probert (2001), Karekezi (2002), Pachauri and Spreng (2004), etc. The per capita income relates positively with poverty which shows an increase in per capita causes an increase in poverty level, which account for high income inequality across countries. The result is confirmed by the previous studies of Ncube et al. (2014), Jamal (2006), etc. The health expenditures show a negative impact on poverty as it refers that an increase in the better health condition of the people in Asian countries results in the increase in their capacity to work and earn more, which subsequently decreases

Table 4 Estimates of panel cointegration test

Statistics	Model-1	Model-2	Model-3	Model-4	Model-5	Model-6	Model-7	Model-8
Panel v-statistic	Й	Й	Й	Й	Й	Й	Й	Й
Panel rho-statistic	Й	Й	Й	Й	Й	Й	Й	Й
Panel PP-statistic	√	√	√	Й	√	Й	Й	Й
Panel ADF-statistic	Й	√	Й	Й	√	Й	Й	Й
Group rho-statistic	Й	Й	Й	Й	Й	Й	Й	Й
Group PP-statistic	√	√	√	Й	√	Й	Й	√
Group ADF-statistic	Й	√	Й	Й	Й	Й	Й	Й

Note: Й shows no cointegration, √ shows cointegration

Table 5 Estimates of panel random effect model

Statistics	DV: MIG	DV: CPI	DV: POV	DV: GDPPC	DV: HEXP	DV: ENRG	DV: WS	DV: M2
Constant	3536316*	8.854972*	24.60528*	9465.686*	6.118928*	1656.962*	78.30573	68.48628
FLOOD	0.001262*	1.73E−09	1.71E−09	4.64E−07	− 3.98E−10	4.32E−07*	− 2.60E−10	5.01E−09
STORM	–	–	1.43E−07*	− 4.43E−05*	–	–	− 3.09E−08	− 2.75E−07
$STORM^2$	0.001421*	2.43E−14*	–	–	2.62E−16*	2.45E−11**	–	–
HEXP	− 481,714.7*	− 0.412195	− 1.871137*	–	–	–	–	–
NFDEP	2902724*	–	–	–	–	–	–	–
$MDEP^2$	2.30E+08*	–	–	–	–	–	–	–
GDPPC	67.95288*	–	–	–	–	–	–	–
ENRG	–	− 0.001344	− 0.005672*	–	–	–	–	–
FDI	–	1.073258*	0.257483	− 97.48766	–	− 32.08901**	–	–
TOP	–	− 0.024028	–	− 12.07464	–	− 5.243040*	–	–
GDPPC	–	–	0.000312*		7.83E−05*	–	–	0.005194*
CPI	–	–	–	− 24.21565	–	–	–	− 0.744561
POV^2	–	–	–	–	0.00071*	–	–	–
MR^2	–	–	–	–	0.001702*	–	–	–
CO2	–	–	–	–	− 0.008941	–	–	–
$INDST^2$	–	–	–	–	–	335.3586*	–	–
AGR^2	–	–	–	–	–	–	0.352312*	–
FRT	–	–	–	–	–	–	0.015795*	–
CY	–	–	–	–	–	–	0.004147*	–
RI	–	–	–	–	–	–	–	0.999209***
Statistical tests								
R^2	0.997	0.467	0.461	0.101	0.841	0.995	0.688	0.414
Adjusted R^2	0.979	0.429	0.422	0.048	0.829	0.980	0.669	0.379
Prob. F-stats	0.005	0.000	0.000	0.100	0.000	0.000	0.000	0.004

Note: *, **, and *** indicate 1%, 5%, and 10% significance level. DV shows dependent variable

the poverty level in the economy. The results are confirmed by the previous studies of Sarti et al. (2017), Khemili and Belloumi (2018), etc.

The results further show that storm poses a negative relationship with GDP per capita, which confined that increase in storms episodes leads to decrease country's GDP per capita, as crops and other productive areas get effected by these vulnerable storms that largely decrease country's income. The result is confirmed by the previous studies of Pielke Jr et al. (2003), Yang (2008), etc. The result found the positive relationship between storm and health expenditures in a panel of Asian countries, which implies that an increase in storms intensity causes large-scale destruction, which ultimately leads to increase healthcare expenditures in affected areas. The previous studies of Bosello et al. (2006), World Health Organization (2008), and Watts et al. (2015) provoked the need of life safety in natural disasters and emphasized the need to increase healthcare expenditures across countries. The results further argued that due to lack of resources, poor people are more inclined towards health issues, which ultimately cause an upward shift in health expenditure. The studies of Flores et al. (2008) and Blackburn (1991) shed light on the above stated results. The country's per capita income has a positive association with health expenditures, which confined that income is the chief factor that supports healthcare expenditures in order to increase in affected areas where required. Gerdtham et al. (1992) and Anand and Ravallion (1993) studies are impressive in the given scenario. The results show a positive relation between mortality rate and health expenditures, which implies that an increase in mortality rate leads to increase in health expenditures that need fair healthcare policies to reduce high mortality rate across countries. The results are confirmed by the studies of Hall and Jones (2007) and Saltman et al. (1997) show comprehensive debate in a given scenario.

The results demonstrate a positive relationship between natural disasters such as floods and storms and energy demand, as increase in natural disasters led to increase energy demand across countries. Mochizuki and Chang (2017) concluded that natural disasters although affected on large-scale destruct energy and economic resources, while it assumes an opportunity to the revival of energy transition and

early recovery of tsunami for sustained growth. Industrialization required more energy reserves in order to gear economic system, which is pivotal for broad-based growth (Howarth et al. 2017). Trade openness and FDI inflows both have a negative impact on energy resources, which illustrates that an increase in trade openness results in the decline of energy resources due to import energy saving technologies across countries (Yang et al. 2017). The result reveals the positive relationship of agriculture with water supply, which means that the higher the use of cultivable land the more water resource is required for greater yield (Steduto et al. 2017). There is an indirect relationship between fertilizers and water supply, as the larger use of fertilizers in production raises less need of water demand. Cereal yields are another factor which has a significant relationship with water supply, i.e., it is positively associated with water supply. Cassman (1999) and Condon et al. (2002) largely supported the argument in a given perspective. Final model shows the direct relationship between economic growth and broad money supply, which implies that financial activities would be more regulated and work under sound economic infrastructure, which uplift the economy through sound financial system (Du 2017). The CPI shows a negative relationship with M2, which means that a rise in CPI leads to a decrease of the M2 in the panel of Asian countries because high prices force the consumers to spend less and save more due to the uncertainty in the future. The real interest rate is positively related to broad money supply, as the upward shift in the real interest rate raises the money supply across countries. The detail discussion could be found in Moore (1988) and Friedman and Kuttner (1992) scholarly work for common understanding.

Conclusions and recommendations

The natural disasters have always been the serious concern globally. These disasters are vulnerable in many aspects of economic activities. Economy has to bear huge losses, including physical losses and destruction of the infrastructure. The study used eight broad models to trace out the vulnerabilities done by natural disasters in selected Asian countries. The results reveal that flood, storm, net forest depletion, and country's per capita income largely increase external migration, while improvement in health expenditures inverted the decision of migrants to stay in their places. The impact of storm on changes in price level is quite visible, as natural disasters uplift general price level in the affected economies. Natural disasters led to the increase in poverty incidence in a country, while energy demand and health expenditures supported the poor through providing opportunity to do work with safety hands. The results proclaimed that natural disasters substantially decrease country's per capita income via the channel of energy infrastructure destructions across countries. The government should take the following steps to improve the disaster management process:

- build technically sound emergency management systems to handle the unfortunate situations,
- the Government should enhance the research activities to carry out new scientific methods to overcome the natural vulnerabilities,
- create awareness among the masses to get understanding about the importance of clean environment to stop manmade disasters,
- landslide and flood level areas always remain in danger during the disaster episodes; thus, there is a need of proper planning for reconstruction homes, apartments, businesses, etc., as per safety standards,
- tree planting plays an important role in changing the environment. Government can do this on large-scale within a short time by creating awareness about natural hazards among public that will incline the locals to plant trees for their own benefits,
- those who live in poverty have no safety nets. If they lose their crops due to natural disaster then they get into worse condition after disaster because they have nothing to make their bread and butter. So, the Government should make strong policies to deal with the issue to save precious lives,
- it is the duty of the Government to make strong price mechanism because soon after the natural disaster, the prices rise in the affected localities, and
- after the disaster, there exist high chances of outburst of infectious diseases, which can kill the people, so the team of highly qualified experts must be on standby to cope with the vulnerable situation.

Disaster mitigation strategies are imperative for the prevention of large-scale disasters that need well-coordinated efforts in advancement of technology, training, education, early response time, etc., which we can reduce internal and external migration, stabilize prices, improve energy and water infrastructure, promote financial system, and improve healthcare expenditures.

Funding information This study was financially supported by the Deanship of Scientific Research at King Saud University through research group no. RG-1437-027.

References

Abbott PL (2004) Natural disaster. McGraw Hill. Higher Education, Boston.

Anand S, & Ravallion M (1993) Human development in poor countries: on the role of private incomes and public services. J Econ perspectives, 7(1):133–150.

Awan U, Kraslawski A, Huiskonen J (2018) Governing interfirm relationships for social sustainability: the relationship between governance mechanisms, sustainable collaboration, and cultural intelligence. Sustainability 10(12) Article ID: 4473

Bangalore M, Smith A, Veldkamp T (2016) Exposure to floods, climate change, and poverty in Vietnam. The World Bank, Washington D.C.

Beine M, Parsons C (2015) Climatic factors as determinants of international migration. Scand J Econ 117(2):723–767

Blackburn C (1991) Poverty and health: working with families. Open University Press, Buckingham

Bondonio D, Greenbaum RT (2018) Natural disasters and relief assistance: empirical evidence on the resilience of US counties using dynamic propensity score matching. J Reg Sci 58(3):659–680

Bosello F, Roson R, Tol RS (2006) Economy-wide estimates of the implications of climate change: human health. Ecol Econ 58(3):579–591

Botzen WW, Bouwer LM, Scussolini P, Kuik O, Haasnoot M, Lawrence J, Aerts JC (2019) Integrated disaster risk management and adaptation. In loss and damage from climate change. Springer, Cham, pp 287–315

Boustan LP, Kahn ME, Rhode PW, Yanguas ML (2017) The effect of natural disasters on economic activity in us counties: a century of data (no. w23410). National Bureau of Economic Research, Cambridge

Bui AT, Dungey M, Nguyen CV, Pham TP (2014) The impact of natural disasters on household income, expenditure, poverty and inequality: evidence from Vietnam. Appl Econ 46(15):1751–1766

Carter MR, Little PD, Mogues T, Negatu W (2007) Poverty traps and natural disasters in Ethiopia and Honduras. World Dev 35(5):835–856

Cassman KG (1999) Ecological intensification of cereal production systems: yield potential, soil quality, and precision agriculture. Proc Natl Acad Sci 96(11):5952–5959

Cavallo A, Cavallo E, Rigobon R (2014) Prices and supply disruptions during natural disasters. Rev Income Wealth 60(S2):449–471

Chou J, Xian T, Dong W, Xu Y (2019) Regional temporal and spatial trends in drought and flood disasters in China and assessment of economic losses in recent years. Sustainability 11(1) Article ID: 55

Collier P, Goderis B (2008) Commodity prices, growth, and the natural resource curse: reconciling a conundrum. Online available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1473716. Accessed 24 Nov 2018

Condon AG, Richards RA, Rebetzke GJ, Farquhar GD (2002) Improving intrinsic water-use efficiency and crop yield. Crop Sci 42(1):122–131

Connell J, Zurn P, Stilwell B, Awases M, Braichet JM (2007) Sub-Saharan Africa: beyond the health worker migration crisis? Soc Sci Med 64(9):1876–1891

Drabo A, Mbaye LM (2015) Natural disasters, migration and education: an empirical analysis in developing countries. Environ Dev Econ 20(6):767–796

Du M (2017) Study on the relationship among money supply, and inflation economic growth: base on the statistic data 1990–2015 in China. ISJ Theor Appl Sci 9(53):60–67

Earthquake Engineering Research Institute (2006) The Kashmir earthquake of October 8, 2005: impacts in Pakistan. Online available at: https://reliefweb.int/report/pakistan/kashmir-earthquake-october-8-2005-impacts-pakistan. Accessed 25 Nov 2018

EM-DAT (2017) The international disaster database. Centre for research on the epidemiology of disasters–CRED. Emergency Events Database, Brussels

Flores G, Krishnakumar J, O'donnell O, Van Doorslaer E (2008) Coping with health-care costs: implications for the measurement of catastrophic expenditures and poverty. Health Econ 17(12):1393–1412

Friedman BM, Kuttner KN (1992) Money, income, prices, and interest rates. Am Econ Rev 82(3):472–492

Gerdtham UG, Søgaard J, Andersson F, Jönsson B (1992) An econometric analysis of health care expenditure: a cross-section study of the OECD countries. J Health Econ 11(1):63–84

Gray CL, Mueller V (2012) Natural disasters and population mobility in Bangladesh. Proc Natl Acad Sci 109(16):6000–6005

Haddad EA, Teixeira E (2015) Economic impacts of natural disasters in megacities: the case of floods in São Paulo, Brazil. Habitat Int 45:106–113

Hall RE, Jones CI (2007) The value of life and the rise in health spending. Q J Econ 122(1):39–72

Haque CE (2003) Perspectives of natural disasters in East and South Asia, and the Pacific Island States: socio-economic correlates and needs assessment. Nat Hazards 29(3):465–483

Helderop E, Grubesic TH (2019) Hurricane storm surge in Volusia County, Florida: evidence of a tipping point for infrastructure damage. Disasters 43(1):157–180

Howarth N, Galeotti M, Lanza A, Dubey K (2017) Economic development and energy consumption in the GCC: an international sectoral analysis. Energy Transitions 1(2) article no. 6

Ivers LC, Ryan ET (2006) Infectious diseases of severe weather-related and flood-related natural disasters. Curr Opin Infect Dis 19(5):408–414

Jaber JO, Probert SD (2001) Energy demand, poverty and the urban environment in Jordan. Appl Energy 68(2):119–134

Jamal H (2006) Does inequality matter for poverty reduction? Evidence from Pakistan's poverty trends. The Pakistan development review, pp 439–459

Ji X, Chen B (2017) Assessing the energy-saving effect of urbanization in China based on stochastic impacts by regression on population, affluence and technology (STIRPAT) model. J Clean Prod 163:S306–S314

Kahn ME (2005) The death toll from natural disasters: the role of income, geography, and institutions. Rev Econ Stat 87(2):271–284

Karekezi S (2002) Poverty and energy in Africa—a brief review. Energy Policy 30(11–12):915–919

Keerthiratne S, Tol RS (2018) Impact of natural disasters on income inequality in Sri Lanka. World Dev 105:217–230

Kellenberg DK, Mobarak AM (2008) Does rising income increase or decrease damage risk from natural disasters? J Urban Econ 63(3):788–802

Khemili H, Belloumi M (2018) Social security and fighting poverty in Tunisia. Economies 6(1) article no. 12

Kliot N (2004) Environmentally induced population movements: their complex sources and consequences. A critical review. In: Environmental change and its implications for population migration. Springer, Dordrecht, pp 69–99

Loayza NV, Olaberria E, Rigolini J, Christiaensen L (2012) Natural disasters and growth: going beyond the averages. World Dev 40(7):1317–1336

Lubere J (2016) The impact of migration of people on natural resources in Ruvuma River Valley, in Ruvuma Region (Doctoral dissertation, The Open University of Tanzania)

Mal S, Singh RB, Huggel C, Grover A (2018) Introducing linkages between climate change, extreme events, and disaster risk reduction. In: Climate change, extreme events and disaster risk reduction. Springer, Cham, pp 1–14

Mercene F (2017) 1975—Super typhoon Nina. Online available at: https://www.pressreader.com/philippines/tempo/20170707/281629600299765. Accessed 25 Nov 2018

Mochizuki J, Chang SE (2017) Disasters as opportunity for change: tsunami recovery and energy transition in Japan. Int J Disaster Risk Reduct 21:331–339

Moore BJ (1988) The endogenous money supply. J Post Keynes Econ 10(3):372–385

Nandi A, Mazumdar S, Behrman JR (2018) The effect of natural disaster on fertility, birth spacing, and child sex ratio: evidence from a major earthquake in India. J Popul Econ 31(1):267–293

Ncube M, Anyanwu JC, Hausken K (2014) Inequality, economic growth and poverty in the Middle East and North Africa (MENA). Afr Dev Rev 26(3):435–453

Pachauri S, Spreng D (2004) Energy use and energy access in relation to poverty. Econ Polit Wkly 39(3):271–278

Pedersen PJ, Pytlikova M, Smith N (2008) Selection and network effects—migration flows into OECD countries 1990–2000. Eur Econ Rev 52(7):1160–1186

Phifer JF, Kaniasty KZ, Norris FH (1988) The impact of natural disaster on the health of older adults: a multiwave prospective study. J Health Soc Behav 29(1):65–78

Pielke RA Jr, Rubiera J, Landsea C, Fernández ML, Klein R (2003) Hurricane vulnerability in Latin America and the Caribbean: normalized damage and loss potentials. Nat Hazard Rev 4(3):101–114

Pond B, McPake B (2006) The health migration crisis: the role of four organisation for economic cooperation and development countries. Lancet 367(9520):1448–1455

Rajapaksa D, Islam M, Managi S (2017) Natural capital depletion: the impact of natural disasters on inclusive growth. Econ Disaster Clim Chang 1(3):233–244

Ramsay KW (2011) Revisiting the resource curse: natural disasters, the price of oil, and democracy. Int Organ 65(3):507–529

Reinhart MC, Rogoff MK (2003) FDI to Africa: the role of price stability and currency instability (no. 3–10). International Monetary Fund, Washington D.C.

Rodriguez-Oreggia E, De La Fuente A, De La Torre R, Moreno HA (2013) Natural disasters, human development and poverty at the municipal level in Mexico. J Dev Stud 49(3):442–455

Saldaña-Zorrilla SO, Sandberg K (2009) Impact of climate-related disasters on human migration in Mexico: a spatial model. Clim Chang 96(1):97–118

Saltman RB, Figueras J, World Health Organization (1997) European health care reform: analysis of current strategies. WHO Regional Publications, European Series, No. 72

Sarti S, Terraneo M, Bordogna MT (2017) Poverty and private health expenditures in Italian households during the recent crisis. Health Policy 121(3):307–314

Sayek S (2009) Foreign direct investment and inflation. South Econ J 76(2):419–443

Seraphin H (2019) Natural disaster and destination management: the case of the Caribbean and hurricane Irma. Curr Issue Tour 22(1):21–28

Shabnam N (2014) Natural disasters and economic growth: a review. Int J Disaster Risk Sc 5(2):157–163

Shahzad U (2014) Impact Assessment of Natural Disasters upon Economic Growth in Pakistan. Dissertation, Lahore School of Economics, Lahore, Pakistan.

Skidmore M, Toya H (2002) Do natural disasters promote long-run growth? Econ Inq 40:664–687

Smith SK, McCarty C (1996) Demographic effects of natural disasters: a case study of hurricane Andrew. Demography 33(2):265–275

Steduto P, Hoogeveen J, Winpenny J, Burke J (2017) Coping with water scarcity: an action framework for agriculture and food security. Food and Agriculture Organization of the United Nations, Rome

Taylor JE, Rozelle S, De Brauw A (2003) Migration and incomes in source communities: a new economics of migration perspective from China. Econ Dev Cult Chang 52(1):75–101

The Guardian (2013) Typhoon Haiyan: how does it compare with other tropical cyclones? Online available at: https://www.theguardian.com/news/datablog/2013/nov/08/typhoon-haiyan-philippines-tropical-cyclones. Accessed 25 Nov 2018

Watts N, Adger WN, Agnolucci P, Blackstock J, Byass P, Cai W et al (2015) Health and climate change: policy responses to protect public health. Lancet 386(10006):1861–1914

World Bank (2017) World development indicators. World Bank, Washington D.C

World Health Organization (2008) Climate change and health. Online available at: http://www.who.int/globalchange/A61_R19_en.pdf. Accessed 25 Nov 2018

Wu J, Han G, Zhou H, Li N (2018) Economic development and declining vulnerability to climate-related disasters in China. Environ Res Lett 13(3) article no. 034013

Xie W, Rose A, Li S, He J, Li N, Ali T (2018) Dynamic economic resilience and economic recovery from disasters: a quantitative assessment. Risk Anal 38(6):1306–1318

Yang D (2008) Coping with disaster: the impact of hurricanes on international financial flows, 1970–2002. J Econ Anal Policy 8(1):1–45

Yang Z, Shao S, Yang L, Liu J (2017) Differentiated effects of diversified technological sources on energy-saving technological progress: empirical evidence from China's industrial sectors. Renew Sust Energ Rev 72:1379–1388

Zhou L, Wu X, Xu Z, Fujita H (2018) Emergency decision making for natural disasters: an overview. International Journal of Disaster Risk Reduction 27:567–576