Natural Hazards (2020) 104:143–169
https://doi.org/10.1007/s11069-020-04163-w

ORIGINAL PAPER

Nexus between natural and technical disaster shocks, resource depletion and growth-specific factors: evidence from quantile regression

Waseem Akhter[1] · Khalid Zaman[1] · Abdelmohsen A. Nassani[2] · Muhammad Moinuddin Qazi Abro[2]

Received: 19 November 2019 / Accepted: 4 July 2020 / Published online: 12 July 2020

Abstract
The objective of the study is to examine the impact of natural disasters on environmental resource depletion in a context of Pakistan by using a consistent time series data from 1975 to 2016. The results of quantile regression confirm that both the natural and technical disaster degrade the environment in the form of forest depletion, mineral depletion and energy resource depletion at different quantile distributions. Further, FDI inflows and per capita income deteriorate natural environment through unsustainable mode of production in a country. The results emphasized the need to make an efficient disaster management unit to minimize economic losses through large-scale information and communication technologies. The results conclude that natural resources globally are being consumed faster than the speed of restoration. Worse is the case in Pakistan. As such the Government should make a systematic methodology to identify the protectoral functions within the communities for safeguarding and reestablishing these natural resources.

Keywords Natural disasters · Technical disaster · Natural resource depletion · GDP per capita · FDI inflows · Trade openness · Quantile regression · Pakistan

1 Introduction

Social sustainability is the paramount concern for achieving the environmental sustainability that largely discussed in the environmental literatures (Awan et al. 2018), while sustainable development goals greatly influenced with high risk of natural disasters that negatively affect the growth of natural capital component (Siwedza and Shava 2020; Fang

✉ Khalid Zaman
Khalid_zaman786@yahoo.com

Abdelmohsen A. Nassani
Nassani@ksu.edu.sa

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

[2] Department of Management, College of Business Administration, King Saud University, P.O. Box 71115, Riyadh 11587, Saudi Arabia

et al. 2019). The technological innovation and energy efficiency would play a main role in order to reduce carbon abatement cost and improving economic structure that is helpful to minimize disaster shocks across countries (Zhang et al. 2019). Industrial ecology is another important aspect of sustainable development that confined its importance in between human system and ecosystem to attain mutual exclusive future gains of green development (Awan 2020). Natural disasters can bring some drastic environmental changes directly affecting natural resources. Floods, hurricanes, earthquakes and volcanic eruptions are all natural hazards, but they become natural disasters when a large part of the community is directly affected. It destroys homes and lives on a larger scale. People living in poor conditions are more vulnerable to these natural disasters because their resources are scarce to rebuild their lives and get sustenance again (Blaikie et al. 2004). These natural disasters have a very old history, perhaps 4.6 billion years ago they started to hit planet earth. It is said that extinction of dinosaurs was also the result of one or the other natural disaster, some 65 million of years ago. There were mass forest fires, sun light blocked and level of carbon dioxide in the atmosphere also rose considerably. Hence, looking at the previous history of natural disasters we know what to expect next, in future (Ward 2006).

According to the statistics based on global effects and implications, i.e., 11% population in developing countries is exposed to these natural hazards and 53% are casualties (Peduzzi et al. 2002). But on the other hand, the developed countries are exposed to 15% of these hazards, and the number of causalities is only 1.8%. The rigorousness of the natural disaster is measured by loss of lives, properties and natural resources. The disaster on unpopulated area is not measured as natural disaster. This will be accounted for the degradation of properties and natural resources. Natural disasters can be meteorological and geological. In meteorological disaster, there are hurricanes and floods, while in geological disaster, earthquake and landslides occur. These can occur as quickly as in seconds, but sometimes it takes days, weeks, months or even years (Gallina et al. 2016).

The impact of natural disasters on natural resources is very destructive, even incur huge cost in the long- and short-run. Developing countries are, especially, having huge problems, as economic growth of that particular economy can be distorted through by natural disaster (Cavallo and Noy 2009). The world has very unsatisfying accounts about the impacts of natural disaster on natural resources. Natural disasters are sure regarded as a major impediment to full utilization of global resources, and their impacts on natural resources are very menacing. The United Nations General Assembly has paid stress upon the impact of natural disaster, largely affecting human population. By natural disaster, not only the poor are mostly touched in the short-run, and their households are affected in the long-run, but also affecting the economy on a bigger scale. The world has faced severe threats of epidemics that created hurdles to reach the natural assets (Grossman and Krueger 1995).

Natural disasters occur naturally, and manmade disasters occur when economy interrupts the natural resources. Indonesia is one such example, which contains some huge volcanic eruptions in the world. In Indonesia, 129 volcanoes erupted recently and the huge number of peoples was affected (Marfai et al. 2008). Natural disasters like earthquakes, volcanoes, tsunamis, hurricanes and floods are having major impact on natural resources of an economy. At the time Hugo arrived in the USA, it brought landfall with it, its wind speed recorded was approximately 138 miles per hour, which instantly destroyed houses and standing crops. Only in the USA in 1989, the death toll due to Hugo rose up to 21%. At the time of storm, sea level rises above 10.4 ft, it produces serious flooding, and the death ratio goes up with the storm (Freedy et al. 1992). Another cause of the deaths due to earthquakes, storm, hurricanes and high temperature is that quite a lot of people are burnt-to-death in developing countries. Inter-governmental panel on climate change reports that

65% of world deaths are between 1985 and 1999 due to natural disasters (Kahn 2005). Earthquakes destroy or damage the electric power system of the particular countries. Severe earthquakes in Haiti, Indonesia, Chile, China, Japan, Italy, the Philippines, Mexico, the USA and Turkey caused wide scale destruction of the infrastructure of the power supply, in addition to damages to properties and losses of lives. However, earthquakes are not only the reason to destroy or damage the power system but also cause tsunami, typhoons, hurricanes, tornados, landslides, ice storms, volcanic eruption and floods. These types of natural disasters damage the structure of electricity and cause a blow to economic development of the particulars countries (Rudnick 2011).

Over the last 2 decades, millions of the people have been affected by natural disasters, at least 1 billion people's lives disturbed. These outcomes are enough for the economic damages example, and developing countries may have lack of resources, healthcare issues, low infrastructure and an inadequate disaster management system that affect questionably their economies. Due to the natural disasters, the death ratio increases; rapid onset disasters cause crush injuries or suffocating. There are occasions of transmittable infections as aftereffects of disaster events (Watson et al. 2007). In Southeast Asia, Philippines was at the top of the list to be hit by the natural disasters, floods, epidemics and typhoons. In that particular area, maximum people were affected through natural disaster with having negative economic and environmental impacts. Moreover, due to natural disaster not only people are exposed to epidemics, but also agriculture and natural resources are heavily affected. Most of the developing countries do not have disaster management system to alarm them in time, as consequences agriculture and natural resources are destroyed considerably. Philippines economy is largely depending on agriculture sector, and these typhoons and droughts highly affected on that particular sector (Israel and Briones 2012).

In past few years, the world has faced serious damages of the social construction and economic development due to the frequent occurrence of the natural disasters. For example, tsunami in Indonesia in 2004, freezing rain disaster in southern China in 2008, "5.12" Wenchuan earthquake in 2008, heavy floods in India in 2013, hail disaster in Yancheng in 2016 and devastating 2011 earthquake in Japan wrecked the economic condition and also destroyed the ecosystem of the countries. In July 2016, heavy rain in the north of China and at the same time severe floods in southern China heavily demolished the locales. These natural disasters are also a natural process directly related to the ecosystem and a cause of loss of the stability of the social–economic system and loss to the balance of demand and supply of the social resources (Zhou et al. 2018). Recent drought in the USA gives an extended picture of losses and long-lasting susceptibility to wide scale damages. In between 1996 and 1998, the Southern and Southwestern Great Plains experienced spectacular impacts on water supply, tourism, wildfires, agriculture and recreation and transportation. The losses due to droughts in Texas in between 1996 and 1998 have been estimated at US$6 billion and US$5.8 respectively. In Oklahoma in 1998, the agricultural losses were estimated more than US$2 billion. Florida, Georgia, Louisiana and South Carolina were also affected and bore heavy losses (Wilhite 2000). In between 1970s and 1980s, twenty-five countries suffered the greatest number of disasters, and on the other side, more than 12 small islands in developing states (SIDS) were affected by natural disaster (Pelling and Uitto 2001).

The main threat to the society is to have the loss of sustainable economic development due to natural disasters. Agriculture is the most affected sector in the world due to continuous occurrences of natural disaster. Mainly, it decreases the level of optimum production from agriculture sector and hence the decrease in revenue. The farm infrastructure (i.e., irrigation systems, equipment and machinery installations and storage buildings) also come

under the direct hit, with the ruin of environment. Natural resources are being depleted or being destroyed, and it is major reason for change of natural environment. The effects on the natural environment can be destructive, destruction of lands, buildings and houses. There are huge losses of water supplies, food unavailability and destruction of crops. The climate change varies from disaster to disaster, such as earthquake destroys buildings but not crops, and on the other hand a violent wind like cyclone may destroy crops and infrastructure. The climate change and environmental changes are causes of disaster (Kapur 2016).

A country comprised of a nation should build and design systems and implement protective measures to trim down the effects of natural disasters in those particular areas where these activities are sure to happen (Toya and Skidmore 2007). Besides, a country has to incur basic costs of natural disasters in terms of mortality, infrastructure damages and numbers of people displaced. These costs may have the huge effect on economic output and growth. The short- and long-run impacts of natural disasters on economic growth cause to lower the economic condition of the particular country. Different disasters may have different impacts on society, but floods are the most lethal for the economy. The hydrological disaster in 2010 caused approximately $46.9 billion damage to the world economies. However, in 2010 floods killed 8,100 people, and 179 million people were displaced. In addition to the climate change, the domino effect of the floods is: damage of lives, infrastructure and agriculture production. Second, the climate change may have huge and susceptible effects on natural resources and economic output as well (Cunado and Ferreira 2014).

In the coming decades, the climate change has the most challenges that economy has to face. To some extent, climate change bringing natural disaster is the result of human activities. These activities seem to change the natural process of adaptation, and current and future process become irreversible. In the next few decades, the climate change will have more impacts on natural resources like agriculture and food system. Due to the massive CO_2 emissions, the temperatures will be changed, defined forecast of climate change. The climate change can also be through the activities of humankind and livelihoods of even small landholders. The natural disaster and climate change not only destroy water resources and fresh water reserves, but also it impacts on agriculture and livestock. The people who are living in that area where the impacts of natural disaster are very high, they are exposed to susceptible threats. The natural disasters are also affecting the lives of people living in tropical and subtropical areas. Due to the natural disaster, the people who live near the islands are having major threats to their lives, food and livestock (Rehman et al. 2017).

The physical, social and economic well-being of economy is exposed to the major threats from natural disasters. The threats to the economy are huge or at low level as per the disaster intensity. In 2005, the hurricane Katrina killed 2000 of individuals and caused approximately US$96 billion of loss, and as per rough estimation 300,000 homes were destroyed (Townsend 2006). At the international level, in December 2004, the earthquake, converted into the tsunami, affected African and Asian countries resulting in 200,000 causalities and approximately 600,000 homes were wrecked. Similarly, in October 2012, the Hurricane Sandy destroyed the East Coast destroyed approximately 650,000 homes and killed about 147 individuals (Tyler 2016). In 2008, the climate change such as floods, droughts and hurricanes was the most extreme events which caused destruction of the industrialization and development of the economies. The extreme climate change is giving a common message since the beginning of the twenty-first century that floods, hurricanes and droughts are not rare. In the USA, the financial crises originated transformed the economy into the global recession, and one reason can be the which caused to worsen the economic condition of the USA. With the unlikely recession, the climate change may

be irremediable and that is the main reason which caused the economic losses. The USA faced both financial and environmental crises at the time of recession and climate change. Both financial and environmental crises lower the economic output and hinder the development of the economy (Doytch and Uctum 2016).

According to the Global World survey, the frequencies of natural disasters tripled from the 1960s to the 1980s that caused huge economic damages. From 1990 to 1996, the economic damages were reached at US$400 billion. In the year 1992 and 1996, the losses related to the natural disasters in the USA were approximately US$54.2 billion per week (Carolwicz 1996). The losses due to the natural disaster to the economic, social and environmental resources are dramatically increasing. In 1975, droughts damaged the crops by the annual average of US$700 billion in the Great Plains region of the USA. In 1995, according to the US Federal Emergency Management Agency (FEMA) the estimated yearly based losses related to the drought were US$6–8 billion. More precisely, the recent droughts in the USA show the clear picture of the losses from the drought which shows our long-lasting vulnerability. In 1996 and 1998, the Southwest and Southern Great Plain of the USA were severely affected by natural disaster and its effects on agriculture, wildfires, water supply, tourism and transportation and recreation were evident. In Texas, in 1996 and 1998, the impacts of droughts damaged the infrastructure roughly estimated to be US$6 billion and US$5.8 billion (Chenault and Parsons 1998). Oklahoma drought in 1998 had resulted in the losses of above US$2 billion in agriculture sector only. The development process was slowed down due to the natural disaster, and it had impact on economic, environment, social and natural resources. Droughts may be due to urbanization, population growth and regional migration to more drought-prone areas. The climate change and natural disaster have the potential impact on natural resources which are being prevailed on, through the severity of these disasters. According to the National Drought Mitigation Centre, 48 neighboring states of the USA verified that extreme level of droughts influenced more than 25% of the country in the last 27 years (Wilhite 2000).

Around 232 million people are affected due to natural disaster the world over, over 100,000 people killed, and cause approx. US$ 100 billion damage every year from 2001 to 2010. Guha-Sapir et al. (2007) observe that people in low-income developing countries are twelve times more expected to die by natural catastrophes, similarly more suffer serious economic costs by disasters. Despite the fact that these developing countries do not differ from developed countries in terms of geographic or environmental behaviors, they also suffer the same number of disasters every year. Furthermore, the frequency of natural disasters documented each year has increased noticeably since 1940 (Munang et al. 2013). Factors such as population explosion and infrastructure expansion in risky areas have amplified the risk of loss and damage from natural catastrophe (IPCC 2012). Since 1989, the USA has suffered approximately 40 billion USD in damages because of hurricanes hitting its mainland. There were hundreds of causalities, and millions were devastated homeless. These devastated people suffered psychologically as well. They suffered from the diseases such as anxiety, port-traumatic stress, depression, alcohol, violent attitudes and family (Green 1994; Rubonis and Bickman 1991).

The disaster in Uttarakhand State in 2013 could be a wake-up call for development policy planners. It is prerequisite that they should look at the ecological sensitivity of the area before planning any project for development. Foresters can plan a very important role, as well as the ecologists. In 1970s and 1980s, droughts/famines were the direst killers in India, and the situation stands different today. It is possible because of a combination of factors like resources management has improved as well as food security methods that have greatly bring down the deaths rates because of droughts/

famines. High winds, earthquakes and floods dominate the reported grievances, with increase in numbers during the last 10 years. From 1973 to 2001, there occur a great number of earthquakes in Asia that have a brought the ratio of death much higher. Floods, cyclones, droughts, earthquakes, avalanches and landslides are some incidences of major natural catastrophes that recurrently and ever more affect Asia (Lee et al. 2007).

Participation of community has been discussed here as one of the significant strategies for the sustainable development plan. For two reasons, it is the most important factor, i.e., (1) for environment management and protection, the community-based initiative combines indigenous knowledge about ecology and traditional policies about environment management, with scientific techniques, modes and methods (Aswani and Hamilton 2004), and (2) the efficient community-driven participation identifies most agroecological issues located at a local community level (Reed 2008). No doubt, natural catastrophes directly cast impact upon economy, food supply and security, agriculture, environment, health and sanitation every year. Henceforth, it has been one of the largest main concerns of the developing countries, like Pakistan. Over the years, different natural disasters have caused enough physical damage to agriculture and infrastructure. There are losses to crops and livestock due to severe drought in Thur region. Floods in some areas and cyclones cause extensive damage to the infrastructure and leave a heavy cost to bear by the authorities. Not only are the physical costs, but also the most hideous aspect of these natural disasters the number of casualties. A huge number of deaths are another aspect to look into, as people are left psychologically benefit as well.

On the basis of significant debate and analyzed essential facts, the present study has following objectives, i.e.,

1. To examine the impact of natural disasters on environmental resources at 25% quantile, 50% quantile and 75% quantile distribution.
2. To what extent FDI inflows and trade openness deteriorate natural capital resources in a country.
3. To investigate the possible impacts of high population growth on natural resource depletion in a country, and
4. To analyze the impact of county's economic growth on natural resource conservation program.

Following the research objectives, the study has a number of proposed research questions, i.e.,

1. Does natural disaster influence United Nation's sustainability agenda in the form of natural resource depletion in a country?
2. Does financial and trade labialization policies harmful for natural environment? and
3. Whether high mass population is a hurdle against the natural resource conservation program in a country.

These questions required substantial investigation in a given country context to assess sustainable development agenda.

2 Literature review

The previous studies have largely discussed the vulnerability to natural disaster in different economic settings, while by taking a case study of Pakistan; very few studies are directly linked with the natural resource depletion, which is being considered in this study for conclusive findings. Israel and Briones (2012) surveyed both the qualitative and quantitative impacts of natural disaster on agriculture and environmental resources in Philippines. The study shows that, at the national level, the floods and droughts have impacts on natural resources and agriculture production, while at the provincial level, the typhoons have negative impact on natural resources. The study analyzes the negative impact of natural disaster on agriculture resources, foods and environment, as these typhoons, floods and droughts destroy the crops and agro-product. The study also examined the household consumption and non-consumption behavior to manage the impact of natural disaster on agriculture production, and it is found that natural disasters negatively impact on natural resources, food security and environment. The result of the study shows that there were 171 typhoons from 2001 to 2010, which led to serious impact on food challenges of the country.

Kahn (2005) analyzed the relationship between natural disasters and its possible mitigation process among poorer and richer countries as compared to the developed countries. Poor nations are more drastically affected by natural disasters. The results show that poorer nations do suffer more death from natural disasters as compared to richer nations. The developed institutions prevent natural disasters and overcome crisis faster with planned systems. The frequency of natural disasters increases by the climate change such as floods, and hurricanes are resulted by the climate warming. Many of the disasters such as earthquakes, floods, epidemics, landslides and windstorms may put significant effect on natural resources. These types of natural disasters impose significant impact on death counts as well. From 1990 to 2000, 4300 disasters took place globally and killed 8,15,077 people and destroyed unlimited number of houses. Rehman et al. (2017) analyzed the impact of climate change on agriculture, food security and rural livelihoods across countries globally. The study shows that the climate change imposes a significant impact on livelihoods of billions of poor peoples in the World. Climate change imposes the vulnerable effects on agriculture production due to the high dependency of agriculture on climate change. Due to the sustainability in climate, the agriculture sector of Asia is facing many problems. This study collected sample data of 280 Farmers from Rajanpur district of Pakistan and analyzed the impact of climate change on livelihoods of these farmers. All of the respondents agreed that climate change puts negative impacts on agriculture production. On the other hand, the respondents reported that climate change on sowing and food security by pesticide application affected negatively. The respondents further reported that climate change passively puts great effect on annual income and lives of peoples of that area. Kapur (2016) concluded that natural disasters and environmental issues are not only the main concern of India, but also they affect countries globally. The study shows that natural disaster has significant impact upon natural resources resulting depletion. In India, the natural disasters affect natural resources and cause environmental dilapidation. The results show that population explosion negatively impacts on environment and natural resources. The result of study rectifies the issues to make them accounted and measured for the preservation and nourishment of the natural resources and the environment ultimately.

Toya and Skidmore (2007) reasoned that natural disasters affected country's development to a larger scale and it leads to the human and economic losses in the long-run. The study found that economies having high economic development, high-income and high

growth rate, have less rate of losses from natural disaster. Income is not only the unit which is used to measure the development of the country, but there is higher education, greater openness, strong financial system and government, considered helpful measures of development. Moreover, the natural disaster casualties are also reduced by the economic development of the country. The study also shows some measures taken in the long-run for disaster reduction by improving and increasing the education systems, openness and improving the financial institution in the economy. The results of the study show that natural disasters have direct negative impacts on education, financial institutions, economic development and lives of peoples. Skidmore and Toya (2002) disclosed the relationship between disaster, capital accumulation, total factor productivity and economic growth across countries globally. The higher rates of climate change and disasters are associated with high rate of economic growth, high rate of factor productivity and human capital accumulation. Natural disaster impact in future will increase the total factor productivity by improving new technologies and techniques and increasing the economic growth. Natural disasters are reduced at the expected rate of return on human capital accumulation, but relative rate of return increases on human capital. Through the natural disaster, the physical capital investment falls but human capital investment increases. Natural disasters also give opportunities to improve the total factor productivity by introducing or adopting new technologies and new techniques. Total factor productivity also affects economic growth through climate changes. Sodhi (2016) resolved that population vulnerability increases the hazards shoring up and impacts on country's production and economic growth. Natural disaster impacts on population vulnerability of the country and then on creating a reinforcing loop. This study shows that natural disaster impacts on worldwide growth on the period of disaster event after stabilizing the global income and global population. The most important part of this study is to improve prevention of disaster and rebuild the economy. According to the results of the study, there were 240 disasters in 2014 in the world and each of the disasters affected 5.57 people out of 100,000. The result of the study illustrates to rethink about disaster management and to develop new technologies to reduce this vicious cycle.

Watson et al. (2007) claimed that natural disaster and communicable diseases are frequently misinterpreted. The risk factor is highlighted, and it is associated with dead bodies and epidemics after natural disasters. The risk factor for outbreak is also related to health and safety of the affected people with their displacement problems. The unavailability of safe water and sanitation facilities is more important factors which are associated with affected population which in turn lead to communicable diseases and increase the death ratio. This study indicates to establish the course of action for communicable diseases after the natural disasters, minimizing outbreak the risk factors. The results of the study are related to reducing the risk factor for outbreak in the affected population and also priorities set for communicable diseases by curing and providing the shelter, safe water, sanitation system and more importantly to facilitate with medical services. Gallina et al. (2016) studied the effect of natural disaster (storm, floods and droughts) in a defined timeframe (e.g., year, season and decade). The major research work efforts were focused on the combination of multiple hazard types by the way of quantitative and semiquantitative approaches. Some of the methodologies interact with multiple objectives to specific natural disasters by local and regional means of indicators and vulnerability functions. The study presents the multiple-risk assessment concepts and tools for achieving development and reducing high level of losses from natural disaster. The overall results of the study show that climate change does not affect on multiple-risk approach and no change on visible elements by the approach of static vulnerability. The study is inexact to develop comprehensive approaches to reduce the natural disaster, epidemics and vulnerability, which required

selection and combination of appropriate hazards and vulnerability to make sure about the climate change impact on natural resources. To focus on the climate change, the multiple-risk assessment approach is very highly correlated with vulnerability of multiple targets. Pelling and Uitto (2001) indicated that Small Island Developing States (SIDS) faced many natural disasters and they bring massive impacts on human vulnerability. Due to the insularity, environmental factors, economic and demographic structure and small size, the SIDS are getting vulnerable. In the global level, the natural disasters can open new opportunities, but on the other hand there are restrictions on building of indigenous flexibility. Country's economic and political systems build the country to be placed at the global level. United Nations is the global actor which analyzed the vulnerability in island states and reviewed the impact of UN for the reduction in natural disasters. The study concluded that SIDS are to have critical time due to the global change and that change must be resisted by the SIDS, by making more struggle for development and economic liberalization. Their environmental dilapidation is threatening their economic and physical security.

Nel and Righarts (2008) found that natural disasters are a risk factor for violent civil conflict. The study uses the 187 political units for sample data from the period of 1950 to 2000 and explored that natural disasters impose the effect on low- and middle-income countries that have the high level of inequality, low level of economic growth and mixed political regimes. The natural disasters such as earthquake, tsunami, hurricane, flood and epidemics increase the risk factor for violent civil conflict in a society. Rapid and continuous arrival of natural disasters is found to be minor to major conflict, and some of the disasters related to the climate change pose a huge level of risk factor. Rapid climate change increases a huge level of frequency of natural disasters, and it shows different dynamics to compare minor to major violent civil conflicts, but in both the cases natural disasters are significant for the increased level of the risk of violent civil conflict. The study suggested that social and political risks must be put in line with these types of catastrophic events. The results show that continuous outset of natural disaster increases vicious civil conflict of risk in long term. Masozera et al. (2007) observed the effect of natural disasters on vulnerability in field of Hurricane Katrina. The study examined the impact of Hurricane Katrina on the neighborhoods in New Orleans and their social, physical and economic vulnerabilities. To analyze the household income, housing values and food level, they used the Geographic Information System (GIS) technology. At the next step of the study, it analyzes the response of particular social and political groups in the society which were more vulnerable during the period of recovery. The study found that Hurricane Katrina were imposed severe negative impacts upon food of New Orleans neighborhoods, as per income level and social–economic factors. The findings of the study suggested to impose the preexisting socioeconomic conditions which can be effected to different economic classes, so that response is made quickly on the disaster conditions and to control the effect of Hurricane Katrina in effect. Iwata et al. (2014) scrutinized that natural disasters worsen the country's income. The study used the panel countries from 1975 to 2014 and showed two types of disaster mitigation policies. The study results show that public mitigation has positively less total damage from natural disaster as compared to private mitigation. The estimation of the study shows that rural zone is more operative than urban prefecture on the basis of large and frequent disasters. The results further show that natural disaster destroyed urban prefecture is more; however, the policymakers are advised to improve the overall country's investment and improve infrastructure of mitigation to control high level of disaster indemnities.

Klomp and Hoogezand (2018) observed that natural disasters impact negatively on the agriculture production. The study conducted survey of 76 countries, thereby connected

to the trade of 70 commodities of agricultural products. The study recounts to bargain between agricultural protection and availability of the food on the large scale of society. The findings suggest that natural disasters mostly raise the control of agricultural trade in the hands of domestic farmers. After the natural disaster, the limited imports create trade barriers. In high-income countries, floods and storms led to increased agricultural protection, while at the time of extreme droughts the trade barriers in most of the LDCs are reduced due to the drop of food scarcity. The result of the study shows that natural disaster was significantly having positive effect on agriculture protection in a short-run. Thus, it is desirable to provide more intention on the agriculture protection than to providing the food to whole society. Klomp (2016) used the data from the night time satellite images to show more intensity of manmade and natural disaster in a particular country having high income per capita. The finding of the study shows that, in the short-run the natural disaster reduces the light intensity of those specific countries, while the results are different in the long-run. Adeagbo et al. (2016) examine the relationship between natural disaster and household losses. The study shows that the natural disaster imposes negative impact on households' well-being. Natural disaster affects sanitation system, electricity and water supply. The study conducted the survey from rural and urban society. The report of the respondents shows that they suffered more damages, spent a big proportion of income on repairs. The gender-based survey report shows that women were more affected by sanitation facility and disruption of water system and their health and education status also affected, while on the other hand, men were also more affected by low residence facility and reduction in their income level, disruption of water, electricity and sanitation system. The displacement trouble was also faced due to the natural disaster effects.

Ojha et al. (2018) study the relationship between climate change and natural resource depletion in Indian district. The study shows that natural disasters or climatic change are the major threats to the global economy. Through the climatic change, the health and agricultural productivity are affected. The study enforces adaptation measures to reduce the climatic effect by using the geospatial technology. For the planning system, the suggested adaptation measures will help control the socioeconomic environment and development of natural resources. Human interventions and climatic change can ruin both of the major natural resources, i.e., land and water. The study results suggested that the geospatial technology is useful for site-suitability analysis of land and for water management planning for the socioeconomic development. Cunado and Ferreira (2014) showed that natural disaster has a positive impact on economic growth across countries. After the flood, the productivity of the land increases and that is beneficial for the agricultural production. Developing and developed countries lend support to this argument due to having different dynamic paths in their particular countries. There is increase in agricultural growth in a year when the natural disaster like flood is larger and more intensive in a developing country typically dependent on more traditional and less severe forms of agriculture, although developing countries have no experience of the positive impact of floods on overall growth and agricultural sectors. According to Kaya (2001), mineral resource crises are faced by human beings the world over. Fastest growing population is consuming limited supply of minerals available on earth. The situation is worse as the mineral consumption is faster than the growth of population. Though the community needs more mineral, we cannot ignore the fact that the more usage will pollute the planet earth with very little sources to produce. These negative effects were found in sporadic places, but now it is the concern of the people all around the world. Unfortunately, this heavy mineral consumption is causing acid rains, and more so the destruction of ozone layer. Main concern now is that earth has touched its limits in the supply of minerals. The locales throughout the world cannot ignore this impeding threat to

the lives of the people. They must stop polluting and exploiting the limited leftover reserves of minerals on this planet for safe survival. In the USA alone, the environmental impact of natural resources exploitation is calculated by Environmental Protection Agency (EPA). Data for atmospheric pollution collected recently in the USA show that mineral production of Pb is 30%, PM 25%, SO 18%, of 490 Volatile Organic Compounds it is 13%, CO 3%, and NO emissions is 2%. From all of these, three major pollutants are from: (1) mining, a major PM source, (2) smelting, major SO source, and (3) crude oil/natural gas, major NO source. Nevertheless, the level of emission generation by the mineral resources has significantly dropped during the last decades, in the USA (EPA 1991). Between 1976 and 2000, total land owned by mining globally was about 37,000 km^2 or 0.2% of the total earth's surface. For excavation, about 60% of the disturbed areas are used, while the remaining part, i.e., 40%, is used for disposal of wastes. Some modern materials are also causing relief like plastic, polymer, ceramics and other composites. These indestructible materials are used in place of conventional minerals. The recycling of materials like glass, metals, plastics and industrial minerals will also decrease some environmental issues. Hence, the miners have repercussions to exploit the minerals, but in environmentally friendly manner as the globalized concerns about environment pose some serious ethical problems. Miners, today, are very well aware that planet earth is at the brink of its limit regarding mineral pollution.

Okuyama and Inaba (2017) surveyed that other than multi-faceted losses and damages, natural disaster have potential to ultimately change the conditions of social capital resources, by putting an effect upon people's attitudes and their perceptions. In their study, they challenged the empirical inquiries to sort out this issue by looking deep on social engagements in the post-disaster time period when Great East Japan Earthquake happened in March 2011. Two topics of research were focused upon, i.e., (1) the influence natural disasters have on social engagements and that impact of social engagements upon post-disaster subjective-well-being. Most important findings are day-to-day interactions of neighbors and friends, and (2) friendly acquaintances are not so much among those who were less affected than those who suffered more in the disastrous event. The first term of analysis shows that daily communications of those who suffered less in the disaster were very fewer. But those who were affected with quite a big loss in the disaster were quite near to each other in sharing their loss, grief and mutual experiences. The second term of analysis revealed some astounding facts that interactions of neighbors, their friends and other acquaintances having experienced the disaster relate positively to subjective-well-being showing life-satisfaction, they are those people who have been affected by disaster having quite a financial impact too. These social engagements were worth of approximately 119,700 to 258,400 JPY in Monetary Value. Neumayer and Plümper (2007) observed that people are not affected equally by natural disasters. Rather, according to the vulnerability approach toward disaster exposure inequalities, risk sensitivity, resources access inequalities, opportunities and capabilities methodically disadvantage some people, making them all the more vulnerable to the ultimate impacts of catastrophes. In this study, gender vulnerability is analyzed, specifically, the vulnerability of female gender with respect to mortality rate. Further explanation is provided by looking into the social norms and behaviors. A sample of 141 countries was taken from the period from 1981 to 2002, and it was observed then that the effects of the disasters kill more women than men. Moreover, the stronger the disaster, the stronger the effect on women of weaker financial conditions. The higher the socioeconomic status of women, the less they suffer. The results show that relatively high female mortality rate due to disaster is induced by socially built gender-specific vulnerability of women in everyday social life. Gaillard et al. (2007) surveyed that four Tropical Depressions and Typhoons hit Easter Coast of Luzon, Philippines, in between November

14 and December 4, 2004. Due to heavy rains, there were huge landslides and roaring flash of floods. The estimated causalities during this time were more than 1600. Soon after the disaster, the authorities agreed that activities toward natural phenomenon and deforestation on wider scale triggered such disasters. The disaster hit areas of Philippines like Nakar, Infanta, and Real had some other factors to be considered than demographic, political or socioeconomic in nature. One of them could be overload of population, and there is no or less access to lands, and resources, corrupt government institutions and elites in power.

Brown et al. (2006) showed in a study that natural disasters, e.g., hurricanes, earthquakes and tsunamis, destroy and damage the sea, land, forests and other resources held important for the livelihoods of the people. The titleholders are killed, demarcations are erased, and documentations are destroyed too. After these disasters, the compensation is never adequate, and the refugees would put immeasurable pressure over the limited leftover resources. The poor and marginalized societies can better survive and get quick recovery where the rights for the resources are clearly chalked out, verifiable and equitable. Resource rights are important in the sense that they demarcate how individuals or the communities should use certain resources and form options for livelihood available to most of the people. These allocated resources can adopt the shape of common, open and state/private property, and here includes all the ownerships of the land, rights for fishing, grazing rights, etc. For the poor community, the control and access of these resources are vital determining factors of their vulnerability, as well as resilience to further natural disasters. Before these natural disasters, the resilience of individuals and groups can be made strong by defining their resource rights. Access and control to such resources put influence upon spatial planning in those areas which are vulnerable to natural disasters, there would be investments in resilience, and it will help to decrease the environment degradation which increases vulnerability. After the disaster, a lot of issues rise about the relocation of affected communities, the infrastructure reconstruction, reimbursement of rights and the restoration of sources of revenue. First of all, the relocation of the affected people is the most important factor to consider, as huge movement from the place of disaster to the safer areas can provoke high environmental degradation. Lindell and Prater (2003) studied that earlier researches are made on the impacts of natural disaster upon community, there will be different types of results, but no coherent model of the process could be evolved by which disaster agent characteristics producing physical and social impacts could be measured. Suda (2000) examined the lack of setup for preparedness of disaster in Kenya. It has been still an enduring challenge for the country. Between in 1997 and 1998, El Nino flooded most of the parts the country. Then, there was a longer period of drought in the year 2000. Both of these disasters saw huge displacement of communities, lives were lost, property destroyed, there was energy and water crises, and important infrastructure collapsed. The disaster response of the country was ad hoc, and there were short-term uncoordinated measures in the form of emergency services provided to the most affected areas. However, environmental and disaster management should have integrated the disaster preparedness course of actions and recovery measures into a full development program for better sustainability. The vision of this sustainable development plan is to get long-term well-being for everyone. Lack of disaster preparedness plan and environmental degradation increase the vulnerability to the disasters and also affect the well-being of present and coming generations. The study also attempts to describe the issues related to disaster developments. It also illustrates that effective disaster management strategies require a change of focus from just relief provision to other long-term multi-sectoral approaches which would materialize the existing short-term development plans into a disaster preparedness management system. The study also discusses the participation of the community as one integral

strategy in sustainable development plan. Table 1 shows the recent literature on natural disaster and resource depletion across countries.

The above study confirmed that natural disaster is associated with climate change that largely degrades natural environment in the form of environmental and resource depletion. On the basis of given discussion, the study formulated the following research hypotheses, i.e.,

H1: It is likelihood that natural and technical disasters degrade natural resource depletion in the form of forest resource depletion, mineral depletion and energy resource depletion.
H2: The positive relationship is expected between financial and trade liberalization policies and resource depletion, and
H3: There will be a negative relationship between population growth and environmental resource depletion in a country.

The present study examined the stated relationship in the context of Pakistan, as the country is affected with many natural disasters historically; hence, it is good motivation to analyze the disaster—resource nexus for long-term sustainable policy in a given country.

3 Data and methodology

The time series data are taken from 1975 to 2016. The data of the variables are taken from EM-DAT (2017) and World Bank (2017). Table 2 shows the list of variables and its measurement.

The study followed the framework of Rajapaksa et al. (2017) and estimated the following empirical equations, i.e.,

$$\begin{aligned}\text{Ln(NRDEP)} = {} & \beta_o + \beta_1 \ln(\text{ND}) + \beta_2 \ln(\text{TD}) + \beta_3 \ln(\text{FDI}) \\ & + \beta_4 \ln(\text{GDPPC}) + \beta_5 \ln(\text{PG}) + \beta_6 \ln(\text{TOP}) + \varepsilon\end{aligned} \tag{1}$$

$$\begin{aligned}\text{Ln(FDEP)} = {} & \beta_o + \beta_1 \ln(\text{ND}) + \beta_2 \ln(\text{TD}) + \beta_3 \ln(\text{FDI}) \\ & + \beta_4 \ln(\text{GDPPC}) + \beta_5 \ln(\text{PG}) + \beta_6 \ln(\text{TOP}) + \varepsilon\end{aligned} \tag{2}$$

$$\begin{aligned}\text{Ln(MDEP)} = {} & \beta_o + \beta_1 \ln(\text{ND}) + \beta_2 \ln(\text{TD}) + \beta_3 \ln(\text{FDI}) \\ & + \beta_4 \ln(\text{GDPPC}) + \beta_5 \ln(\text{PG}) + \beta_6 \ln(\text{TOP}) + \varepsilon\end{aligned} \tag{3}$$

$$\begin{aligned}\text{Ln(EDEP)} = {} & \beta_o + \beta_1 \ln(\text{ND}) + \beta_2 \ln(\text{TD}) + \beta_3 \ln(\text{FDI}) \\ & + \beta_4 \ln(\text{GDPPC}) + \beta_5 \ln(\text{PG}) + \beta_6 \ln(\text{TOP}) + \varepsilon\end{aligned} \tag{4}$$

where ND shows natural disaster, TD shows technical disaster, FDEP shows forest depletion, MDEP shows mineral depletion, EDEP shows energy depletion, NRDEP shows natural resources depletion, GDPPC shows gross domestic product per capita, TOP shows trade openness and FDI shows foreign direct investment inflows, PG shows population growth and ln shows natural log.

Figure 1 shows the research framework of the study for ready reference.

Table 1 Recent literature on natural disaster and resource depletion

Authors	Country	Results
Rajapaksa et al. (2017)	108 countries	Inverted U-shaped relationship exists between natural disaster and resource depletion, while trade and FDI inflows helpful to conserve natural resources through symmetric information technologies among countries
Robinson et al. (2017)	North Africa and the Middle East	CERF supplied funds more to the stated countries to minimize disaster effect
Gopalakrishnan et al. (2017)	North Carolina	Adaptation of coastal climate change is required to conserve environmental and resource depletion
Nguyen et al. (2018)	Vietnam	Natural disasters negatively affect rice production
Ojha et al. (2018)	India	Forestation, plantation, agro-horticulture, and dams required to minimize vulnerable impact of climate change
Chu (2017)	Vietnam	Natural disaster affects human, property, and resource degradation
Knez et al. (2018)	Sweden	Place identity and human well being is strongly connected with each other before disaster while it reverse after disaster
Fischer (2018)	USA	Climate change adaptation improves livelihood of the common people in natural resource dependent communities
Benali et al. (2018)	9 countries	Natural disaster shocks increasing public debt that leads to budget deficit and hampers economic activities
Qureshi et al. (2019)	Malaysia	Natural disasters largely exhausted country's economic resources, which need disaster action cell to reduce human and infrastructure costs for long-term sustainable development
Khan et al. (2019)	Selected Asian countries	External migration, poverty level, and price surge are the main factors that associated with natural disasters that should need some precautionary measures to reduce socio-economic costs for achieving global prosperity
Chandio et al. (2020)	Pakistan	Climatic vulnerabilities influenced agricultural production that could be managed by supporting farmers through subsidized fertilizers prices
Boustan et al. (2020)	US counties	Natural disasters increase migration rates, dropping housing rents, labor demand, and domestic production
Miao et al. (2020)	China	Natural disaster shocks put a massive burden on country's financial resources in the form of increasing public spending and intergovernmental transfers
Coulibaly et al. (2020)	African countries	Extreme temperature and droughts both negatively affect countries agricultural production

Table 2 List of variables

Variables	Symbols	Unit	Data sources
Natural disaster	ND	No. of people affected	EM-DAT (2017)
Technical disaster	TD	No. of people affected	EM-DAT (2017)
Net forest depletion	NFDEP	% of GNI	World Bank (2017)
Mineral depletion	MDEP	% of GNI	World Bank (2017)
Energy depletion	EDEP	% of GNI	World Bank (2017)
Natural resource depletion	NRDEP	% of GNI	World Bank (2017)
GDP per capita	GDPPC	Constant 2010 US $	World Bank (2017)
Trade openness	TOP	% of GDP	World Bank (2017)
FDI inflows	FDI	% of GDP	World Bank (2017)
Population growth	PG	Annual %	World Bank (2017)

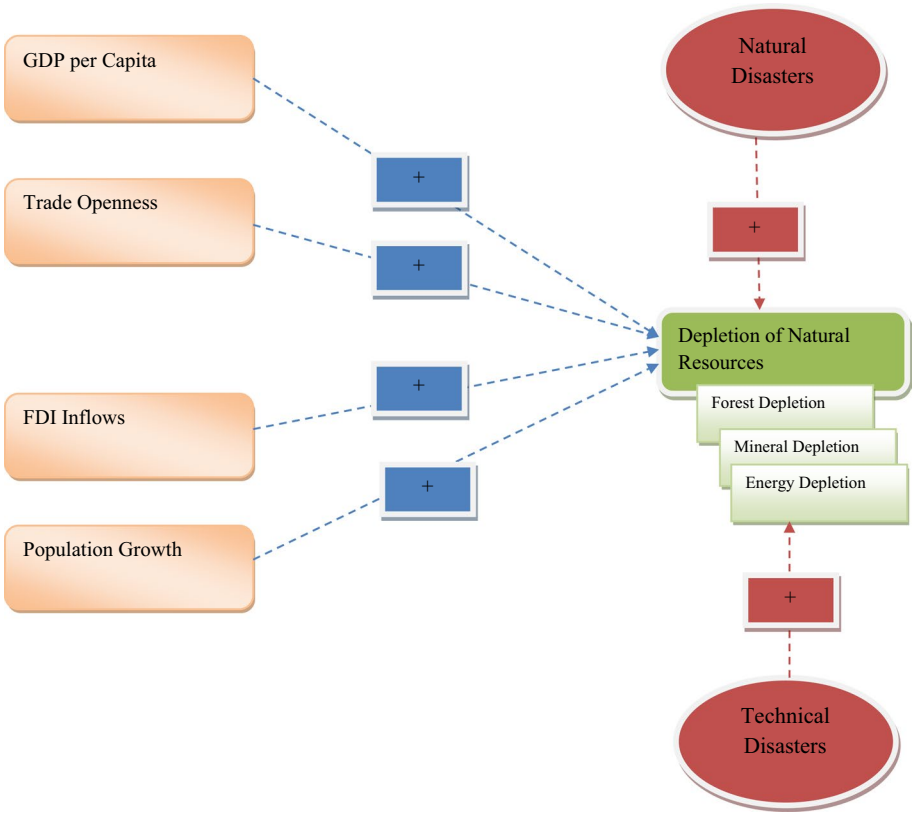

Fig. 1 Research framework of the study. *Source*: Self extract

Figure 1 shows that growth-specific factors largely influenced natural resources depletion under the technical and natural disasters shocks. The technical and natural disaster shocks hampered the economic activity by damaging the natural capital resources

of a country. The efficient disaster management infrastructure is imperative to minimize economic and environmental losses worldwide.

The study employed quantile regression to assess natural disaster and environment and resource depletion at 25%, 50% and 75% quantile distribution. Koenker and Bassett (1978) presented the concept of quantile regression, which gives more sound inferences to analyze the relationship at different quantiles that conventional regression apparatus largely missing. Further, the results of least square method are estimated with the conditional mean of the response variable with the given values of the predictor variables, while the aim of the quantile regression is to estimate the conditional median and the value of quantile of respondent variables. The quantile regression is the modified form of linear regression. It can be used when the linear regression's conditions are not applicable. The primary aim of the ordinary least squares (OLS) is to define the conditional mean of response variable, given certain predictor variable and then find out the expected value, while quantile regression estimated regression estimates at 25%, 50% and 75% quantile distribution. Figure 2 presents the rough sketch of quantile regression for variable "*Y*" distribution at 0.50 quantile distribution.

Figure 2 clearly illustrates that least square regression is estimated at 0.50 quantile distribution, while least square estimates unable to distribute the regression into different quantiles to assess the different variations of the "*Y*" distribution. Thus, quantile regression provides robust inferences for the same regression estimates at different quantiles.

4 Results and discussion

Table 3 shows the descriptive statistics of the variables. Energy depletion has a mean value of 0.774% of GNI with a maximum value of 1.919% of GNI and minimum value of 0.079% of GNI. It has a positively skewed distribution and high kurtosis value. Mineral depletion, forest depletion, natural resource depletion, natural disaster, technical disaster, FDI, GDP

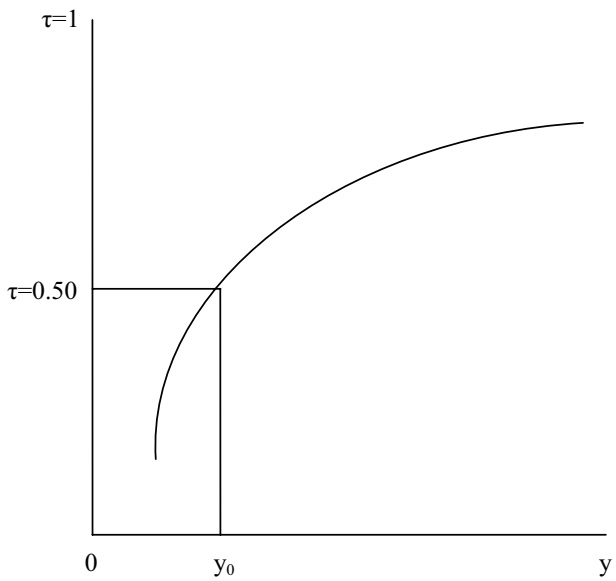

Fig. 2 Median quantile regression

Table 3 Descriptive statistics

Statistics	EDEP % of GNI	MDEP % of GNI	NFDEP % of GNI	NRDEP % of GNI	ND (No. of people affected)	TD (number of deaths)	FDI (current U$)	GDPPC (US$)	PG (%)	TOP (% of GDP)
Mean	0.774	0.007	0.238	1.020	1951.571	38.904	9.66E+08	811.417	2.598	33.368
Maximum	1.919	0.040	0.810	2.122	73,838	407	5.59E+09	1178.798	3.360	38.909
Minimum	0.079	0	0.112	0.362	0	0	8,220,530	481.457	1.998	25.139
Std. Dev.	0.536	0.013	0.132	0.505	11,371.81	94.427	1.36E+09	199.165	0.497	3.162
Skewness	0.688	1.471	3.056	0.768	6.231	2.693	2.177	0.035	0.239	−0.481
Kurtosis	2.393	3.653	12.351	2.485	39.898	9.790	7.334	1.967	1.453	2.935

per capita and population growth have positively skewed distribution, and mean values are as follows, i.e., 0.007% of GNI, 0.238% of GNI, 1.020% of GNI, 1951.157 people affected, 38.904 number of deaths, 9.66E+08% US$, 811.4178 US$ and 2.598%, respectively. Trade openness has a mean value of 33.368% of GDP with a maximum value of 39.909% of GDP and minimum value of 25.139% of GDP.

Table 4 shows the correlation estimates. The estimates show that natural disaster, technical disaster, FDI and GDPPC have a positive correlation with energy depletion, mineral depletion and natural resource depletion, while forest depletion has a negative correlation with the resource depletion. The result implies that disasters and economic factors largely depleted environmental resources, which need climate mitigation strategies and sound economic policies to minimize natural resource losses. Population growth has a negative correlation with energy depletion, mineral depletion and natural resources although forest depletion has a positive correlation with the population growth. Trade openness has positively correlated with energy depletion and negatively correlated with mineral depletion, forest depletion and natural resource depletion. Thus, the results provoke that population growth leads to deforestation, while trade negatively influenced energy resources.

Table 5 shows the quantile regression estimates for Model-1. The result shows that there is a positive and significant relationship between natural resource depletion and technical disaster. On the 0.50 and 0.75 quantiles distribution, the result is significant and shows that technical disasters decrease the stock of natural resources, as Richardson (1994) argued

Table 4 Correlation matrix

Probability	Correlation									
	EDEP	MDEP	NFDEP	NRDEP	ND	TD	FDI	GDPPC	PG	TOP
EDEP	1									
	–									
MDEP	0.835	1								
	0.000	–								
NFDEP	−0.431	−0.225	1							
	0.004	0.150	–							
NRDEP	0.970	0.853	−0.201	1						
	0.000	0.000	0.200	–						
ND	0.270	0.148	−0.142	0.253	1					
	0.082	0.349	0.367	0.104	–					
TD	0.270	0.127	−0.041	0.279	0.165	1				
	0.083	0.421	0.793	0.073	0.296	–				
FDI	0.762	0.814	−0.277	0.758	0.143	−0.063	1			
	0.000	0.000	0.074	0.000	0.363	0.690	–			
GDPPC	0.783	0.694	−0.493	0.720	0.135	0.140	0.685	1		
	0.000	0.000	0.000	0.000	0.392	0.376	0.000	–		
PG	−0.750	−0.637	0.333	−0.725	−0.178	−0.091	−0.651	−0.895	1	
	0.000	0.000	0.031	0.000	0.256	0.563	0.000	0.000	–	
TOP	0.058	−0.030	−0.346	−0.030	0.094	0.375	−0.038	−0.158	0.239	1
	0.714	0.847	0.024	0.849	0.550	0.014	0.809	0.316	0.126	–

Below correlation estimates, there is a probability values

Table 5 Quantile regression estimates for model-1: natural resource depletion

Variables	$\tau_{0.25}$	$\tau_{0.50}$	$\tau_{0.75}$
NDISASTER	7.16E−06	3.30E−06	1.48E−06
TECHDISASTER	0.001181	0.001909*	0.001598*
FDI	2.59E−10*	1.71E−10**	1.80E−10*
GDPPC	−0.000465	0.000305	0.000465
PG	−0.269045	−0.306773	−0.239194
TOP	0.004801	−0.025076	−0.020459
C	1.417850	2.180701	1.878644
Statistical test			
Pseudo *R*-squared	0.452191	0.529777	0.623604
Adjusted *R*-squared	0.358281	0.449168	0.559080

Dependent variable: NRDEP

*and **indicates 1% and 5% significance level. τ shows quantile distribution

that technical disasters can be happened in plant and factory, field area of agriculture, transportation system and production function, when these disasters occur, organizational and technological systems are break down and these disasters create large-scale damages to economic and social human life, which ultimately put a negative impact on natural resource reserves. Gill and Picou (1998) confirmed that technical disaster has a positive and significant impact on natural resource depletion. Technological disaster disrupts the environment by the way of waste site, toxic spoil and oil spoil. This eruption causes to degrade the environment and natural resources.

The results further showed the significant relationship between FDI inflows and natural resource depletion at different quantile distributions, i.e., at 0.25, 0.50 and 0.75 distribution. The previous study by Escaleras and Register (2011) confirmed that FDI inflows influenced natural environment through massive trade and financial liberalization policies, i.e., natural disasters can have a negative effect on labor stocks, social infrastructure and physical capital that are necessary for communication system and transportation. Mabey and McNally (1999) confirmed that FDI inflows degrade natural environment in the form of natural resource depletion. The greenhouse gas emissions, deforestation, loss of biodiversity, etc., all are the chief environmental destruction factors and these are driven by increased economic activities in the economy and FDI inflows, which are largely involved in substantiated "pollution haven hypothesis" in a country. Ali et al. (2020) argued that extreme climate events largely affect countries socioeconomic and environmental resources that need for adaptation of climatic mitigation strategies to control such extremes in the future. Sharif et al. (2020) confined their findings in support of mitigating rare disaster shocks via the use of renewable energy infrastructure, which would be helpful to integrate environmental policies with economic policies for conservation of natural capital resources across the globe. Khayyam (2020) concluded that climate-induced flood risks not only limited to damaging agriculture yield while it ends up to increasing poverty and decreasing economic status. The need for climate mitigation strategies may reduce the risks of flood and supported global agricultural production. Table 6 shows the quantile regression estimates for Model-II.

The results show that there is a positive and significant relationship between technical disaster and forest depletion at 0.25 and 0.50 quantiles distribution. The previous study

Table 6 Quantile regression estimates for model-II: forest depletion

Variables	$\tau_{0.25}$	$\tau_{0.50}$	$\tau_{0.75}$
NDISASTER	−1.01E−06**	−1.16E−06**	−2.15E−06**
TECHDISASTER	0.000178**	0.000268***	0.000310
FDI	7.63E−12	5.81E−12	1.04E−12
GDPPC	−0.000306***	−0.000140	−0.000955**
PG	−0.038955	0.025022	−0.255399
TOP	−0.002609	−0.010685**	−0.022587***
C	0.616880	0.611841	2.480165
Statistical test			
Pseudo *R*-squared	0.197819	0.202636	0.305886
Adjusted *R*-squared	0.060303	0.065945	0.186895

Dependent variable: FDEP

*, **, *** indicates 1%, 5% and 10% significance level. τ shows quantile distribution

by Chakravarty et al. (2012) provoked that technical disaster belongs to the deforestation which cause due to the timber production, new infrastructure and development. New plantation in the area of forest is the cause to degradation of forest resources. Bowonder (1983) confirmed that technical disaster largely happens due to demolishing a large number of forest reserves in a country. Natural disaster is negatively correlated with forest depletion at 0.25, 0.50 and 0.75 quantiles distribution. The previous study of Hammill et al. (2005) confirmed that natural disaster happened due to depleting large forest reserves in a country. Duclos et al. (1990) confirmed that natural disaster demolished forest reserves via the channel of fire disaster made by manmade activity and through natural factors. At 0.25 and 0.75 quantiles distribution, balanced economic growth decreases forest reserves, which is a healthy sign to conserve natural resources by improving country's per capita income. The previous study of Rajapaksa et al. (2017) confirmed that due to development of industrial sector and large involvement in infrastructural development, the forest reserves largely depleted to achieve economic transformation process in a country. At 0.50 and 0.75 quantiles distribution, it shows that the trade openness has a negative correlation with forest depletion. The results show that forest reserves largely restored due to massive economic transformation in the form of trade liberalization policies, which is a good indicator to conserve natural resources in a country. Ahmed et al. (2019) argued that trade-led income hypothesis support growth-oriented policies in the short-run; however, it hampers sustainable development agenda in the long-run. The exports quality goods should be ecofriendly, and it should be supported to green growth agenda. Table 7 shows the quantile regression estimates for Model-III.

The results show that natural disaster has a positive and significant relationship with mineral depletion at 0.25 and 0.50 quantiles distribution. The results show that natural disaster depletes the mineral resources. In the previous study, Meinert et al. (2016) argued that mineral resources (copper, iron and oil) are discovered through by using the technologies and heavy machinery. On the time of natural disaster, the machinery is destroying and the mineral resources are being misplaced that lead to deplete mineral resources. At 0.75 quantile distribution, technical disaster shows a positive correlation with mineral resource depletion. Due to the significant positive relationship, technical disaster shows high depletion of mineral resources. The previous study of Kaya (2001) argued that disaster could

Table 7 Quantile regression estimates for model-III: mineral depletion

Variables	$\tau_{0.25}$	$\tau_{0.50}$	$\tau_{0.75}$
NDISASTER	1.17E−07**	1.02E−07**	−1.21E−07
TECHDISASTER	1.74E−06	8.30E−07	5.99E−05**
FDI	7.21E−12*	7.34E−12*	9.35E−12*
GDPPC	−3.67E−06	−1.98E−06	1.42E−08
PG	0.001930	0.001779	−0.001057
TOP	−9.05E−05	−0.000113	−7.38E−05
C	−0.001842	−0.001436	0.005294
Statistical test			
Pseudo *R*-squared	0.442252	0.530180	0.648460
Adjusted *R*-squared	0.346638	0.449639	0.588196

Dependent variable: MDEP

* and ** indicates 1% and 5% significance level. τ shows quantile distribution

be happened with global warming, acid rain and ozone layer destruction which cause to damage mineral resources. Hodges (1995) found that the consumption of mineral resources is exhausted due to high mass population growth, which happened with technical disaster across countries. With the quantile distribution of 0.25, 0.50 and 0.75, FDI shows a positive correlation with mineral depletion. The previous study of Long et al. (2017) concluded that FDI inflows contribute to increase ecological withdrawals and dependently react on the natural resource sector for economic growth and the cause for the depletion of mineral resources in a country. Table 8 shows the quantile regression estimates of Model-IV.

The results show that energy depletion is influenced by natural disaster at 0.25 quantile distribution, which shows that natural disaster largely depletes energy resources. The previous study of Rudnick (2011) argued that natural disaster destroys all of the energy resources and country faces huge energy crisis. Goldemberg (1998) found that electricity resources and nuclear energy resources are depleting through air pollution, acid rain and climate change. Technical disaster has a positive relationship with energy depletion. At

Table 8 Quantile regression estimates for model-IV: energy depletion

Variables	$\tau_{0.25}$	$\tau_{0.50}$	$\tau_{0.75}$
NDISASTER	8.92E−06***	5.18E−06	2.16E−06
TECHDISASTER	0.000582	0.001786*	0.001002***
FDI	2.48E−10*	1.66E−10**	1.22E−10**
GDPPC	0.000148	0.001254	0.001769***
PG	−0.125370	−0.009061	−0.057347
TOP	0.028096	−0.010030	0.008172
C	−0.455076	−0.131539	−0.751453
Statistical test			
Pseudo *R*-squared	0.520241	0.554566	0.658436
Adjusted *R*-squared	0.437996	0.478206	0.599883

Dependent variable: EDEP

*, **, *** indicates 1%, 5% and 10% significance level. τ shows quantile distribution

quantiles distribution of 0.50 and 0.75, the technical disaster depletes the energy resources. FDI inflows have a positive and significant relationship with energy depletion, which confirmed the "pollution haven hypothesis" in a country. The results confined the need to reform disaster management unit and climate mitigation policies in order to conserve environmental resources in a country.

5 Conclusions and policy implication

The impact of natural disasters on natural resource depletion is widely discussed in resource economics, where natural and technical disasters deteriorate natural environment in the form of forest, mineral and energy resources depletion. This study examined the impact of natural disaster and technical disaster on natural resource depletion by using the consistent time series data from 1975 to 2016 in the context of Pakistan. The study employed quantile regression at 0.25, 0.50 and 0.75 distributions. The result shows that technical disaster deteriorates the environment in the form of natural resource depletion at 0.75 quantile regression; forest depletion at 0.25 and 0.50 quantile regression; mineral depletion at 0.75 quantile regression; and energy depletion at 0.50 and 0.75 quantile regression. The results further show that natural disaster in the form of storm, earthquake and epidemics substances depletes mineral resources at 0.25 and 0.50 quantile regression, while it further depletes energy resources at 0.25 quantile regression. The impact of FDI flows on natural resource depletion, mineral resource development and energy resource development is quit visible at different quantile regressions. Hence, we may conclude that natural resources are largely influenced by FDI flows in a country. The per capita income depleted energy resource at 0.75 quantile regression. The results conclude that natural and technical disaster both depleted natural resources in a given country context, which need sound policy inferences for conservation of natural resources in a country.

5.1 Policy implications

Some policies are significantly suggested as a result of the above study. The implementation of these policies can be beneficial for the disaster stricken areas of the country in the wider scope. Trees plantation plays an important role in changing the environment. Government should allocate space for plantations to improve the particulate emissions in the environment. There is convincing evidence that climate change is directly related to the forests world over. With depleted forests, there could be high temperature, storm and rainfall frequency as well as magnitude, and the most horrifying, diseases and pest outbreaks. Hence, to create resilience in the community against natural disaster, awareness about plantation should be created at the governmental level. Some good steps have already been taken in KPK region of Pakistan regarding forestation and new plantation, and same precedence should be followed by other provinces too.

In lieu of our research, we strongly suggest, the government should chalk out a multidisciplinary program, which should combine elements like risk and hazard assessment, education and awareness, preparedness for emergent calls, recovery, mitigation, reconstruction and rehabilitation, predictions and warning, strategies to learn from catastrophes and international cooperation. The elements should be amalgamated into one strategy, so that one single framework for resilience toward natural disasters could be set forth for the next 10 years.

With high tech systems in hand, the government should develop computerized multi-hazard-geographic information system that would help in availability of all the information readily to the decision makers, instead of storing information on papers, or maps and charts traditionally. To create resilience toward natural disasters, the researchers from the R&D department should come forward for these research areas, i.e., (1) research on biological as well as physical factors that mainly contribute in causing disasters, (2) research on those main socio-factors that influence human response to these disasters and (3) research on technological/societal strategies for the reduction of disasters. In the perspective of the ongoing discussion in this present study, the Government should take steps to create community-wide awareness, as well as education plans, on priority basis. These programs should involve all strata of life and locations of the risk-oriented areas. The levels of information dissemination should include: household precautionary plan and emergency supplies should be made available. Seminars for creating awareness and for preparedness should be conducted in schools, colleges and university levels. In these sessions, awareness toward response to disaster should be given. These could be changed into training sessions as well. In the offices, the employees should be given sessions to ensure security and safety of the worker and how to maintain security of the assets too. As it has been observed, the low-income areas have more mortality rate than the high income. For this purpose and to preserve the economic prosperity and social equity, government should promote and enhance the environmental safety for the future and present generation. Although through creation of jobs, poverty can be reduced but in the case of natural disaster, government should develop the sustainable disaster management policies for achieving broad-based growth.

The disaster management and preparedness can be systematic and long term if the government works its way through these six steps:

1. Identify the capabilities and needs of state and local level for preparedness.
2. Training of interdisciplinary, multi-jurisdictional teams and groups for response, reconstruction and recovery.
3. Among Government, schools, businesses, industries and volunteer teams, there should be improvement in emergency communication and coordination.
4. There should be development in the procedures for managing not only the volunteers, but also the resources that have been donated.
5. In planning preparedness, there should be involvement of utility as well as some life line industries, and
6. Projects should be created for demonstration of preparedness.

The capital spending should be on the behalf of the natural disasters. As well as to control the climatic change, the study suggests that on the issue of funding after the natural disaster, government should adopt macro policy which laid the foundation for recovery and to build new infrastructure and to recover the health condition of the effected peoples.

The most important of all is the areas of “prediction” in time and giving “warning” to the communities inhabiting in risk-prone areas. It can be a major factor to bring down disaster-related mortality rate. There are significant gaps in the ability to predict the catastrophes in time and then deliver the warning especially to those sleeping, in care of others, away from the communication system, hearing disabled, or others. What should be done in case of power failures, should also be the focus of attention. The most important lesson that we can learn from the study results is that until and unless we have proper disaster

management structure, we will keep on suffering helplessly in the hands of nature. A lesson learned about the impacts of the disaster is that local policymakers should know details about their community's economic bases, e.g., commercial, industrial or agricultural businesses, what type of employment people have, within the disaster risk areas. So that at the time of development plan, they could involve community on the basis of their social stances.

There should be a system of allocation of resource rights as well. The government officials do not focus upon this main disadvantage of the society. But no doubt these natural disasters do kill government officials too like everybody else in the community and disrupt the government services also. In these circumstances, redefining the resource rights can bring the system focused upon immediate humanitarian relief. The resource rights system contributes a lot to increased disaster resilience, and recovery of poor, marginalized communities, the governments, private sector, humanitarian NGOs and international community, they all have a role to play. What these roles should be, who and how these can be mutually supportive, now requires a careful consideration from the authorities.

Acknowledgements Researchers Supporting Project Number (RSP-2020/87), King Saud University, Riyadh, Saudi Arabia.

References

Adeagbo A, Daramola A, Carim-Sanni A, Akujobi C, Ukpong C (2016) Effects of natural disasters on social and economic well-being: a study in Nigeria. Int J Disaster Risk Reduct 17:1–12

Ahmed K, Ozturk I, Ghumro IA, Mukesh P (2019) Effect of trade on ecological quality: a case of D-8 countries. Environ Sci Pollut Res 26(35):35935–35944

Ali SM, Khalid B, Akhter A, Islam A, Adnan S (2020) Analyzing the occurrence of floods and droughts in connection with climate change in Punjab province, Pakistan. Nat Hazards. https://doi.org/10.1007/s11069-020-04095-5

Aswani S, Hamilton RJ (2004) Integrating indigenous ecological knowledge and customary sea tenure with marine and social science for conservation of bumphead parrotfish (*Bolbometopon muricatum*) in the Roviana Lagoon, Solomon Islands. Environ Conserv 31(1):69–83

Awan U (2020) Industrial ecology in support of sustainable development goals. In: Leal Filho W, Azul AM, Brandli L, Özuyar PG, Wall T (eds) Responsible consumption and production. Encyclopedia of the UN sustainable development goals. Springer, Cham

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):4473

Benali N, Abdelkafi I, Feki R (2018) Natural-disaster shocks and government's behavior: evidence from middle-income countries. Int J Disaster Risk Reduct 27:1–6

Blaikie P, Cannon T, Davis I, Wisner B (2004) At risk: natural hazards, people's vulnerability and disasters. Routledge, London

Boustan LP, Kahn ME, Rhode PW, Yanguas ML (2020) The effect of natural disasters on economic activity in US counties: a century of data. J Urban Econ 118:103257

Bowonder B (1983) Forest depletion: some policy options. Resour Policy 9(3):206–224

Brown O, Crawford A, Hammill A (2006) Natural disasters and resource rights building resilience, rebuilding lives. International Institute for Sustainable Development, Winnipeg

Carolwicz M (1996) Nature hazards need not lead to natural disasters. EOS 77(16):149–153

Cavallo EA, Noy I (2009) The economics of natural disasters: a survey or online available at SSRN: https://ssrn.com/abstract=1817217. Accessed on 15 July 2018

Chakravarty S, Ghosh SK, Suresh CP, Dey AN, Shukla G (2012) Deforestation: causes, effects and control strategies. In: Clement AO (ed) Global perspectives on sustainable forest management. InTech, Rijeka

Chandio AA, Magsi H, Ozturk I (2020) Examining the effects of climate change on rice production: case study of Pakistan. Environ Sci Pollut Res 27(8):7812–7822

Chenault EA, Parsons G (1998) Drought worse than 96; cotton crop's one of worst ever. http://agnews.tamu.edu/stories/AGEC/AugI998a.htm. Accessed on 7 Oct 2017
Chu TTH (2017) Natural disaster, catastrophe and environmental protection in Vietnam. J Vietnam Environ 8(1):1–3
Coulibaly T, Islam M, Managi S (2020) The impacts of climate change and natural disasters on agriculture in African countries. Econ Disasters Climate Change. https://doi.org/10.1007/s41885-019-00057-9
Cunado J, Ferreira S (2014) The macroeconomic impacts of natural disasters: the case of floods. Land Econ 90(1):149–168
Doytch N, Uctum M (2016) Globalization and the environmental impact of sectoral FDI. Econ Syst 40(4):582–594
Duclos P, Sanderson LM, Lipsett M (1990) The 1987 forest fire disaster in California: assessment of emergency room visits. Arch Environ Health Int J 45(1):53–58
EM-DAT (2017) The international Disaster Database. Centre for Research on the Epidemiology of Disasters—CRED. Emergency Events Database, Brussels, Belgium
EPA (1991) U.S. environmental protection agency: 1991 management control plan. The United States Environmental Protection Agency, Washington D.C
Escaleras M, Register CA (2011) Natural disasters and foreign direct investment. Land Econ 87(2):346–363
Fang J, Lau CKM, Lu Z, Wu W, Zhu L (2019) Natural disasters, climate change, and their impact on inclusive wealth in G20 countries. Environ Sci Pollut Res 26(2):1455–1463
Fischer AP (2018) Pathways of adaptation to external stressors in coastal natural-resource-dependent communities: implications for climate change. World Dev 108:235–248
Freedy JR, Shaw DL, Jarrell MP, Masters CR (1992) Towards an understanding of the psychological impact of natural disasters: an application of the conservation resources stress model. J Trauma Stress 5(3):441–454
Gaillard JC, Liamzon CC, Villanueva JD (2007) 'Natural'disaster? A retrospect into the causes of the late-2004 typhoon disaster in Eastern Luzon, Philippines. Environ Hazards 7(4):257–270
Gallina V, Torresan S, Critto A, Sperotto A, Glade T, Marcomini A (2016) A review of multi-risk methodologies for natural hazards: consequences and challenges for a climate change impact assessment. J Environ Manag 168:123–132
Gill DA, Picou JS (1998) Technological disaster and chronic community stress. Soc Nat Resour 11(8):795–815
Goldemberg J (1998) Leapfrog energy technologies. Energy Policy 26(10):729–741
Gopalakrishnan S, Landry CE, Smith MD (2017) Climate change adaptation in coastal environments: modeling challenges for resource and environmental economists. Rev Environ Econ Policy 12(1):48–68
Green TH (1994) Experimental studies of trace-element partitioning applicable to igneous petrogenesis—Sedona 16 years later. Chem Geol 117(1–4):1–36
Grossman GM, Krueger AB (1995) Economic growth and the environment. Q J Econ 110(2):353–377
Guha-Sapir D, Van Panhuis WG, Lagoutte J (2007) Patterns of chronic and acute diseases after natural disasters—a study from the International Committee of the Red Cross field hospital in Banda Aceh after the 2004 Indian Ocean tsunami. Trop Med Int Health 12(11):1338–1341
Hammill A, Brown O, Crawford A (2005) Forests, natural disasters and human security. Arborvitae (IUCN/WWF For Conserv Newsl) 27:8–9
Hodges CA (1995) Mineral resources, environmental issues, and land use. Science 268(5215):1305–1312
IPCC (2012) Determinants of risk: exposure and vulnerability. Intergovernmental panel on climate change, https://www.ipcc.ch/pdf/special-reports/srex/SREX-Chap2_FINAL.pdf. Accessed on 21 Feb 2018
Israel DC, Briones RM (2012) Impacts of natural disasters on agriculture, food security, and natural resources and environment in the Philippines (No. 2012-36). PIDS discussion paper series
Iwata K, Ito Y, Managi S (2014) Public and private mitigation for natural disasters in Japan. Int J Disaster Risk Reduct 7:39–50
Kahn ME (2005) The death toll from natural disasters: the role of income, geography, and institutions. Rev Econ Stat 87(2):271–284
Kapur R (2016) Natural resources and environmental issues. J Ecosyst Ecogr 6(196):1–2
Kaya M (2001) Environmental impacts of mineral resource exploitation and use. In: 17th international mining congress and exhibition of Turkey-IMCET, ISBN, pp 975–395
Khan KA, Zaman K, Shoukry AM, Sharkawy A, Gani S, Ahmad J, Khan A, Hishan SS (2019) Natural disasters and economic losses: controlling external migration, energy and environmental resources, water demand, and financial development for global prosperity. Environ Sci Pollut Res 26(14):14287–14299
Khayyam U (2020) Floods: impacts on livelihood, economic status and poverty in the north-west region of Pakistan. Nat Hazards 102:1033–1056

Klomp J (2016) Economic development and natural disasters: a satellite data analysis. Glob Environ Chang 36:67–88
Klomp J, Hoogezand B (2018) Natural disasters and agricultural protection: a panel data analysis. World Dev 104:404–417
Knez I, Butler A, Sang ÅO, Ångman E, Sarlöv-Herlin I, Åkerskog A (2018) Before and after a natural disaster: disruption in emotion component of place-identity and wellbeing. J Environ Psychol 55:11–17
Koenker R, Bassett G Jr (1978) Regression quantiles. Econom J Econom Soc 46(1):33–50
Lee HY, Wu HC, Wang YJ (2007) Contagion effect in financial markets after the South-East Asia Tsunami. Res Int Bus Finance 21(2):281–296
Lindell MK, Prater CS (2003) Assessing community impacts of natural disasters. Nat Hazards Rev 4(4):176–185
Long MA, Stretesky PB, Lynch MJ (2017) Foreign direct investment, ecological withdrawals, and natural-resource-dependent economies. Soc Nat Resour 30(10):1261–1276
Mabey N, McNally R (1999) Foreign direct investment and the environment. WWF-UK, Godalming
Marfai MA, King L, Singh LP, Mardiatno D, Sartohadi J, Hadmoko DS, Dewi A (2008) Natural hazards in Central Java Province, Indonesia: an overview. Environ Geol 56(2):335–351
Masozera M, Bailey M, Kerchner C (2007) Distribution of impacts of natural disasters across income groups: a case study of New Orleans. Ecol Econ 63(2–3):299–306
Meinert LD, Robinson GR, Nassar NT (2016) Mineral resources: reserves, peak production and the future. Resources 5(1):14. https://doi.org/10.3390/resources5010014
Miao Q, Chen C, Lu Y, Abrigo M (2020) Natural disasters and financial implications for subnational governments: evidence from China. Public Finance Rev 48(1):72–101
Munang R, Thiaw I, Alverson K, Mumba M, Liu J, Rivington M (2013) Climate change and ecosystem-based adaptation: a new pragmatic approach to buffering climate change impacts. Curr Opin Environ Sustain 5(1):67–71
Nel P, Righarts M (2008) Natural disasters and the risk of violent civil conflict. Int Stud Quart 52(1):159–185
Neumayer E, Plümper T (2007) The gendered nature of natural disasters: the impact of catastrophic events on the gender gap in life expectancy, 1981–2002. Ann As Am Geogr 97(3):551–566
Nguyen HR, Ngo QT, Nguyen ND (2018) Effects of natural disaster on rice production at farm level: new evidence from Vietnam. Agris On-Line Pap Econ Inform 10(1):37–49
Ojha A, Pattnaik AK, Rout J (2018) Climate change impacts on natural resources and communities: a geospatial approach for management. Lakes Reserv Res Manag 23(1):34–42
Okuyama N, Inaba Y (2017) Influence of natural disasters on social engagement and post-disaster well-being: the case of the Great East Japan Earthquake. Jpn World Econ 44:1–13
Peduzzi P, Henderson W, Hartigan P, Lavori P (2002) Analysis of randomized controlled trials. Epidemiol Rev 24(1):26–38
Pelling M, Uitto JI (2001) Small island developing states: natural disaster vulnerability and global change. Glob Environ Change Part B Environ Hazards 3(2):49–62
Qureshi MI, Yusoff RM, Hishan SS, Alam AF, Zaman K, Rasli AM (2019) Natural disasters and Malaysian economic growth: policy reforms for disasters management. Environ Sci Pollut Res 26(15):15496–15509
Rajapaksa D, Islam M, Managi S (2017) Natural capital depletion: the impact of natural disasters on inclusive growth. Econ Disasters Climate Change 1(3):233–244
Reed MS (2008) Stakeholder participation for environmental management: a literature review. Biol Conserv 141(10):2417–2431
Rehman MA, Hashmi N, Siddiqui BN, Afzal A, Zaffar A, Masud K, Adeel M, Khan MR, Dawood KM, Shah SAA (2017) Climate change and its effect on crop and livestock productivity: farmers' perception of Rajanpur, Pakistan. Int J Adv Res Biol Sci 4(4):30–36
Richardson B (1994) Socio-technical disasters: profile and prevalence. Disaster Prev Manag Int J 3(4):41–69
Robinson TD, Oliveira TM, Kayden S (2017) Factors affecting the United Nations' response to natural disasters: what determines the allocation of the Central Emergency Response Fund? Disasters 41(4):631–648
Rubonis AV, Bickman L (1991) Psychological impairment in the wake of disaster: the disaster–psychopathology relationship. Psychol Bull 109(3):384–399
Rudnick H (2011) Impact of natural disasters on electricity supply [guest editorial]. IEEE Power Energy Mag 9(2):22–26
Sharif A, Dogan E, Aman A, Khan HHA, Zaighum I (2020) Rare disaster and renewable energy in the USA: new insights from wavelet coherence and rolling-window analysis. Nat Hazards. https://doi.org/10.1007/s11069-020-04100-x

Siwedza S, Shava S (2020) Insurance, increasing natural disaster risks and the SDGs: a focus on Southern Africa. In: Nhamo G, Odularu G, Mjimba V (eds) Scaling up SDGs implementation. Springer, Cham, pp 129–138
Skidmore M, Toya H (2002) Do natural disasters promote long-run growth? Econ Inq 40(4):664–687
Sodhi MS (2016) Natural disasters, the economy and population vulnerability as a vicious cycle with exogenous hazards. J Oper Manag 45:101–113
Suda CA (2000) Natural disaster preparedness, environmental degradation and sustainable development in Kenya. Afr Study Monogr 21(3):91–103
Townsend F (2006) The federal response to Hurricane Katrina: lessons learned. U.S. Government Printing Office, Washington, DC
Toya H, Skidmore M (2007) Economic development and the impacts of natural disasters. Econ Lett 94(1):20–25
Tyler J (2016) Sustainable hazard mitigation: exploring the importance of green infrastructure in building disaster resilient communities. Consilience 15:134–145
Ward P (2006) Out of thin air: dinosaurs, birds, and Earth's ancient atmosphere. National Academies Press, Washington, DC
Watson JT, Gayer M, Connolly MA (2007) Epidemics after natural disasters. Emerg Infect Dis 13(1):1–5
Wilhite DA (2000) Chapter 1 Drought as a natural hazard: concepts and definitions. Drought Mitigation Center Faculty Publications, 69. http://digitalcommons.unl.edu/droughtfacpub/69. Accessed on 20 July 2018
World Bank (2017) World development indicator. World Bank, Washington, DC
Zhang S, Hu T, Li J, Cheng C, Song M, Xu B, Baležentis T (2019) The effects of energy price, technology, and disaster shocks on China's Energy-Environment-Economy system. J Clean Prod 207:204–213
Zhou L, Wu X, Xu Z, Fujita H (2018) Emergency decision making for natural disasters: an overview. Int J Disaster Risk Reduct 27:567–576