Review of Natural Hazards and Disasters and their Impacts in Pakistan

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Abstract

This study presents a brief review of natural hazards and disasters in Pakistan. The main focus of this study is two natural phenomena i.e., floods and earthquakes. Pakistan lies in geographically hazard prone area. The global climatic changes and tectonics setting of Pakistan makes it vulnerable to natural hazards and disasters. Floods and earthquakes are natural and recurrent phenomenon. Floods caused approximately USD 38 billion in Pakistan during the last 67 years. The causes and impacts of floods and earthquakes frequently occurring in Pakistan are briefly discussed. These events result in fatalities and monetary damage. It's need of hour to make pre disaster and post disaster mitigation strategies and policies at local and national level. Recommendations have been made to ensure safety of public as well as infrastructure to prevent huge losses in the future.

Keywords

Natural Hazards, Floods, Earthquakes, Pakistan

1. Introduction

A sudden accident or natural catastrophe is a disaster that has unfortunate consequences like endangering the lives of humans as well as animals, destroying crops or ruining the human abodes. The living beings are caught in disasters unaware as these are sweeping, sudden and erratic in nature. The unfortunate consequences of these disasters which are a cause of natural changes or sometimes the intrusion of man into nature's course, cause massive loss of lives and properties, leaving

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society paralyzed and in a fix, unless the destruction is replaced with construction (Alcantara-Ayala, 2002). Generally natural processes are responsible for such events like earthquake is caused by tectonic movements and volcanic motion. Similarly, a prolonged era without rains will lead to droughts. The diversity of geo-climatic conditions around the globe tend to influence and accelerate different types of disasters like floods, volcanic eruptions, landslides, earthquakes etc. Every year these natural disasters cause a loss of billions of dollars exterminate hundreds of human lives, ravage the crops and sabotage the infrastructure (Chapagain & Raizada, 2017). The International Disaster Database states that at global scale the estimated damage, the effected population and the reported calamities may increase. The disaster risk is on a constant increase but there are certain factors which add to these hazards for example, abrupt climatic changes, poor or no urbanization administration, lack of disaster management policies, faulty governance, and above all deficient endogenous capacities (Aitsi-Selmi, 2015; Gencer, 2013).

The damage caused by flooding and earthquake both are horrendous depending on their nature. They can be equally horrendous and devastating either it's a rural land or urban vicinity, yet, the unchecked urban growth can turn this disaster into phenomena. Between 2000 and 2009, there were 2 billion disaster stricken people out of which flood affected were 44%, while 4% were the victims of earthquake and the 3% of these calamity stricken people were those who were hit by the drought. Since 2000, there is an alarming increase of up to 60% (of the total casualties) in the earthquakes (Ferris, 2010).

Flood from 2006-2015 were the primary cause of hydrological disaster deaths in Western Central, and Southern Asia, in Southern and Central America, and all UN African regions. In 2016 one flood affected 2 million people in India, 2010 flood in Pakistan 20 million people were affected. In East Asia, the highest economic losses caused by floods reaches up to total of USD 32.26 billion. Another worst case example includes USD 42.3 billion losses for Thailand in 2011 flood (Guha-Sapir et al., 2015).

A heavy rainfall leads to the floods but continuous heavy rains extended over long time threaten an on –coming large scale disaster as the rivers over flow. The Chinese rivers Songhua, Yellow and Yangtze overflowed and ravaged 60,000 homes and 120 million people were victims of this flood in 2010 (Fuller, 2010). A comparison of earthquake and flood makes it clear that as earthquake is a sudden natural disaster, and occurs quite randomly, the population of the calamity stricken area cannot be moved immediately. To avoid large scale loss of human life, the concentration should be on imparting education and training the masses on how to react when the tremors strike. Moreover earthquake resistant buildings should be built in a potentially endangered zone. The wide spread and extreme earthquakes have dreadful effects on the agriculture and livestock but compared to the widespread wreck caused by an uncontrolled flooding water is far more pervasive (Ferris, 2010).

According to Kundzewicz et al., (2014) from 1985 to 2010 the big flood hits were 3713. The phenomena of pervasive floods are recurrent. Pakistan, India and China were hit by invasive floods in the summer of 2010 while Columbia was a victim of a dreadful flood from October to December 2010. Australia also was stricken by flood in the austral summer during 2010/2011. China was selected to estimate the maximum flood led damage in a country and it was reported that the total loss was calculated as USD 51 billion dollars. 2010 was a dreadful year in context with floods as the monsoon thrusted the floods which resulted in 2000 immediate casualties. Mozambique, Namibia, South Africa and Uganda in Africa; Brazil, Columbia, Mexico and the United States in the Americas; and Cambodia, China, India, Korea, Pakistan, the Philippines and Thailand in Asia, were serious flood victims. The demolition of infrastructure and the ruining of commodities were recorded alarmingly high, especially in the developing countries listed above (Kundzewicz et al., 2012). The year 2012 was no less than a turmoil for those living in the flood stricken areas of Madagascar, Niger and Nigeria in Africa; Bangladesh, China, India, North and South Korea, Phillippines and Russia in Asia; and Argentina, the United States and Haiti in the Americas (Kundzewicz, 2014) and due to their devastating nature the floods could be termed as killer floods.

The death toll because of floods, recorded during the last 30 years is almost 400,000 while the injuries incurred by the earthquake are 1 million while 61.5 million people were left affected by this calamity. These numbers especially about the injured ones and turned homeless are expected to be higher because of inadequate reporting levels. The death toll caused by earthquake varies from region to region and by economic growth. The lower economic development and a high magnanimity of calamity combine to increase the mortality rate. Asia globally is the highly impacted earthquake region as the number of dead and the amount of affected population was incredibly high. Some factors are held more responsible for this vast destruction which includes poor socioeconomic status, being indoors and being in a poorly constructed building during the time of the event. The future further abounds with the increasing post- earthquake devastation due to population growth of in high-risk seismic areas and the areas with low levels of development and poor construction quality. In such situation the need for preventive measures cannot be overemphasized. Some concerted and far reaching strategies should be adopted, with the momentous and lasting results. For example, in a country like Haiti, it won't be enough to bring improvement in the construction strategies. On the other hand there are some frequently earthquake hit areas where there is dire need for up gradation of building codes, construction methods, and reinforcement of already the built structures (Doocy et al.,2013).

Amongst hazard exposed areas in the world, Pakistan is one, hit by a variety of natural disasters like floods, earthquakes, landslides, cyclones, glacier outbursts, epidemics and tsunami. As per frequent occurrence of natural disasters from 1954 to 2000, flooding is the most often occurring natural disaster followed by earthquakes and wind storms (Ainuddin and Routray, 2012). The hydro-metrological accidents are rising continuously (Kellens et al., 2013). Consequently the economic price associated with that is also on a rise. The pervasiveness and the capacity of floods for economic deterioration make them dangerous of all the calamities (Ferris, 2010). The past two decades of dreadful natural calamities in Singapore, India, Bangladesh and Pakistan has made Asia a "supermarket of difficulties" (Escape 2015).

2. Floods

With diverse geographical features Pakistan has high Northern regions enclosed with glaciers and Sothern plains along with the Arabian Sea (Figure 1). From north to south, five main rivers including Jhelum, Sutlej, Chenab and Ravi are flowing through (Hashmi et al., 2012). The losses due to the frequent occurrence of floods are on increase. In the recent years, floods in hills and semi hilly areas, caused by natural stream resulting from localized torrential rains have really demonstrated a serious potential of devastation. The recurrent and frequent occurrence of floods in Pakistan always poses a dangerous threat to human life, crops and properties. Since creation the land faced 22 horrific floods. The floods have damaged an area of 613,721 Km^2, leading to a monetary loss of more than USD 38 billion in Pakistan during the last 67 years (Qasim et al., 2017).

The main source of coherence of floods in Pakistan is overwhelming exceptional precipitation in the river catchments that is once in a while expanded by the snowmelt streams that last outcome into floods especially in the period of monsoon. Sporadically storm flows starting in the Bay of Bengal result in dangerous and cruel surges in a few or for the most part all the waterway of Indus framework (Hashmi et al., 2012). Not long after its creation in the 1947, Pakistan understood the requirement for having an early surge cautioning and anticipating frameworks because of consistent surges in the nation. A completely fledged Flood Forecasting System (FFS) was built up after the Pakistan endured a cataclysmic flood in 1976. The framework was additionally created in the wake of investigating shortcomings and taking in involvement from the serious floods in 1990s. The framework got upgrades with the progression of time and now it has transformed into sufficiently comprehensive; yet at the same time, it requires additionally solid endeavours to fabricate it more effective and independent (Dorosh et al., 2010). Floods are the most commonly occurring natural disasters in Pakistan.

Figure 1) Physical Map of Pakistan

Source: Pakphysical, 2004

Pakistan provides encountered a multitude of floods and consequent injuries. These floods can be extremely bothersome, leading to frequent collapse of infrastructure (Kirsch et al., 2012). Hefty rains during monsoon time cause riverine and flash floods upon annual basis in several regions. These flooded areas suffered with varying level of impacts regarding lives dropped and value of ruin from year upon year in the past. Generally, the trend in lives misplaced declined with a few exceptions till 1984. The losing of lives is pretty significant once again from 1988 to 2010. The most harmful flood recently occurred in 2010, which immobilized some areas of Pakistan for years. More than two thousand were shed, and thousands of people were infected. A destruction of USD 15 billion was approximated by government. In 2014, floods took 367 lives (Saqib et al., 2016). This means that Pakistan is standard flood-prone risk citizenry. There are many studies related to flooding and flooding causes and risk have already been done in Pakistan (Khan, 2013; Qasimet al., 2017). These studies are only related to specific part of country. These studies generalize the flood risk but complete flood risk assessment is without question lacking

The river catchments having intense, heavy rainfall combined with the snowmelt water from the mountains is the foremost cause of floods in Pakistan, especially in monsoon season. Monsoon currents in the Bay of Bengal also lead to pervasive and dreadful floods in some or mostly all the rivers that contribute to Indus system (Hashmi et al., 2012). The FFS (Flood Forecasting System) was established after the catastrophic flood of 1976. Later, its weaknesses were rectified after experiencing the horrific floods of 1990. Though, system got improved with the passage of time and to some extent it is adequate, yet, its usefulness can be increased by making it more self-contained and rapid in performance (Dorosh et al., 2010).

As flood is the most commonly occurring disaster (NDMA, 2012), the consequences in the form of loss of life, destruction of crops and wreck of properties are so magnanimous that the victims suffer a serious setback and the revival of normal life takes considerable time (Kirsch et al., 2012). The frequently flood hit areas have different levels of damage from time to time. Gradually the loss of lives has declined since 1984, yet, again from 1998 to 2010 there was a rise in the death toll because of floods (FFC, 2012). The 2010 flood left Pakistan with a damage of USD15, billion (FFC, 2012). Likewise in 2014 flood killed 367 people and 5 million others were ravaged economically.

The reason for an acceleration of flood disaster can be attributed to various factors. One of the leading causes is the change in local weather. The rise in the atmospheric and sea surface area temperature combined with an ascending moisture increase the risk of flooding (Guha-Sapir et al., 2015; Trenberth 2011,). In the wake of rapidly occurring atmospheric changes, Pakistan is on the verge of high risk of flooding. Previously, flooding was a far-fetched phenomenon but currently it poses a danger to both urban and rural vicinities. In the developing countries, the cities are generally a pivot of attention but remote areas are overlooked. The hydro-meteorological events are amplified regularly and there is an increase in the monopoly of moisture in the Southwest Asia which increases the hazard for the inhabitants of flood plains (Shahid & Piracha, 2010). Pakistan is prone to multifarious hazards especially when it comes to flooding. From 1973 to 2015, flood catastrophe and entailing

damage make up 46% of all types of natural calamities. The financial losses have been 74%. The most ravaging and the most frequent, since last 40 years (40/70 in all), has been the river in flooding (EM DAT, 2016). Pakistan was 12th amongst the countries exposed to effects of down turn changes in 2009. Alarmingly, it moved to an initial place in 2010 and then in 2014 to 5th position by climate risk index (CRI) and the reason behind was constant floods (Kreft et al., 2015). These were the floods which played havoc by taking hundreds of lives, depriving thousands of people of their abodes, ruining the precious crops and turning the masses homeless (Nadeem et al., 2014). According to an estimate about USD 21 billion in damages had been incurred right from 1950 to 2015 (EM DAT, 2016).

Eight floods came ceaselessly in the time of 1990's from 1991-1998 including two noteworthy floods of 1992 and 1998 in the months of August and March Respectively. The flood of 1992 caused extreme aftermaths in everywhere throughout the nation with the exception of Balochistan. At long last, Pakistan confronted eight floods of fluctuating qualities and forces around consistently from 2000-2009, with the exception of in 2002 and 2004. Floods happened two times in the 2005, in the months of February and June. The most disastrous flood of 2010 was the real flooding occasion of the following decade "2010s". The flood of 2010 started on 22 July everywhere throughout the Pakistan seriously (Manzoor et al., 2013).

In 2011, Sindh and Baluchistan were the worst hits of flood in the month of August (FFC, 2012). Since 2007, there is an unchecked increase in floods and what makes it more serious concern is an equal increase in long term after effects on human population and the infrastructure. Since the creation, these floods have placed Pakistan in position of constant combat against this deadly catastrophe and the misery has not yet been wiped out. The victims of flood immerse into an indescribable misery when they meet the losses of lives, properties, their livestock, crop and the sources of their sustenance. Punjab and KPK, which make the North East of Pakistan, have almost always been the worst victims of flood while Baluchistan remained the least effected. There is a variation in recording the impact of flood in terms of human as

well as material loss and the reason is inaccessibility to some flooding areas. However, as compared to past, now more data is available about the impacts of floods of 21st century on people, livestock and country's economy. The death toll in the flood of 1950 was the highest one while the flood of 2010 as well impacted a huge population. Similarly maximum agricultural land was ravaged by the flood of 2010 and the destruction of houses was the maximum in the flood of 1976. Moreover, the flood of 2010 had the most tormenting effect on economy as well. In the wake of the facts listed above, the Pakistani government needs to devise a strategy to overcome the factors leading to these catastrophes (Manzoor et al., 2013).

The late monsoon spell in September 2014 again pushed the country into another flooding event resulting in a big loss of human life and livestock. The areas of Gilgit Baltistamn and Azad Jammu and Kashmir were hit by six landslides and avalanches. The damage was pervasive as all the four tributaries of Indus collected huge amount of water and swept everything on their paths, ultimately victimizing the human population, ruining the agricultural land and sabotaging the livestock in the central and southeast parts of the Punjab region. This flood resulted in the death of 346 people and the injury of 620 while those who were displaced were eight million. The merciless streams of water swept over 928 villages, sabotaging 55,200 homes and ravaging four million manor of farming land with rich crops. The NDMA (National Disaster Control Authority) endeavoured coordinated venture to help out the affected population carry out the relief activities while provincial and district authorities respectively on their levels responded with same dedication by calamity management officials. The calamity was magnanimous and still the preparations were inadequate to meet it. This led to discovery of major health issues by the NDMA, one of which was the inadequate medical facilities, poor supply of medicines, impoverished precautionary measures etc. The emergency service of Rescue 1122 was functional at that time, yet, there were some visible loopholes. For example, joint recommended actions were little to be seen, especially regarding the tertiary health care services, skilled mechanism to handle health issues and ad-hoc treatment agreements with the national and other organization. Such scenario places an urgent requirement for prioritized

response. HEICS, that is a standard procedure, is a useful source of providing command and control and a means to ensure liaison among the responsible administrative entities. Depending on the nature of the disasters, crisis health services need to be reviewed and upgraded with standard intervals (Abdullah et al., 2015).

The on-going reduction of Himalayan and Siachen glaciers, on account of changing atmospheric conditions causes flooding inside the Indus Stream Basin (Hartmann & Andresky, 2013). Several of these situations demand coordinated, structured and targeted endeavours to set up adaptation methods to reduce the impact of the calamity to the minimum level. Structural as well as non-structural flood alleviation strategies should be laid out. One such possible strategy could be some insurance programme as protection against flood (Abbas et al., 2015)

3. Earthquakes

With a history of earthquakes, Pakistan has been a worst hit of some dreadful and ravaging earthquakes and many of its regions contain active fault lines and are located on a high seismic belt bordering making them more vulnerable to the earthquakes. It has been established that over 90% of the world's seismicity occurs within comparatively close belts where two or more of the tectonic plates slide past or collide with each other. Many seismological sources have been recorded in Pakistan. The paper takes into account the seismological as well as geological history of the region based on earthquake catalogue and associated fault system in the region.

In geological terms, two tectonic plates overlap Pakistan, Eurasian plate and Indian plate. Punjab and Sindh are located on the north-western edge of Indian plate while within the Eurasian Plates Khyber-Pakhtunkhwa and Baluchistan are situated. Azad Jammu and Kashmir and Northern areas are the most vulnerable areas to earthquake. As a matter of fact, still there is a dearth of substantial studies and research work in this field in Pakistan. As an after effect of 2005 Muzaffarabad earthquake, government, for the time being, realized the importance of earthquake studies. There have been alarming earthquakes since ever including recent Ziarat earthquake on 28 October 2008 of M 6.4, Awaran

district Baluchistan earthquake on September 24, 2013 of M 7.8 and Awaran district Baluchistan earthquake on September 28, 2013, M 6.8 and on 26 Oct 2015 of magnitude 7.6 struck northern areas, and they have posed a serious threat to humans (Sarwar et al., 2016).

The studies related to the earthquake prediction are not a focus of considerable attention. That‘s why they don’t fall in the actively researched fields in Pakistan, compared with the other countries of the world. Only few hazard maps based on Peak Ground Acceleration (PGA) value are available. . But it’s not valid enough as an essential parameter of it is the catalogue completeness and in those seismogenic zones where the occurring events are not reported in the catalogue, the hazard values may be underestimated. Another huge drawback of this approach is neglecting the effects of crustal properties on attenuation while overly simplified attenuation functions have been utilized to derive the ground motion parameters. For a valid and practicable solution of these problems, the field studies with a focus on the recognition of the seismogenic potential of major active faults should be conducted on a wider scale (Rehman et al., 2016).

This is the high time that the reasons for horrendous and large scale destruction caused by the earthquake should be sorted out on the basis of a useful and targeted research and the causes should be addressed which include the proper implementation of building code, specially areas with major threats of earthquake, and a dense population like Islamabad, Muzzaferabad and Quetta. The government in cooperation with the private sector should arrange safety and preparedness training programs for the individuals so that the risk factor should be curtailed as much As possible. (Sarwar, et al., 2016).

The major potential earthquake regions are Himalayas, Karakorums and Hindu Kush. The Koh-e-Sulaiman range on the western part of the country with Chaman fault, and Mekran fault along the coast posses great threat. The Arabian plate collision with Eurasian Plate and its continuous northwest movement caused several types of occurrences in these regions. The horrific earthquake of 1935, in Quetta city demolished it. The earthquakes from mid 1970s to 1990s annihilated 5,669 people in the Northern Areas (NA), KPK and Baluchistan. In February 2005, in

KPK, an earthquake killed twenty-four people while 129, 1000 people were harmed in various other ways. Pakistan has been exposed to horrendous natural calamities but the earthquake of 2005 was the worst of all and it turned into an historical human tragedy, ever occurred since the inception of Pakistan. The study conducted post Oct, 2005 testifies country's vulnerability to the natural hazards in the regions listed above (Khan & Khan, 2008).4. Conclusion and Recommendations

Since the inception of Pakistan, it has been observed that the country has seen some worst natural disasters, including dreadful earthquakes and horrible floods. These disasters with the passage of time gained momentum and caused fatality, loss of properties and infrastructure, leaving the economy tattered. The tragic fact is that despite recurrent disasters and pervasive losses, an adequate and accomplished effort has always been lacking to combat these horrific events. At some points there seems a lack of a strong will as some people believe that it would be a useless practice to predict earthquakes or to manage flooding threats before time. But the developed countries of the world have set an example. In Pakistan, coordinated work between different responsible administrative sectors is missing. However, still some important measures which have been laid out below can be taken,

It has been proven that climate change and global warming contribute to the increase in meteorological imbalances and, along with this, natural disasters. Regarding this point, the involvement of businesses in environmental conservation is one of the keys to prevention. It's equally important to introduce risk prevention and evaluation measures into public policies, as well as protocols for action before, during and after natural disasters. The developed countries have focused on devising and implementing strong early warning systems. Thus Pakistan should also do concerted efforts and encourage the people to undertake research in this area to improve the capacity of our country to lessen the effects of natural disasters by applying early warning systems. The fields study should be promoted so that the students of geology are aware of the actual situations. Attention should be paid to long term solution of the problems instead of temporary solution like moving the population from the disaster affected areas as it happens in

case of flooding situations. The settlements may be relocated from frequently affected flood plains. The disaster relief insurance policies should be devised and the people should be encouraged to take those insurance policies. The loss of human lives and the material objects can be reduced by promoting scientific and technological knowledge. The countries with better disaster management control can be asked to offer technical assistance that works based on prevention, evaluation and diagnostic protocols to lessen natural disasters.

The policy makers must centralize their attention to lessen the loss of life as well as social and economic distress caused by disasters such as earthquakes, hurricanes or floods, among others otherwise the changing atmospheric conditions and rapidly volatile natural phenomena will attack us with more might in the form of natural disasters, leaving our economy crippled and people distressed.

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