Impact of Human Development Indicators on the Losses Caused By Natural Disasters in South Asian Countries: A Panel Data Analysis

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A thesis submitted to the Department of Economics & Social Sciences in partial fulfillment of the requirements for the degree of
Master of Science in Applied Economics

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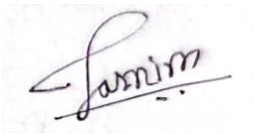

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Approval

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Abstract

A large number of natural disasters hit the South Asian region every year taking away many lives, damaging million dollars' worth properties, crop lands, livestock and leaving thousands of people injured and homeless. South Asia faces so many adverse events due to its geo-climatic characteristic but the socio-economic factors i.e. lack of awareness, insufficient funds for pre and post disaster relief, overloaded population, corruption, poor governance, weak infrastructures add more to weaken the situation. Though disasters are unpredictable and they are obvious to happen, some factors are considered in reducing the damages from disasters. A panel of 5 countries (Bangladesh, India, Nepal, Pakistan and Sri Lanka) covering period 1981-2019 was used to examine the effect of four explanatory variables – (1) population density, (2) GDP, (3) education and (4) life expectancy on the (1) total number of deaths, (2) total number of affected and (3) total financial damages. Using log-log model and linear panel regression, population density is found to have positive impact on the total deaths and affected. Life expectancy of birth is negatively related to the number of deaths and affected as expected. Again, education is found to be positively related to the total affected but reducing the total deaths and total damages. On the other hand, GDP is found to be positively related to human loss significantly but to total financial damages negatively.

Keywords: South Asia**,** Natural Disaster, Development, Disaster risk, Socio-economic factors, Damage.

Table of Contents

List of Tables

List of Figures

Chapter 1

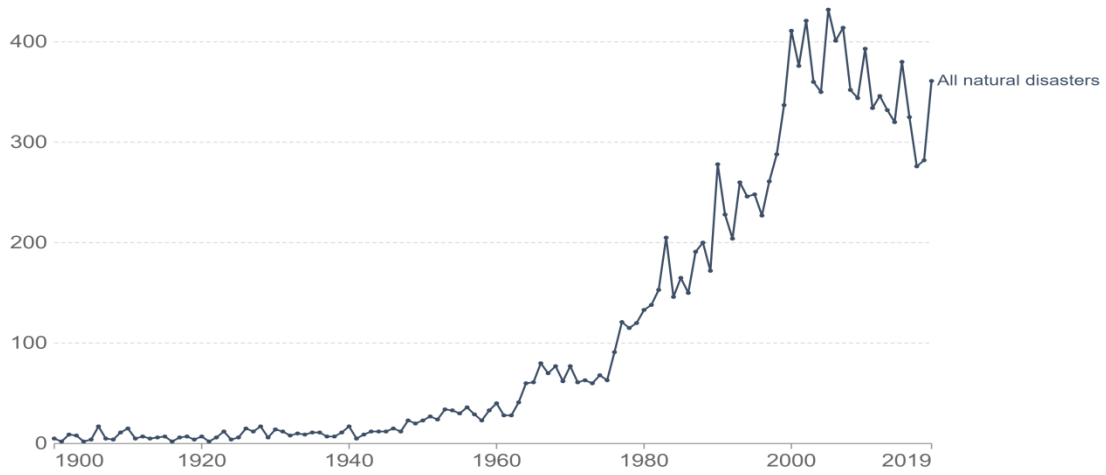
Introduction

Natural disasters are adverse events of some natural process which crudely affect human lives and economic stability every year. There are different types of natural disasters i.e. geophysical, meteorological, climate events that kills millions of people, injuries many and damages the financial stability of affected people. A disaster event leaves a long-run impact on the economy and its population taking away its million dollars property and thousands of lives. The number of deaths varies from year to year depending on the frequency and magnitude of the disasters. Some years pass by few deaths until and unless there is no large disaster shock. Floods and droughts are most fatal disaster events around the world. However, earthquakes also occur frequently in recent decades. The 1983-85 famine and drought in Ethiopia, cyclone "Nargis" in Myanmar in 2008, Indian Ocean earthquake and Tsunami in 2004, Port-au-Prince earthquake in Haiti in 2010 are the examples of such big shocks that lead the number of deaths to 2, 00,000 that comprised 0.4% of the total deaths. In the earlier decades, annual average number of deaths was 45,000 which represented 0.01% of total deaths. According to Global Change Data Lab, the number of death was the highest during 1960s when deaths reached to 5, 00,000. However, there is a large decline in the deaths around 60,000 on average every year. Though these numbers are not less but are impressive if we compare them with the population growth.

Different types of disasters hit different countries depending on their geographical structures. But developing countries are more vulnerable to disasters as these countries lack the preparedness and resource to withstand the damage of disasters. According to CRED, 432 disaster events occurred worldwide in 2021 accounting for 10,492 deaths, 101.8 million affected and US$ 252.1 billion among which Asia had faced 40% of the disasters alone. Disasters leave long term effect on developing economies by damaging properties, killing human lives. Developing countries are more vulnerable to disasters because people live in unsafe urban areas, poorly built house that can be easily damaged by a disaster, poor warning system before disaster, poor social safety networks to cope with disasters (Matjia Zorn, 2018). Poor governance, poverty, foreign debt, excess population, lower education level causes the people to unsustainable farming techniques, deforestation which in turn leads to disasters. These economies already lag behind financially than developed countries from where they have to serve the affected people, repair the infrastructure and feed the homeless,

fund the needy, grant relief after a shock. These all things make the countries divert their fund from development program and worsen the financial condition. Burton (1978) indicated that 95% of the total deaths from natural disaster occur in the developing countries. Tucker (1993) pointed out that earthquake vulnerability in also increasing among developing countries. The loss was 70% in the 1949s that increased to 99% in the period 1950-92.

Figure 1: Total number of recorded disaster events, 1900-2019.



Source: Our World in Data based on EM-DAT, CRED- Brussels, Belgium (www.emdat.be)

Disaster, being natural events, is unpredictable and unstoppable but it is still possible to reduce the damages from disasters and save the valuable lives and properties. Studies suggest that countries with lower socio-economic backgrounds are more vulnerable to disaster damage than the ones with higher socio-economic status (Delgado, 2019). Other scholars pointed out that higher income and education level play significant role in reducing the damages of disaster. Whereas, some studies reveals that countries with higher growth suffer more financial damage during disaster because rich countries accounted for more value assets and infrastructure formation which are exposed to risk during disasters. Higher educated people are more conscious about the preparedness of pre-disaster event, following the government instructions during a disaster, dos and don'ts and the recovery process after disasters. Also, there is evidence that the intervention of government plays significant role in reducing damage from disaster (Surtiari, 2021). Government size, openness to trade, government consumption, GDP growth, corruption, unemployment rate (major socio-economic indicators of countries that are comparatively high in South Asia region) explain part of the variability in damages due to disaster events. There are also studies on the governance in risk reduction, patterns of disasters and statistics on the human and financial

losses in South Asia over time. But few studies are available on South Asian context describing the development factors impact on the losses of disaster.

South Asia is a region of developing and less developed countries. It is counted as the second poorest region in the world with 38.6% people living below poverty line, however these countries have showed robust growth by notable reduction in poverty and increasing education and health. According to World Bank data, South Asian countries have experienced an increase in growth from 6.2 to 7.5% between 2013-2016 while other developing nations still far behind. On the other hand, South Asia is a disaster prone region mainly due to its geo-climatic structure. More than 900 events of disaster occurred since 1970s along with over 800 million deaths, and over $50billion damages. Floods and heavy rains accounted for half of the total events reported in South Asia. As South Asia is growing rapidly in terms of population and socio-economic growth and being a disaster prone region, it is crucial to examine if the growth and development of the South Asian countries is actually contributing to reducing the human and financial losses of the disasters or not. Researchers have drawn attention on this issue in different periods assessing national, sub-national levels and randomly selected developed and developing countries. There are also studies available on the South Asian context regarding loss statistics. But few papers have drawn attention to the issue of human development indicators in contributing to reducing the human and financial loss caused by the disaster.

The aim of this paper is to examine the relationship between the major human development indicators and losses caused by natural disasters. After a literature review, education, income and health were chosen as the major variables of interest as these three indicators are the primary indicators of the socio-economic status of a country as the previous studies say that increase in income and education leads to a reduction in the losses caused by natural disasters. Population is also considered as development of a nation largely depends on the number of people especially in South Asian countries where the population is too much in proportion to the land area which is a burden for the nation in the path of development and growth. This paper also considers a new variable “Life expectancy rate” (measure of health) expecting that a more healthy community is more capable in resisting disaster damage. The later chapters of the paper are organized as literature review, describing the data and methodology and the obtained results respectively. A policy recommendation is also added following the empirical results.

Chapter 2

Literature Review

A growing body of literatures is available on the contribution of human development indicators in reducing the human and financial damage of disasters on various country and regions. This section has reviewed the studies that analyzed the effect of different countries' socio-economic status on the losses of natural disasters. Some studies are focused on national level, some are sub-national and some have cross-country analyses about how the growth and development has contributed in reducing the human and financial losses. Studies are organized based on their year of publication in ascending order.

According to Bruce (1994), economic losses have increased dramatically in 1992 which is 10 times more than the average loss of 1960s. There are three types of global change i.e. economic development, change in land surfaces and frequency and severity of disaster that affects the human and economic losses in times of natural disaster. Countries that are well prepared for disaster can achieve reduction in losses, though population growth and higher economic development have resulted in increased exposure in some hazard zones.

Kahn (2005) examined the role of income, geographical and political factors and institutions in analyzing disaster impacts. Results found that countries with higher income experience more deaths during disaster which is also applicable to countries with better institutions and political environment i.e. democracy. Later, Mobarak (2008) expanded this study to show that this relationship between income and death is non-linear. Death increases with lower per capita income and then decreases.

Burney (2007) in the US conducted a study to assess the level of preparedness and found that participants who had previous experience with disaster were more prepared to adjust and rebuild the losses than the ones who had not faced such incidence. But poverty is also a major factor affecting their preparedness.

Neumayer (2007) examined 141 countries using data during 1981-2002 to see the vulnerability of women in terms of the gender difference gap in life expectancy rate as a result of natural disasters. In general, life expectancy of women is more than men but findings figured out that it is reducing day by day compared to men with the magnitude of natural disasters. Number of the Deaths of Women are more than men during disasters and the stronger the disaster, the more deaths occur. But another significant finding is that women

with higher socio-economic status face less risk than weaker ones. So, it clearly indicates the socially constructed gender gap.

Habibullah et al. (2008) used pooled time series regression to analyze the relationship between socio-economic variables and macroeconomic variables using data from 15 Asian countries. They used the variables GDP, land area, population and schooling as the determinants of the deaths caused by natural disasters. Results suggest that higher economic development provides protection to the population up to a certain level and then limits the level of disaster resilience. The study also suggests education as a better resistant for disaster risk. People with higher education tends to choose more safety measures, well protected construction, pre and post disaster precautions which reduces the human losses. Again, countries with higher population suffer more in terms of human loss and less in case of a huge land area in proportion to a scattered population.

Noy, I (2009) examined the effects of literacy rate, openness to trade, better institutions, higher income and stable government to determine fatalities from natural disaster. Results found that countries with higher literacy rate, more openness to trade, larger government appears to be more successful in resisting the losses of natural disaster. Financial accounts such as open capital accounts, higher domestic credit and higher foreign reserves are also remarkable factors in minimizing the losses with less spillover to GDP growth rates.

Klomp (2014) analyzed 25 primary studies to examine the indirect economic effect of natural disaster that is the growth per capita. It is found that natural disaster reduces economic growth significantly which is increasing over time and strongest for climatic and geological based disaster. Moreover, climatic and geological based disaster reduces growth significantly in the short-run and insignificantly in the long-run, but loss from hydro meteorological disasters reduces economic growth significantly both in the short and long-run.

Yang Zhou (2014) conducted study on the relationship between loss of natural disaster and socio-economic development in the eastern, central and western regions comprising 31 provinces of China. They used data from 1990-2010 to run ordinary least square regression (OLS). Economic development was found playing remarkable role in mitigating the loss of natural disaster. A U-shaped relationship was found between growth and disaster loss in the eastern region and the whole country but an inverted-U linkage in the western and central regions. But growth has positively affected the central region than others. Economic development also caused lower deaths in the country whereas lower education level, higher

dependency ratio and higher unemployment contributed to increased death rate around the country. Though this effects are offset by the growth of wealth.

Sodhi, Manmohan (2016) analyzed 50 years of data (1963-2012) across 179 countries to analyze the impact of natural disasters through the output of a countries income. Excess population of a country downwards its income per capita which in turn increases the vulnerability of the population and its disaster damage. Results suggest that per capita income is negatively related to total affected but positively related to the total damages but in the early years. This means people are more affected in poorer countries but rich countries face more loss during disaster. It is not significant in the later years of the period 1963-2012.

Murillo & Shukui (2017) explored the negative consequences of natural disaster on the difference of gender gap in life expectancy rate across Southeast Asia from 1995-2011. They analyzed male-female ration of life expectancy, country vulnerability to disaster, number of disaster related causalities and women's socio-economic and political rights in decision making. Findings pointed out that women's life expectancy is declining with the increased magnitude of the disasters and women's are more vulnerable to disaster related risk than men.

Kumar et al. (2017) analyzed the vulnerability of poor households to flood risk and based on livelihood vulnerability index and socio-economic vulnerability index in India and found the households vulnerable to flood in more than one dimension.

Padli, J. et al. (2018) used panel data from 79 countries to find the effect of human development indicators on the fatalities of natural disasters. They assumed that countries with high level of human development should be able to reduce the losses more in terms of human lives and financial damage. They used education level and income per capita as their variable of interest. Other variables i.e. population density, unemployment, openness, investment, government consumption, corruption were used as determinants of the number of disaster fatalities. They used system G.M.M method for estimation and found education significant in reducing losses during earthquake at 5% significant level and during floods at 10% significance level. They also found densely populated countries more vulnerable to losses compared to countries with lower population. On the other hand, investment along with government consumption tends to be positively related to losses and openness tends to reduce the number of human and economic losses. Lastly, higher level of corruption is associated with higher level of deaths, financial damage and total affected during earthquake, wildfire and droughts. In addition, it is observed that disasters affect more poorly endowed

municipalities in their long term indicators such as the HDI, but the effects seems to take a U-shape when it comes to poverty levels.

Jeong & Yoon (2018) analyzed whether socially and economically marginalized people are more vulnerable to disaster or not. They performed study through a linear regression model collecting data on 230 local communities in South Korea. The study compared the results of spatial autoregressive model to OLS regression for the presence of both spatial autocorrelation and performance of the model. Results found that communities with lower socio-economic status appear to be more vulnerable to disasters. They found positive correlation between low education and disaster loss because uneducated people are more likely to be unaware of the preparedness during disaster and unable to receive the funds and instructions during disaster. Again poor communities are also more vulnerable to disaster risk whereas communities with many manufacturing establishments had negative relationship with extent of damage from natural disaster.

Songwathana (2018) aimed at investigating the relationship between natural disaster and economic development at cross country level. They examined 168 countries during the period 1990-2016 taking the three factors i.e. economic (income), socio-economic (education and population), geographic (land area) into account through panel data analysis. Random effect specification was used to analysis as it accounts for both country and time factors. It was found that countries with higher income level are able to reduce the number of affected people but faces more economic loss during the disasters. Again, significant and strong negative relationship is found between education level and disaster loss and positive relationship between the disaster loss and population size.

De Sliva et al. (2018) conducted a case study in in the rural community of Sri Lanka consisting of 517 households investigated the relationship between poverty and disaster risk. The households were classified as poor and non-poor group and examined their economic loss that they suffered during floods and droughts. It was found that households with low income specially the one living solely on agriculture were more vulnerable to disaster than high income ones.

Billah et al. (2019) conducted a South East Asian analysis on the correlation between patterns of mortality by natural disaster and HDI showed that there is highest death with lowest HDI during 2014-15.

Mochizuki, J., & Naqvi, A. (2019) conducted a study on 131 countries' disaster risk adjusted human development index (RHDI) estimates and found variability in risk across different HDI groups and geographic regions where smaller islands and highly exposed countries in Asia Pacific and Central America were at the highest risk relative to public expenditure and gross investment. Medium HDI countries were found to have more variability in relative disaster risk in case of health education and other facilities and low HDI countries were found to face on average lower relative risk than other HDI groups.

Vassilis T, Emma L.T (2020) figured out the question if disasters can be prevented using political and socio-economic factors tools. Using data from 224 countries over the period (1960-2016), the run fixed effect logit model and found that socioeconomic factors are more significant in preventing losses than political factors. Poor countries are found to be more vulnerable to disaster than richer ones. Education level is also found to have significant and negative effect on the damages caused by disaster whereas political factors as government composition and federalism have no significant effect in reducing the disaster damage. So, findings suggest focusing on investing in economic development, education that is significantly responsible for a country to be vulnerable to disaster.

Chowdhury, J. R. (2021) examined the effect of inequality adjusted human development in minimizing the male and female flood fatalities across 19 states in India during 1983-2013. They checked whether states with higher IHD index affects male and female flood deaths differently while controlling for direct spending on disaster adaptation measures and socio-economic factors. The results found that 10% increase in the IHD index is associated with the probability of 38% lower deaths during floods. Besides, there is also gender based differentiation in the fatalities of flood that a 10% rise in IHD index shows the probability of 26% fewer deaths in male and 12% fewer deaths in female during floods.

Prasetyoputra, P. (2021) through a study in Indonesia examined the effect of HDI and GDP on human loses from deaths and found that higher socio-economic development could reduce death loss. The study also shows that better income, better educational attainment, and also good governance in the financial system have proven to reduce losses.

Atsalakis et al. (2021) used quantile on quantile method (QQ) to shed light on the complex relationship between disaster loss and economic growth using data from 100 countries over a period of 30 years. There is a negative founding in the relationship between growth and disaster loss. But this can be positive depending on the quantile used. The magnitude of the

effect is also different for different combinations of the quantiles of disaster. Again, the results are quite different for countries that differ in terms of climate, economic development.

Farhad T. et al. (2021) examined the impact of development, quality infrastructure and corruption on the damages caused by natural disaster. They used data from 14 Asia and the pacific countries over the period 2007-2017. Results support the theories that countries with higher level of GDP and quality infrastructure are more capable to mitigate the damage from disaster. Again where there is less corruption, there is less damage.

Khan et al. (2022) used generalized additive modeling to explore the effect of risk (hazard, exposure, vulnerability) and resilience (infrastructure, food security, women empowerment, human capital, emergency workforce, communication technology etc.) indicators on the losses of natural disasters in 24 high income countries, 24 upper middle-income countries, 30 lower-middle income countries and 12 low income countries from 1995-2019. Results found positive link between damage and hazard index in all panels and exposure index in high income countries. Again there was decrease in losses of natural disaster due to an increase in infrastructure (upper income, lower income and low income countries), information and communication technology (high income countries), food security (high and upper middle income countries), women empowerment (lower middle income countries), and human capital (low-income countries).

Table 1: Key issues of the previous literature

Findings	**Study description**
Higher development increases exposure to loss due to increase in value assets and infrastructure	Bruce (1994)
	Kahn (2005)
Higher income reduces human and financial loss during disaster	Klomp (2014)
	jeong Yoon (2018); 230 local communities of South Korea by
	Manmohan (2016); 179 countries
	Kumar (2017); India
	De Sliva (2018); 517 rural households of Sri Lanka
	Atsalakis (2021); 100 countries; Quantile on Quantile method
More preparedness reduces death	Burney (2007); US
	Bruce (1994)

Socio-economic variables are strong factor in mitigating the losses caused by disaster	Habibullah (2008); 15 Asian countries; Pooled time series using variables (Education, GDP, land area, population)
	Noy (2009) using variables- Literacy rate, income, institution, govt. size, openness to trade
	Yang Zhou (2014); 31 provinces of China; variables - Education, dependency ratio, unemployment
	Padli (2018); 79 countries; System G.M.M method in log-log model; variables- Education, population density, income, unemployment, corruption, govt. consumption, trade
	Songwathana (2018); 168 countries; Random panel regression; variables- Income, education, population density
	Vassilis (2020); 224 countries; Fixed effect logit model; variables- Education, income, govt. composition
	Prasetyoputra (2021); Indonesia; variables- Education, income, governance in financial system
	Farhad (2021); 14 Asia & Pacific countries; variables- GDP, quality infrastructure, corruption
Higher HDI reduces loss during disaster	Billah (2019); Southeast Asia
	Chowdhury (2021); 19 states of India

Chapter 3

Theories & Backgrounds

Natural disasters are inevitable phenomenon around the world. The year, 2021, experienced huge loss including 7.2 magnitude earthquakes in Haiti (2000 deaths), flood in Germany (200 fatalities), landslides in China (300 killed) and typhoon in Philippines (375 deaths). In the last decade, around 60,000 people died year due to natural disaster that represents 0.1% of the total deaths. Historically, floods and droughts are most fatal disasters but earthquakes are also at its extreme. More than 260 thousand deaths reported due to earthquake during 2010-2019, though the frequency of disasters is declining in proportion to the earlier decades. The number of deaths in the 1920s was 500,000 per year on average. This was because of a number of events that caused the fatalities up to the peak level. A 1923 earthquake in Tokyo killed about 146,000 people that were a big shock for the world. Again, 3 million people were

killed in during the flood and drought (1928-1930) in China. In the later decades, there was some decline in the numbers. However, some events as floods and earthquakes had still kept its trend of deaths. For example, the 1931 flood in China killed around 3.7 million people and the 1935 earthquake killed over 60,000 thousand people in Pakistan. But the fatalities have dropped to 100,000 per year on average which is quite impressive if we compare it to the growing trend of population.

Table 2: Deaths caused by natural disaster in the world during last decade

Types of Disasters	**Total Deaths (2010-2019)**
Earthquake	267,480
Extreme Temperature	74,244
Floods	50,673
Storms	27,632
Droughts	20,120
Landslides	10,109
Mass Movements	100
Volcanic Activity	1,363
Wildfires	881
Total	**452,602**

Source: Our World in Data based on EM-DAT, CRED- Brussels, Belgium (www.emdat.be)

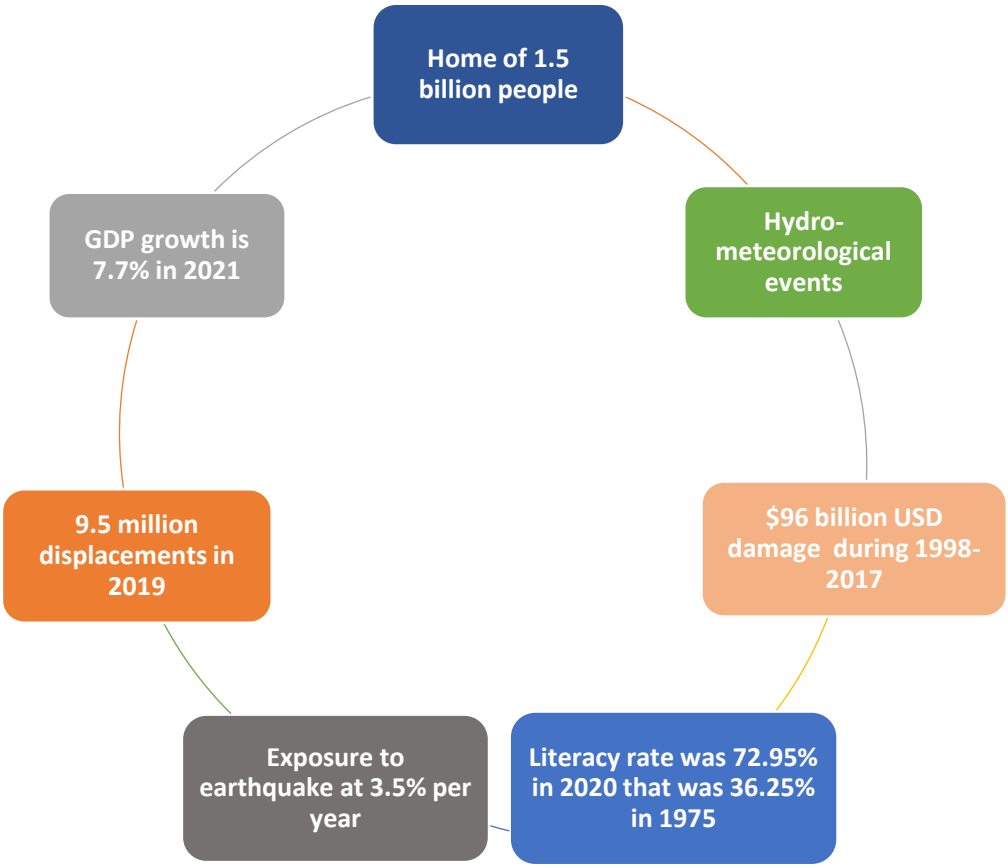
Hit of a natural disaster incurs great loss to a country in terms of its property and financial damage, human loss, loss in trade, food grains, destroying infrastructure and leaving the impoverished displaced and homeless for a long time. And its effect is most in the developing countries with poor governance, weak infrastructure and insufficient funds to grant relief and preparedness, poverty, overloaded population in proportion to land area, lower education rate, higher level of environmental degradation etc. But studies show that countries with higher level of GDP along with expensive homes, lands, infrastructures experience more destruction during disasters. Annually approximately 69 disaster events were recorded during 1970s - 2000s that increased to 350 per year in the world along a growth of US $88 billion economic loss, whereas South Asia alone experienced quadrupled increase in disasters over the past four decades resulting in damage over US$25 billion.

South Asia is the region that comprises 8 developing countries - Bangladesh, Nepal, Pakistan, India, Sri Lanka, Bhutan and Afghanistan and the most vulnerable regions affected by all types of natural disasters. South Asia is a home of 1.5 billion people. Its GDP growth is 7.7% in 2021, which is highest in Nepal at 7.9%. Bangladesh, India and Nepal are considered as

the strongest economy within this region. Countries have achieved growth through investment in manufacture, agriculture etc. But growing damages from the natural disasters hitting every year causes the economies to suffer long-run lifting the negative impact on growth. The region is mainly affected by hydro-meteorological and geological events including floods, droughts, famine, tsunami and earthquake.

South Asia is disaster prone mainly due to its geo-climatic characteristics. These hazards range from earthquakes and avalanches to glacial lakes, cyclones originated in the Bay of Bengal and Arabian Sea, floods and droughts in the plains. Most of the countries in the region share the same geographical formation and river basins, so disasters originated in one country easily cross the national boundaries. So, growing frequency and magnitude of disasters make the countries face a wide range of cyclone, floods, tornado, earthquake, landslide, drought every year with massive loss of human lives and damage of properties. Climate change, unplanned and rapid urbanization, deforestation, environmental degradation, poor socio-economic conditions make the countries more vulnerable to risk of disaster loss. South Asian countries have witnessed alarming rate of deforestation during 1990-2005, whereas Afghanistan, Sri Lanka, Nepal faced 1.9%, 1.3% and 2.7% forest loss annually. Rising temperature of the earth by 0.74% over the last 100 years is also a major threat of which South Asia is also a contributor. Though it is not a major contributor of C02 emission but rapid growth is demanding more energy at a faster pace. A major threat also comes from the melting Himalayas situated in the South Asian region. The major rivers i.e. Ganga, Brahmaputra, Indus, Meghna contribute to the flood of South Asian region. The 2010 and 2011 floods of Pakistan have drawn attention to the patterns of natural disasters of South Asian countries marking as a red zone for change. According to a human suffering index, Bangladesh is one of the most vulnerable countries in case of life loss from natural disaster from 1986 to 1993. Due to vast number of marginalized people i.e. women, poor and dependent indigenous group, the vulnerability increases around the country. According to a report, women accounted for 90% of the total affected and deaths during 1991 cyclone in Bangladesh.

Figure 2: Features of South Asian region



Countries are more exposed to disaster due to increased population, greater capital shocks, economic growth and rapid and unplanned urbanization. South Asian flood losses are 15 times greater than OECD countries relative to the size of GDP. Frequency of disasters increased fivefold from 8 (1971) to more than 40 (2009). The various events affected more than 2 billion people and 8, 00, 000 deaths. Direct economic losses accounted for around US$80 billion excluding the indirect losses. The increase in frequency of the disasters is mainly driven by hydro-meteorological events. This is due to the nation's weak capacity to manage heavy storms and rainfall and increased of assets accumulated in high risk areas. South Asia accounts for 64% of the total population affected by flood. The economic losses also incurs due to the increased accumulation of capital and asset in the exposed areas. Along with the growth in population and urbanization, cities become developed and the accumulated wealth grows that is exposed disaster events. Between the years 1970-2010, spending in the infrastructure development increased by 50 times in the South Asian region. So, it can be pointed out that cities have high valued assets and significant amount of private-

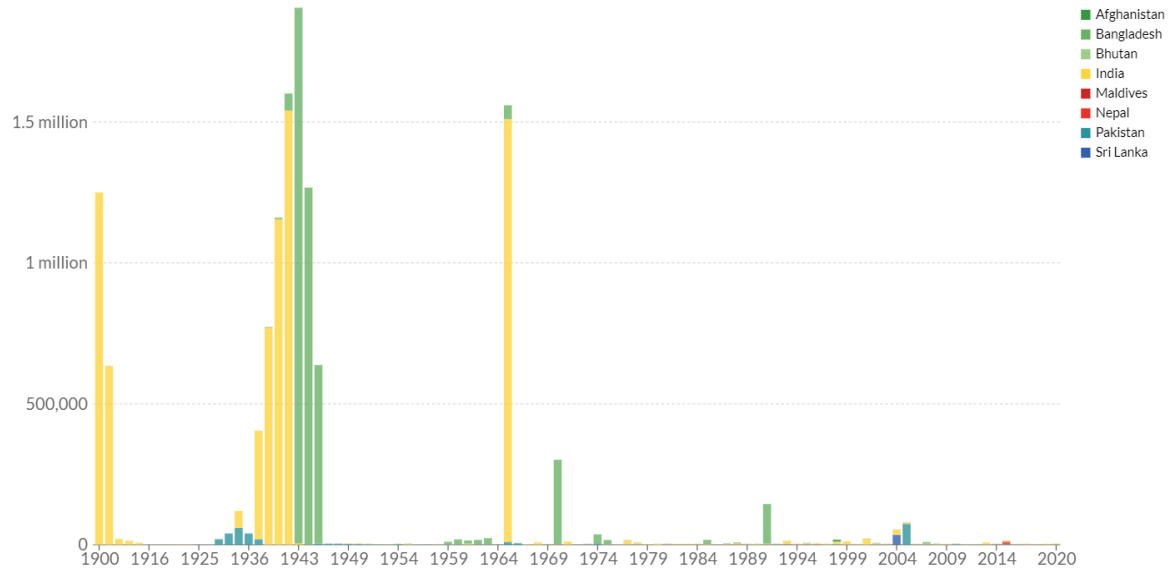
public infrastructure that are not resilient to hazard events despite large scale of development. The development opportunities suffer more during disasters. Public expenditure is put under severe stress for the need to reallocate the fund of development projects to the reconstruction of the post damage activities. For example, India has drought in 2003 and flood in 2005 that consumed the state budget US$ 3.5 billion more than the entire planned expenditure (US$3.04) on agriculture, rural development and irrigation during the period 2002-2007. Population in the coastal areas is rising alarmingly and it will hopefully hit 246 million by 2040 in South Asia in contrast to 160 million in OECD countries. The urban population exposed to cyclone is expected to grow 2.2% per year until 2050. The fastest exposure to earthquake is also the South Asian region at 3.5% per year. The major cities of the region i.e. Dhaka, Chittagong, Delhi, Karachi, Kathmandu, Lahore and Mumbai will still continue to grow population and assets that are highly prone to natural disaster. The impacts of natural disaster are worsening due to increased frequency and magnitude of disasters but the explosion of population, increased growth of wealth; lower education level and lower life expectancy rate also contribute to the loss.

Afghanistan: The country Afghanistan is a victim of humanitarian issues facing internal wars and external attacks. On the top of that, natural disasters have worsened the situation since early 1980s killing over 19,000 people and displacing 7.5 million lives. Disasters such as floods, droughts, earthquakes, landslides affect around 4, 00,000 people every year. The country is more affected by flooding. 66 floods hit during 2000-2018 which is 56% of the total recorded disasters killing 2374 people. The flood of 2010 affected approximately 5, 00,000 people around the country. India also faced 660 deaths and millions of affected in 2007 flood in the West Bengal region. 330 people were killed, 8208 missing and 1 million were left homeless along with more than 15,000 people isolated from relief crews during cyclone “Aila” in 2008. The 2021 flood in Nuristan province took away 260 lives and 360 acres of land and 3200 fruit trees.

Bangladesh: Bangladesh is the most disaster prone country in the region, 15% of which land floods annually which turned to 34% in the flood of 2004. Moreover, two floods and a cyclone in 2007 hit the country killing 4,000 people and losing about US $3 billion. Cyclone “Sidr” hit the southern part killing 3500 people and leaving thousands of people homeless. The 2007 floods that swept across India, Nepal, Bhutan, Pakistan and Bangladesh hit 6 divisions of Bangladesh with 500 deaths and displacement of 5 million people. The cyclone “Aila” that originated in India also caused a massive destruction in Bangladesh by isolating 4,

00,000 people by flooding in coastal region. A severe event of storm of 2011, flooded away four villages in the Nijhum Dip damaging 300 to 400 houses and 50 people injured. During the period 1962-88 flooding, Bangladesh lost around 30% of the food grains each year. The height in the loss was in 1988 which caused a loss of 1.5% in the GDP. In 2021, heavy monsoon rain and rainfall turned into flood affecting 70% of the refugee camps destroyed.

Figure 3: Total number of annual deaths from disasters in South Asia

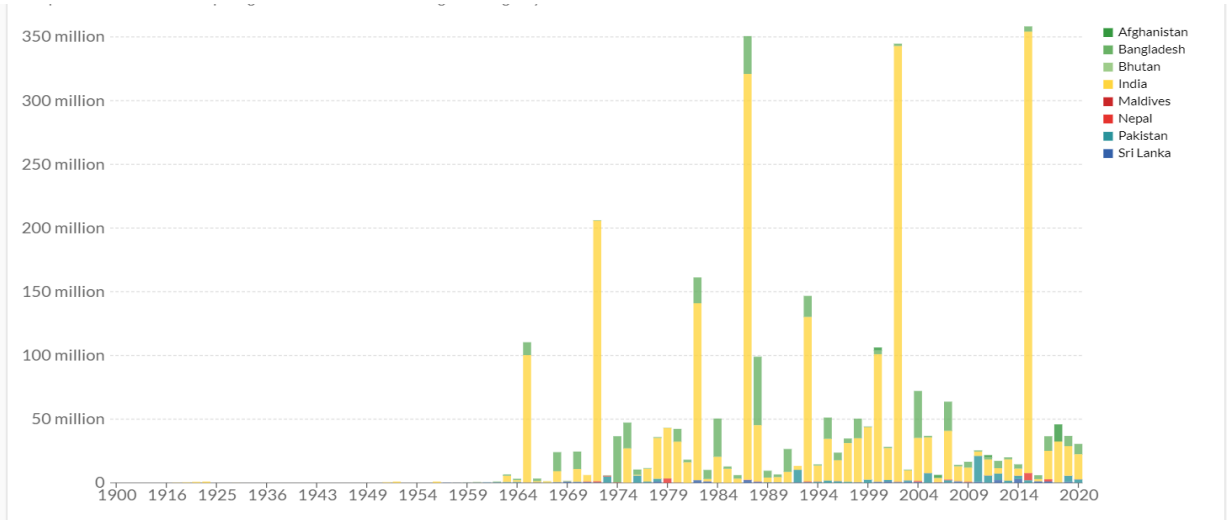


Source: Our World in Data based on EM-DAT, CRED- Brussels, Belgium (www.emdat.be)

Pakistan: Pakistan is also affected by extreme heats, floods, droughts, earthquakes. It has ranked eight for extreme climate events in the last two decades (Climate Risk Index, 2021). Pakistan also faced devastating floods in 2007, 2008 killing more than 40 and displacing over 2, 00,000 people along with damaging 12,000 houses, agricultural lands and crops. The worst flood Pakistan ever faced was in 2009 in the last thirty years. In 2011, the Sindh province faced record breaking rains that caused 466 deaths with 34, 000 villages affected and 1.6 million houses damaged. The rural economy ruined due to a loss of 2.1 million acres of cropped area and 116, 000 cattle heads. A major earthquake hit the "Harnai" district killing 21 lives, 300 injured and damaged 1000 houses approximately. Extreme drought conditions during 2018-2019 also affected five million people. The government of Pakistan also declared a national emergency during the monsoon rain that led to flood in the Sindh province in 2020 affecting around 2.4 million people.

Nepal: Nepal faces almost 1000 deaths per year due to floods and landslides. 28 of the 75 districts of the country were affected during the 2007 flood causing 84 deaths and 9700 families displaced. Nepal has a record of destructive earthquakes of long magnitudes ranging from 2 to 5 scales. More than 30, 000 deaths are caused by earthquakes in the 20th century. Nine major earthquakes hit Nepal over the last 700 years. According to the ministry of home affairs, there was 700 deaths, 181 injured and 80% of the harvested land damage in Nepal in a 2021 flood incident among them 77, 673 people are suffering from food crisis.

Figure 4: Total number of affected from disasters in South Asia



Source: Source: Our World in Data based on EM-DAT, CRED- Brussels, Belgium (www.emdat.be)

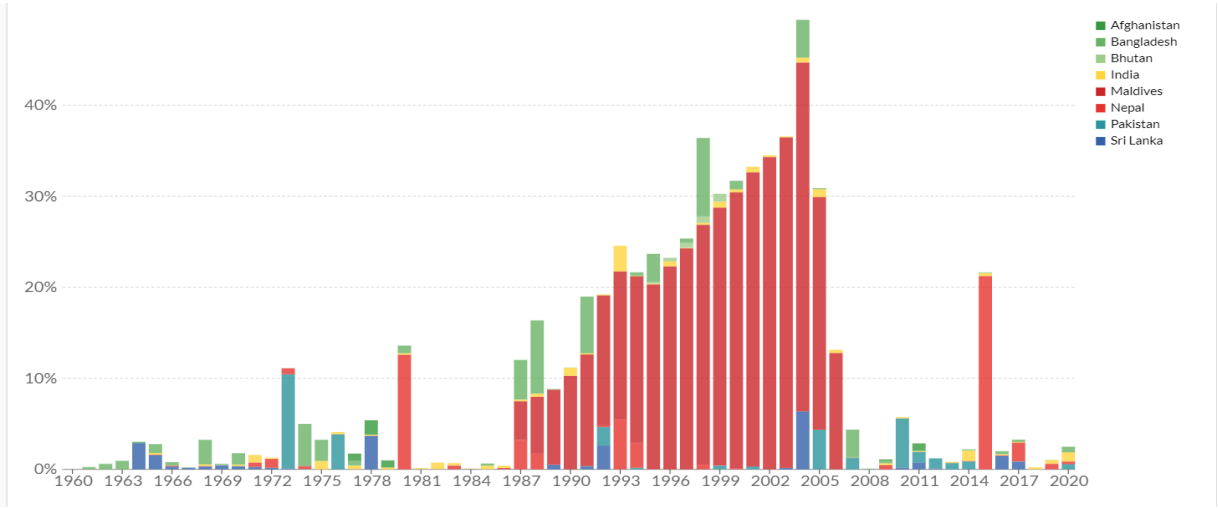
Sri Lanka: Sri Lanka is also exposed to frequent tsunami, flood, landslides, and droughts. In 2011, the country experienced the worst rain that affected 1 million people. From 1980 to 2010, 62 different events were reported among which 2004 disaster was the worst. It killed 30, 196 people and made 1.5 million people homeless. Agricultural sector damaged seriously with 259 square km of paddy land. It again faced a disastrous flood in 2011 killing million people and displacing 4, 00, 00 people. Sri Lanka is more vulnerable to earthquakes that witnessed three major earthquakes in the last quarter of 2009. Heavy rainfall caused floods and mudslides in Sri Lanka affecting 245, 000 people.

Bhutan: Bhutan is also exposed to floods, wildfire, earthquakes, and windstorms. Floods hit every year taking away major percentage of mortality. The country also experienced 12 earthquakes in the last half century including a 2009 earthquake that led to $97 million loss.

Floods also hit Bhutan in those years resulting in 12 lives and US $17 million financial loss. The 2011 earthquake in Bhutan took 14 human lives and damaged property worth around 24.5 million USD. The countries agricultural land, infrastructure is located along drainage basins that are highly vulnerable to flooding during monsoon rains. The center and southern part of the country is also exposed to wildfires.

Maldives: Maldives is the smallest country in the region and lowest country in the world that is only 1.5 meters above the sea level. The 2004 tsunami hit Maldives destroying the lives of a third of the population. Thirteen islands were evacuated claiming 82 lives and 15000 displaced people. The tsunami hit the country's economy badly by destroying hospitals, clinics, schools, homes, transport, fisheries and tourism industries that costs approximately 62% of the country's GDP.

Figure 5: Total number of annual damages from disasters in South Asia



Source: Our World in Data based on EM-DAT, CRED- Brussels, Belgium (www.emdat.be)

Billah (2019) conducted a South East Asian analysis on the correlation between patterns of mortality by natural disaster and HDI showed that there was highest death with lowest HDI during 2014-15. But higher economic development provides protection to the population up to a certain level and then limits the level of disaster resilience (Habibullah, 2008). A larger share of the infrastructure is in the disaster prone areas and the safety measures are not enough to keep pace with the growing development. Lack of resilient development, proper land use planning and proper building codes drives the disaster risk to a great extent. Though South Asian region is growing faster but the growth is still less than the developed world. So,

the financial loss is comparatively low in such countries but higher in terms of human loss. And this growth and population will continue to increase making citizens more vulnerable if developments are not managed properly. The increasing form of development in the slum and disaster prone areas is making South Asia the hotspot region of disaster. To reduce the human and financial losses and mitigate the risk of massive destruction during disasters, the growing development of the countries in terms of education, income, government intervention and consumption, corruption, unemployment, poverty, fixed investment can be a significant alternative besides the political and institutional policies. Communities with lower socio-economic status appear to be more vulnerable to disasters. Studies found positive correlation between low education and disaster loss because uneducated people are more likely to be unaware of the preparedness during disaster and unable to receive the funds and instructions during disaster (Jeong & Yoon, 2018). Higher socio-economic development leads to lower relative risk than other HDI groups (Prasetyoputra, 2021; Mochizuki, 2019), whereas lower education level, higher dependency ratio and higher unemployment contributed to increased death rate around the country (Yang Zhou, 2014).

Literacy rate of a country is its major weapon to combat against all negativities. The more people are educated the more they are conscious about their well-being. They can observe well, prepare well, follow well and serve well. South Asia is a region of developing countries where literacy rate was 72.95% in 2020 that was 36.25% in 1975, a double increase in 45 years. A sharp rise in literacy rate is of great advantage because education tends to play a significant role in reducing disaster risk (Habibullah, 2018). Education is not the only solution but the one of the strongest socio-economic factors reducing disaster loss (Atsalakis, 2021). Risks, emergencies and violence's during disaster affects people specially children badly. This is where education comes into action in spreading peace and non-violence. Educated people are well informed about the risks during disaster, more capable in receiving government instructions, funds, tackle the pre and post disaster vulnerabilities (Jeong & Yoon, 2018; Songwathana, 2018).

Besides, South Asia has faced rapid growth of population in recent years. Population has become 24.89% (1.94 billion) of the world population, putting more people exposed to disaster risk. Countries with higher population suffer more in terms of human loss and less in case of a huge land area in proportion to a scattered population (Habibullah, 2008). Around 65 cities of South Asia have a population of 1 million with 10 million in 5 major cities. Dhaka, Karachi, Delhi, Mumbai and Kolkata are about to reach 20 million in a very short

period. Currently, South Asia consists of most of the mega cities in the world. But large number of the population lives near the coastal lines such as Bangladesh and Maldives citizens. These people are exposed to frequent floods and cyclones. A large number of people also live around the Himalayan belt increasing risk to earthquake, landslides and heavy rainfall. Excess population compared to small land sizes is a burden for economy. Providing safe home, employment food along with disaster protection is next to impossible for the developing economies. Densely populated countries are more vulnerable to losses compared to countries with lower population (Padli, 2018; Manmohan, 2016; Songwathana, 2018).

Countries with higher growth are for vulnerable to disaster as the assets and infrastructures are exposed to damage because of lack of protection. Its GDP has reached $14.83 trillion that will further grow by 6.3% by 2023 as per the growth projections. The GDP devoted to fixed investment has increased remarkably keeping pace with growth. Investment in land, machinery, plant, economic and social infrastructure has increased substantially. The gross fixed capital formation in South Asia has grown by 320 percent from 1991 to 2009. That means, amount of assets exposed to disaster has grown substantially. Countries with higher income can withstand the disaster loss more successfully (Atsalakis, 2021; Songwathana, 2018) but the relationship between GDP and disaster loss is projected to be non-linear Mobarak, 2018). Countries with costly infrastructure and valuable assets experience more financial loss due to the damage of properties (Bruce, 1994; Khan, 2022). But at the same time they are able to reduce the human loss with more income than the poor countries (Habibullah, 2018; Prasojo, 2021). Mobarak (2018) suggests that, the dual goals of and economic development and disaster risk prevention cannot be assumed to be complementary for all forms of natural disaster for the least developed countries.

Again, the negative impacts of disasters are also gender biased. Women's are more vulnerable to disaster risk than men. This threat increases the gender difference in life expectancy as the magnitude of the natural disaster increases (Neumayer, 2007; Murillo, 2017). Life expectancy is an indicator of a healthy community and a healthy community is more capable of resisting disaster damage. Higher life expectancy of a country represents the countries public health achievement and better health infrastructure. People of the country will be more capable in preparing for the disaster and resist the post disaster calamities and different types of diseases coming with the disasters. So, it seems to have a negative relation between the life expectancy rate and loss of disaster. Life expectancy is a significant factor in reducing disaster risk and strategies to achieve greater life expectancy can be an effective

way to reduce disaster risk (Egawa, 2018). In this study, we consider the major human development indicators i.e. education, life expectancy rate, GDP growth and population as our variable of interest upon finding their significance relevance and importance in analyzing the human and financial damage of the natural disasters in South Asia.

Chapter 4

Data & Methodology

This section is divided into two segments- the description of the data and their various sources used in the study. The next segment describes the equation and the method used to find out the relationship between the variables of interest.

4.1 Data

The data set used in the regression consists of a panel of 5 South Asian countries during the period 1981-2019. 39 years of data was used to examine the impact of the growing human development indicators on the losses caused by natural disasters in 5 South Asian countries. South Asia is a region of 8 countries including Bangladesh, Nepal, Pakistan, Sri Lanka, India, Afghanistan, Bhutan and Maldives. 5 countries (Bangladesh, India, Nepal, Pakistan and Sri Lanka) were selected among them due to massive unviability of data on the human and financial losses, education and GDP growth. Data on number of total affected, number of total deaths and total damages was collected from the Centre for Research on the Epidemiology of Disasters (CRED) launched website Emergency Events Database (EM-DAT), established in 1988. Total number of deaths counts the confirmed deaths plus the missing people. Total affected is the people physically or financially suffered and the total damages are the total financial damage in monetary terms faced by the country during a disaster event. Data on the other variables i.e. population density, life expectancy, education and GDP was collected from World Development Indicators (WDI). WDI is the primary collection of the World Bank's data on the various development indicators of cross-countries. Description of the variables is given in Table 1.

Table 3: Description of variables

Variable name	Description of variable	Source
GDP per capita (GDP)	Gross domestic product divided by the total population (current US$)	WDI, 2022
Life expectancy at birth (LE)	Total number of years, an infant lives assuming the present mortality pattern constant (years)	WDI, 2022
Population density (Pop)	Total number of people divided by land area (per square km)	WDI, 2022
Average Years of Schooling (Edu)	Average years of education completed of people aged 15+ (years)	WDI, 2022
Number of deaths (TotDe)	Total number of confirmed deaths and missing people	CRED (EM-
Number of affected (TotAf)	Total number of homeless, injured, displaced	CRED (EM-DAT)
Total damage (TotDa)	Total damages of infrastructure and lands ('000 US$)	EM-DAT

4.2 Methodology

Some papers have used system G.M.M estimator in a log-log model (Padli, 2018), some authors have used linear regression (Jeong & Yoon, 2018). Songwathana, 2018 used a random effect specification whereas Vassilis T, Emma L.T (2020) used fixed effect logit model to find the relationship between losses and macroeconomic variables. Again, Habibullah et al. (2008) used pooled time series regression to examine the relationship between socio-economic variables and macroeconomic variables using data from 15 Asian countries. After going through the literature, this paper aims at a simple panel analysis in a log-log model based on a cross section of 5 and time series of 39 years covering the period 1981-2019. All the variables were transformed into their natural logarithms. The variables were also run through the multicollinearity test and homoscedasticity test to check their fitness for the regression. Considering number of deaths, number of affected and total damages as dependent variables and life expectancy, education, population and GDP as independent variables, this paper proposes the following three log-log models:

$$\text{Log (TotDa)}_{it} = \text{Log (Edu)}_{it} + \text{Log (LE)}_{it} + \text{Log (GDP)}_{it} + \text{Log (Pop)}_{it} + \varepsilon_{it}$$

$$\text{Log (TotDe)}_{it} = \text{Log (Edu)}_{it} + \text{Log (LE)}_{it} + \text{Log (GDP)}_{it} + \text{Log (Pop)}_{it} + \varepsilon_{it}$$

$$\text{Log (TotAf)}_{it} = \text{Log (Edu)}_{it} + \text{Log (LE)}_{it} + \text{Log (GDP)}_{it} + \text{Log (Pop)}_{it} + \varepsilon_{it}$$

Here, i=1, 2, 3 … denotes the various countries and t denotes year. ε_{it} is the error term. Seven types of natural disasters i.e. floods, droughts, cyclones, earthquakes, landslides, storms, excess temperatures were considered depending on the geo-climatic characteristics of South Asia region. The various terms refers Edu= Average years of education completed of people aged 15+ (years), LE= Total number of years, an infant lives assuming the present mortality pattern constant (years), Pop= Total number of people divided by land area (per square km), GDP= Gross domestic product divided by the total population (current US$), TotDe= Total number of confirmed deaths and missing people, TotDa= Total damages of property, infrastructure and lands ('000 US$), TotAf= Total number of homeless, injured, displaced. The variables are also tested in terms of multicollinearity (VIF test) and heteroscedasticity (White test) to check the fitness of the data for regression. The variable "Education" is expected to have negative relationship with the explanatory variables. The more people complete years of schooling, the more they are educated. According to the theories, educated people are more conscious about managing the pre and post disaster management contributing to the reduction of disaster loss (Habibullah, 2018; Jeong & Yoon, 2018; Songwathana, 2018). On the other hand, there is ambiguous relation between GDP and disaster losses. Some studies proved GDP to have a negative impact on losses as rich countries are more capable in financing and reducing the losses (Atsalakis, 2021; Songwathana, 2018; Habibullah, 2018; Prasojo, 2021) whereas, some studies pointed that countries with more GDP have more valuable assets and infrastructures increasing exposed to disasters (Bruce, 1994; Khan, 2022). So, it is to see how the increasing GDP of South Asian countries contribute to disaster loss or it may affect the human and financial losses differently. Life expectancy should have a negative impact on the losses of disasters as more healthy people are more important to combat any disaster related diseases or survive better within an adverse environment (Neumayer, 2007; Murillo, 2017). But population should have a positive relationship with the human and financial losses as increasing number of population in proportion to a land area is a burden for any country and without proper and safe home, shelter during disaster, medical facilities etc., overloaded population contributes more to loss specially in number of deaths and affected (Habibullah, 2008; Padli, 2018; Manmohan, 2016; Songwathana, 2018).

Chapter 5

Empirical Results

The variables are free from multicollinearity as VIF=2.97<4. The White's test of heteroscedasticity says prob > chi2 =0.4445 that greater than 0.05. So, we accept the null hypothesis of homescedasticity. After running a linear panel regression, some results are found in favor of the previous literatures. Data was run through fixed and random effects model and after performing Hausman test, the first two models were found valid in terms of fixed effects and other was valid in terms of random effects. Table 2 shows the various signs, coefficients and significance of the variables.

Table 4: Effect of variables on the losses caused by disasters

variables	TotDa	TotDe	TotAf
Log (Edu)	-19.11702 (-1.56)	-2.044144 (-0.29)	3.30487 (1.40)
Log (GDP)	-0.5452659 (-0.24)	0.1394202 (8.49)	1.102368 (3.82)**
Log (LE)	16.85897 0.53)	-18.49242 (-1.18)	-14.74602 (-1.15)
Log (Pop)	37.63918 (2.21)*	13.11186 (2.40)	1.559691 (2.00)**
No. of observations	16	24	23
Prob>chi2	0.0334	0.40000	0.0000

Notes: Figures in the parentheses indicate the t-statistics. ** indicates significant at 5% significance level. * denotes significant at 10% significance level.

Average years of schooling (Edu) which is the proxy variable for education is negatively related to total deaths and total damage. Though the results are insignificant, it supports the findings of the previous literatures that education can be an important factor in reducing disaster damage (Habibullah, 2018; Jeong & Yoon, 2018; Songwathana, 2018). But the result is different in the context of total affected but that too is insignificant.

GDP is negatively related to the financial losses but it is insignificant. The result supports the findings that countries with higher income are more capable in financing and reducing the

losses (Atsalakis, 2021; Songwathana, 2018; Habibullah, 2018; Prasojo, 2021). Again, GDP is found to have positive impact on the number of human losses which are significant at 5% significance level in case of total affected (0.00). Though it matches the findings of Kahn (2005) that countries with higher income experience more deaths during disaster and countries higher income gives protection to population up to a certain level (Habibullah, 2008). On the other hand, the result goes against the findings of Manmohan, 2016 and Yang Zhou, 2014 that rich countries are more capable in resisting disaster damage and saving lives.

Again, the variable life expectancy (LE) is found to be negatively related to total deaths and total affected level but insignificantly. Also the variable is positively related to the total damages. This finding says that better life expectancy can be a significant factor in reducing human losses (Egawa, 2018) and a healthy country is more capable in reducing the losses of disaster.

Population density is positively related to total deaths insignificantly and total affected (0.045) significantly at 5% significance level, whereas, population density is seen to be positively affect the total damages but significantly (0.063) at 10% significance level. The finding suggests that larger number of scattered people expose more people to disaster risk (Habibullah, 2008) and densely populated countries are more vulnerable to losses (Padli, 2018; Manmohan, 2016; Songwathana, 2018).

Chapter 6

Conclusion

Natural disasters have become common events in everyday life. It causes great damages in terms of financial and human lives. The frequency and magnitude of the natural disasters are increasing day by day due to the environmental degradation, deforestation, soil erosion, air pressure, CO2 emission, etc. World has experienced 401 natural disasters only in the year 2021. And the frequency is the highest in Asia due to its size and susceptibility. Every year, thousands of people become homeless, injured, million dollars' worth property and infrastructure damage due to the cruelty of disasters. And some socio-economic factors as the larger population, less income, unhealthy community, corruption, weak infrastructure, lower education level worsen the situation. South Asia is the highest vulnerable region in this case

due to its geo-climatic characteristics. India is one of the highest disaster (19) facing countries in 2021. South Asia is experiencing fast development. But still there is very much gap due to increasing population, corruption, poverty and gender gap, weak governance etc. Though natural disasters are unpredictable events, the losses can be reduced by taking several measures. Previous literatures found education, unemployment, income, corruption, openness to trade, government size, institutional framework playing significant role in determining the various human and financial losses during disaster. Still, there are few studies on South Asian context regarding how the developing and least developed countries of South Asia is doing given their growing socio-economic status. This paper aims at analyzing how the socio-economic characteristics of the countries of South Asia are contributing to reduce the damages incurred from natural disasters.

The findings of the paper suggest that education is an important factor in reducing the losses of disaster but the results are insignificant. It is only found positively related to the total number of affected that too is insignificant. Population density is found to be positively related to the total deaths and total affected that supports the theories that more scattered population is more exposed to disaster damage. Life expectancy at birth is negatively related to the total deaths and total affected as we assumed that a healthy nation is a strong weapon to combat the adverse events. Lastly, GDP is found affecting the damages negatively as rich countries are prepared and more capable in reducing the disaster losses. But GDP is found to be positively affecting the human losses which are unexpected. This paper tried to examine the variables in the context of South Asian region. Some findings support the previous theories but some are not.

6.1 Policy Recommendation

The government of the countries should work more strategically on their population control. Because excess population is burden on the small land area where most of the population do not have the access to the basic needs. Providing proper food, quality education, basic health needs, and proper employment for so many people is next to impossible. On the other hand, making safe and secure home for so many people, giving them shelter during disaster, post disaster relief causes lots of cost to the government. A desired level of population can make a healthy, educated and strong nation to resist any adverse event. There is no alternative of raising public awareness on this issue.

Based on the findings, we can say that life expectancy is an important factor in reducing the human loss during disaster. And being a disaster prone region, health sector of the countries should be given more attention and importance so that people can easily access the basic health needs and be capable enough to combat any kind of adverse event. In this way, the region can make its population an asset. Health education should be spread among people of all ages.

Again, quality education should be made available for the people so that they are conscious about their well-being and the society. Educated people know the importance of development. They have better thinking capacity and are able to maintain healthy life, capable of employment, population control, necessity of safe infrastructure. They are conscious about receiving instruction from government and authorities during and after disaster, taking or funding relief, taking precautions, taking responsibility of self and others also. Compulsory education up to a grade and including disaster precaution lesson in the text books should be a made. Again, there should be arranged special public meetings; seminars in the disaster prone areas to help the adults or school dropouts make understand the dos and don’ts during disaster so that they can at least help themselves during a danger.

Growth is not desirable without development. Increasing income can help in taking more precautions and pre and post disaster relief for the people but only income is not of much helpful if the quality of the infrastructures near the disaster prone areas is not enhanced. Million dollars infrastructure damage during a disaster can lead a country to few years back in development and growth taking away the larger share of the economy. So, there is no alternative of infrastructure development to provide shelter millions of people and reduce human and financial loss during disaster. Reducing corruption can be the primary step towards development.

6.2 Limitation of the Study

Due to massive unavailability of data for some countries for different years, a balanced panel could not be made; some countries and time periods are dropped. And there are still many gaps with the findings as some results are not in favor of the theories. So, there is scope for re-examining the findings with more consistent and balanced panel.

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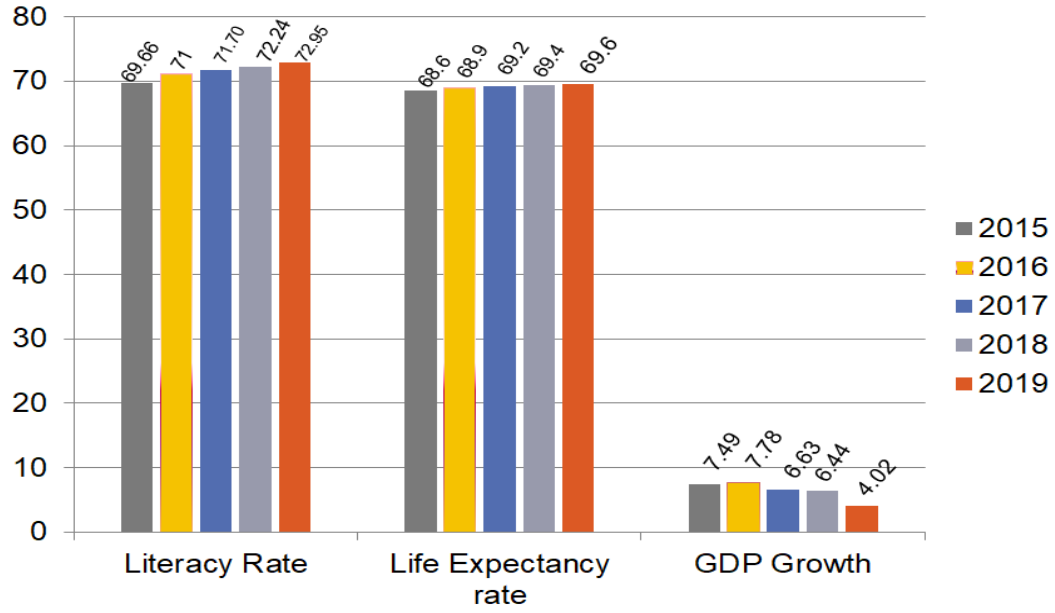
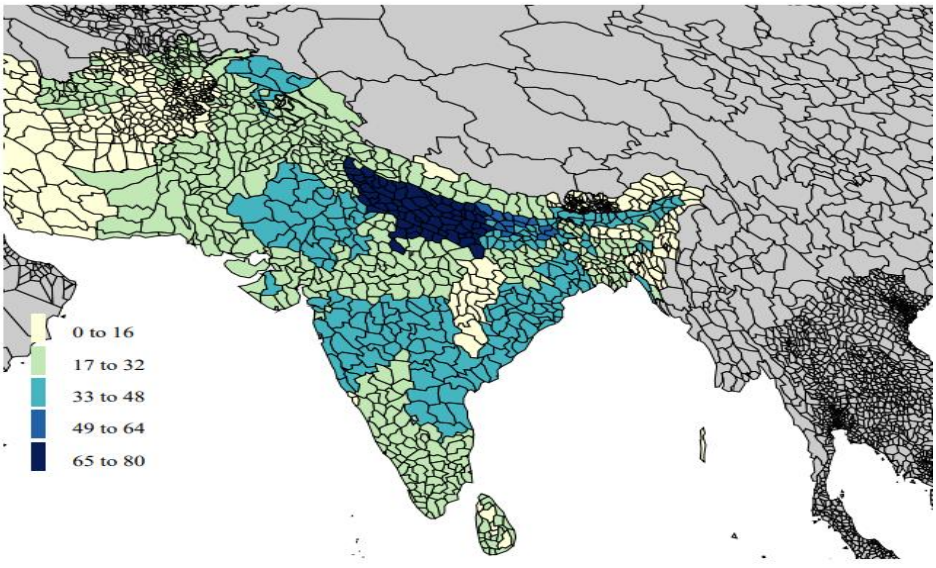
Appendix A.

Figure 1: High disparities among GDP, life expectancy and literacy rate in South Asia



Source: World Bank

Figure 2: Global occurrences from natural disasters in South Asia, 2000-2022



Source: Our World in Data based on EM-DAT, CRED- Brussels, Belgium (www.emdat.be)

1. VIF test:

Variable	VIF
Edu	4.90
LE	4.93
GDP	1.01
PopDen	1.03
Mean ViF	2.97

2. Cameron & Trivedi's decomposition of IM-test:

H_0: Homoscedasticity

H_1: Heteroscedasticity

Prob > chi2 = 0.4445

Source	**Chi2**	**df**	**p**
Heteroscedasticity	14.07	14	0.4445
Skewness	1.82	4	0.7680
Kurtosis	-19830.86	1	1.0000
Total	**-19814**	**19**	**1.0000**

3. Regression results:

I. (a) $\text{Log (TotDe)}_{it} = \text{Log (Edu)}_{it} + \text{Log (LE)}_{it} + \text{Log (GDP)}_{it} + \text{Log (Pop)}_{it} + \varepsilon_{it}$ **(Random effect)**

Log_TotDe	**Coefficient**	**Standard Error**	**z**	**P>z**
Log_Edu	-2.33886	1.947215	-1.20	0.230
Log_LE	-1.242528	10.57866	-0.12	0.906
Log_GDP	.9733446	.2363649	4.12	0.000
Log (Pop)	.417664	.6344179	0.66	0.510
Cons	-5.232765	18.70737	-0.28	0.780

No. of obs= 24 prob>chi2= 0.0000 No. of groups= 5

(b) $\text{Log (TotDe)}_{it} = \text{Log (Edu)}_{it} + \text{Log (LE)}_{it} + \text{Log (GDP)}_{it} + \text{Log (Pop)}_{it} + \varepsilon_{it}$

(fixed effect)

Log_TotDe	**Coefficient**	**Standard Error**	**z**	**P>z**
Log_Edu	-2.044144	6.991757	-0.29	0.774
Log_LE	-18.49242	15.71446	-1.18	0.258
Log_GDP	.1394202	1.328818	0.10	0.918
Log (Pop)	13.11186	10.0653	1.30	0.212
Cons	3.28613	28.30813	0.12	0.909

No. of obs= 24 prob>chi2= 0.4000 No. of groups= 5

Hausman Test:

	---Coefficients---			
	(b)	(B)	(b-B)	sqrt(diag(V_b-V_B))
	Fixed	Random	Difference	S.E.
Log_Edu	-2.044144	-2.33886	.2947159	6.715134
Log_LE	-18.49242	-1.242528	-0.8339244	11.62051
Log_GDP	.1394202	.9733446	-.8339244	1.307628
Log (Pop)	13.11186	.417664	12.6942	10.04528

b=consistent under H0 and Ha; obtained from xtreg

B=inconsistent under Ha, efficient under H0; obtained from xtreg

Test: H0: difference in coefficients not systematic

Chi2= (b-B) ‘[(v_b-v_B)ˆ(-1)](b-B)

= 4.81

Prob>chi2 = 0.3070

II. (a) $\text{Log (TotAf)}_{it} = \text{Log (Edu)}_{it} + \text{Log (LE)}_{it} + \text{Log (GDP)}_{it} + \text{Log (Pop)}_{it} + \varepsilon_{it}$ (**Random effect**)

Log_TotAf	Coef.	Standard Error	z	P>z
Log_Edu	3.30487	2.366066	1.40	0.162
Log_LE	-14.74602	12.82774	-1.15	0.250
Log_GDP	1.102368	.2887728	3.82	0.000
Log (Pop)	1.559691	.7791603	2.00	0.045
Cons	14.5672	22.67959	0.64	0.521

No. of obs= 23 prob>chi2= 0.0000 No. of groups= 5

(b) $\text{Log (TotAf)}_{it} = \text{Log (Edu)}_{it} + \text{Log (LE)}_{it} + \text{Log (GDP)}_{it} + \text{Log (Pop)}_{it} + \varepsilon_{it}$ (**Fixed effect**)

Log_TotAf	Coef.	Standard Error	z	P>z
Log_Edu	-10.09853	6.802811	-1.48	0.160
Log_LE	-24.33533	15.13023	-1.61	0.130
Log_GDP	-1.353559	1.280093	-1.06	0.308
Log (Pop)	37.14135	9.797867	3.79	0.002
Cons	-21.05763	27.4876	-0.77	0.456

No. of obs= 23 prob>chi2= 0.0053 No. of groups= 5

Hausman Test:

	---Coefficients---			
	(b)	(B)	(b-B)	sqrt(diag(V_b-V_B))
	Fixed	Random	Difference	
Log_Edu	-10.09853	3.30487	-13.4034	6.378085
Log_LE	-24.33533	-14.74602	-9.589315	8.023283
Log_GDP	-1.353559	1.102368	-2.455927	1.247096
Log (Pop)	37.14135	1.559691	35.58166	9.766837

b=consistent under H0 and Ha; obtained from xtreg

B=inconsistent under Ha, efficient under H0; obtained from xtreg

Test: H0: difference in coefficients not systematic

Chi2= (b-B) '[(v_b-v_B)^(-1)](b-B)

= 15.66

Prob>chi2 = 0.003

III. (a) $\text{Log (TotDa)}_{it} = \text{Log (Edu)}_{it} + \text{Log (LE)}_{it} + \text{Log (GDP)}_{it} + \text{Log (Pop)}_{it} + \varepsilon_{it}$ (**Random effect)**

Log_TotDa	Coef.	Standard Error	z	P>z
Log_Edu	-5.599219	3.769368	-1.49	0.137
Log_LE	29.58351	21.73559	1.36	0.173
Log_GDP	1.791238	.3703835	4.84	0.000
Log (Pop)	.8289632	1.007745	0.82	0.411
Cons	-66.08282	38.67603	-1.71	0.088

No. of obs= 16 prob>chi2= 0.0000 No. of groups= 5

(b) $\text{Log (TotDa)}_{it} = \text{Log (Edu)}_{it} + \text{Log (LE)}_{it} + \text{Log (GDP)}_{it} + \text{Log (Pop)}_{it} + \varepsilon_{it}$ **(Fixed effect)**

Log_TotDa	Coef.	Standard Error	z	P>z
Log_Edu	-19.11702	12.24074	-1.56	0.162
Log_LE	16.85897	31.60484	0.53	0.610
Log_GDP	-.5452659	2.281493	-0.24	0.818
Log (Pop)	37.63918	17.03101	2.21	0.063
Cons	-101.1405	57.70964	-1.75	-1.75
	0.123			

No. of obs= 16 prob>chi2= 0.0334 No. of groups= 5

Hausman Test:

	---Coefficients---			
	(b)	(B)	(b-B)	sqrt(diag(V_b-V_B))
	Fixed	Random	Difference	S.E.
Log_Edu	-19.11702	-5.599219	-13.5178	11.64593
Log_LE	16.85897	29.58351	-12.72454	22.94405
Log_GDP	-.5452659	1.791238	-2.336504	2.251228
Log (Pop)	37.63918	.8289632	36.81022	17.00116

b=consistent under H0 and Ha; obtained from xtreg

B=inconsistent under Ha, efficient under H0; obtained from xtreg

Test: H0: difference in coefficients not systematic

Chi2= (b-B) ‘[(v_b-v_B)ˆ(-1)](b-B)

= 9.04

Prob>chi2 = 0.0600