Natural Disasters and Economic Growth in Pakistan: An Enquiry of Floods Related Fatalities' Triad

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To My Parents

May ALLAH the Almighty bless them with a long life

ABSTRACT

Voluminous work has been produced on natural disasters and economic growth nexus but studies dealing specifically floods related fatalities and economic growth linkages are scant and this is particularly true for Pakistan. Present study is an attempt to investigate the determinants of the magnitude of floods related fatalities and to gauge impact thereof on GDP per capita growth of Pakistan by employing 'Two Stage Least Square (2SLS)' technique on time series data from 1972-2013. Unlike previous work, this study considers three dimensions of calamity namely floods-affected people, floods related mortalities and damages done by the floods in totality while gauging the impact. This study finds that floods related fatalities have significant negative impact on GDP per capita growth of the economy. The strongest impact is observed for the monetary damages done by the floods. GDP per capita growth and effects of disaster management authorities are found reducing impact of floods through floods-related fatalities suggesting that higher income is enabling the government by increasing financial resources to do investment in floods resistance measures. Most importantly, floods frequency (FF) has a robust positive impact to determine the floods related fatalities suggesting lack of learning from the past floods events. Based on the findings, in general, this work recommends taking both structural and non-structural floods mitigation measures particularly in these regions that are located in floods plain areas. By highlighting some of the findings, we identify research areas of interest for future work.

Keywords: floods frequency, per capita GDP growth, education attainment, infrastructure, determinants of the magnitude of floods-related fatalities.

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Chapter No.1

Introduction

1.1) Background:

The word disaster[1] comes from Latin word "bad star" *i.e.* bad luck which is referred as "*An event that causes great damages, extensive destruction, injury or loss of life*"(Noy and Vu 2010). Natural disasters gained national and international attention due to dramatic increase in its occurrences, economic damages done and precious human lives lost. Human activities damages the environment that lead to change in climatic variability and play an important role to increase frequency and severity of the disasters (Sadia *et al.* 2013).

Floods[2] bring fatalities triad which consist of floods-affected people (F_AFF)[3], floods-related mortalities (F_MORT)[4] and direct monetary damages (F_DAM)[5] caused by the floods. Disaster impinge on the economic growth of a country through several ways such as it adversely impacts the labor force included in the production of output, and reduced family consumption after the death of earning hands etc. Government and non-government sectors also shift their resources from production sector to rehabilitation and reconstruction activities that slow down GDP growth rate (Sadia *et al.* 2013). Floods and hurricanes particularly affect the primary

[1] The CRED applies specific criteria for defining whether an event is a natural disaster or not. Disaster is happened when it comprises of ten or more people were killed; 100 or more people were affected; injured, or homeless. Significant damages were experienced and or a declaration state of emergency and or a request for international assistance was developed.

[2] This study uses damaging floods as an indicator based on definition available at Barredo, (2009).

[3] F_AFF refers to total affected people from floods which included sum of injured, homeless, and affected persons.

[4] F_MORT indicates floods mortalities. Persons who confirmed as dead and persons missing and presumed dead (official figures when available)

[5] F_DAM denotes floods direct monetary damages. According EMDAT data web several institutions employ different methods to value these losses in their specific domain. However, there is no standard technique to determine a global figure for economic impact. Valued damage is given (000) US$

output. Further, they affect the sectors that heavily depend upon natural capital e.g. tourism. Secondary sector gets disturbed also due to fall in production capacity such as damages of roads and bridges that causes delay for transport input (Toya and Skidmore 2007).

Pakistan, like other developing countries, is more vulnerable to climate change impacts and frequently experiences natural disasters. These disasters impinge on the people through their lives and livelihoods. Pakistan is positioned 9th in terms of flood affected countries in the world (Sadia *et al.* 2013). According to the Federal Flood Commission (FFC) report from 1950-2012 floods disturbed 599,459 square kilometers area, 180,234 villages and killed 11,239 human lives. Floods have also caused different kinds of diseases[6] and the economic damages to the national economy range over 39 billion US$ (FFC 2012). Only in 2013, floods damaged[7] 1.05 million acres of standing crops and contributed losses equal to 2 billion US$ to the agriculture sector of the country (ECF 2013).

Floods related-fatalities are an outcome of both climatological and societal factors. Societal system contains different subsystems that characterizes the level of interaction such as poverty, unemployment, infrastructure, health, education, trade, irrigation, communication, water supply, sanitation and mitigation policies etc. (Barredo 2009). For analyzing the floods related-fatalities impact on per capita GDP growth, it is essential to consider such socio economic drivers that effect the economic growth.

Floods depend[8] upon number of factors such as regional climatic variability, increasing GHGs emissions, changing intensity of the precipitation in the monsoon season, financial resources for adopting floods mitigation measures, and disaster management institutions to meet

[6] Diseases like as diarrhea, skin, eye infection, malaria, respiratory infection and hepatitis etc.

[7] See European Commission Floods report on Pakistan, 2013

[8] See for detail 'stern review report on the economics of climate change'

with emergency situations (Ferreira 2010). IPCC (2014) intimates that increasing climate vulnerability and changes in precipitation pattern initiating floods more intense and frequent in the future.

1.2) Natural disasters in Pakistan: A snapshot

Natural disasters affect people's lives and livelihood. Pakistan is a country which has seen natural disasters frequently (Ahmad *et al.* (2011). Damages of these natural disasters can be realized by the fact that from 1947-2007 about111264 people were killed and 53.8 million were affected in different natural disasters in Pakistan (FFC 2013). Due to lack of disaster management institutions to meet with emergency conditions and unpredictability for disastrous situation, thousands of people are killed in different natural disasters.

Natural disasters affected the agriculture sector the most in Pakistan. Pakistan is an agrarian economy. Agriculture accounts for 21 percent of our GDP. Mostly, agriculture relies on monsoon rain falls for irrigation purposes. If monsoon rain falls are less than need then Pakistan has to face drought situation if it is more than needed it brings floods (Farooqi A. B. *et al.* 2005). Extreme weather events disturb the economy, weakening of natural ecosystem, and destruction of infrastructure in the country (Rosegrant M. W. *et al.* 1993). Potential impact of natural disasters in terms of people is the loss of lives and their livelihood due to floods, earthquakes and droughts. All these disasters have significant negative impact on economic activities, infrastructure and human lives (UNDP 2008). It is a fact that natural disasters cannot be avoided but well preparedness for this situation and after happening of disasters, effective response can diminish the mortalities and damages of the capital.

Given the fact that Pakistan is a victim of floods and faces floods about every year than other natural disasters such as earthquake and drought etc. When we take into account for natural disasters related fatalities then we come to know that greater fraction of fatalities arise due to floods events. Therefore, this study focuses on the magnitude of floods related fatalities only. Top fifteen natural disaster-related fatalities triad[9] in Pakistan are given in table 1

Table 1: Fifteen apex Natural Disasters in Pakistan

Years	Disasters	Frequency	Disaster's related mortalities	Affected	Direct monetary damages (In '000' US dollars)
2014	Flood	1	367	2470673	2000000
2014	Drought	1	248	0	18000
2013	Flood	2	268	1497782	1500000
2013	Earthquake	3	462	200974	100000
2012	Flood	3	518	5050564	2500000
2011	Flood	1	509	5400755	2500000
2011	Earthquake	1	2	1000	0
2010	Flood	4	2113	20363496	9500000
2009	Flood	3	102	75080	0
2008	Flood	3	83	290764	103000
2008	Earthquake	1	166	75320	10000
2007	Flood	6	526	2706	327118
2006	Flood	7	400	8125	0
2005	Flood	5	636	7527043	30000
2005	Earthquake	1	73338	5128309	5200000

Source: CRED (2015).

Frequently occurrences of floods indicate that it has significant macroeconomic implications and vital importance for the research.

[9] Fatalities triad comprises of died, affected and damages in natural disasters.

To the best of my knowledge, no study has been found about the floods-related fatalities triad and its impact on per capita GDP growth of Pakistan. The main purpose of this study is to fill the gap of the literature.

1.3) Significance and Scope of the study:

This study is important for two reasons. Firstly, floods have become more frequent in the context of natural disasters and have its distributional implications. It is necessary to know the human and economic costs of floods and how this cost varies over the time to fully explain the climate change impact. Secondly, floods have more scope for policy intervention than earthquake to reduce intensity of floods and mitigation of the damages done by the floods. Research on the factors to determine the extent of the magnitude of floods related fatalities is an important study because it would induce the policy makers to give more importance to the preparedness of floods-disasters and institutional reforms.

1.4) Objectives of the study:

The broader objective of this study is to analyze the impact of floods-related fatalities on the GDP per capita growth. The specific objectives of the study are given below:

i. To analyze the determinants of the floods-related fatalities in Pakistan.
ii. To assess the impacts of floods-related fatalities on the per capita GDP growth of Pakistan.
iii. To suggest policy recommendations based on the results from objectives (i) and (ii)

The rest of the thesis is organized in five chapters. Chapter two describes literature review. Chapter three provides theoretical framework, data, variables construction, and model

specification. Chapter four details estimation, results and discussion. Conclusion, policy implications and limitations are furnished in chapter five.

Chapter No.2

Introduction

This chapter reviews the existing literature relevant to this work. This chapter sets different strands of empirical literature answering the linkage between determinants of the extent of magnitude of floods related fatalities and per capita GDP growth with reference to objectives of this study at lined in section 2.1. At the end, an analytical review of the literature is provided in section 2.2 and finally, contributions of this work to the literature are documented in section 2.3.

2.1) Literature Review:

Albala-Bertrand (1993) analyzed impact of natural disasters by using 28 large natural disasters for 20 years from 1970-1990 of UK and employs macroeconomic model for measuring the disasters impact on GDP. This study suggests that disasters have insignificant effect on GDP and the price level but gross fixed capital formation, public and trade deficit increased significantly due to rehabilitation and reconstruction activities. According to the authors primary output is not affected by the natural disasters.

Studies related to macroeconomic impact of disasters show that natural disaster may immediately diminish the economic growth and trade balances. Narayan (2003) analyzes the natural disasters impact on Fiji's economy through general equilibrium model. This study finds that natural disasters have short run impact on the economy and cyclone adversely affects the net trade, per capita income, saving, investment and the balance of payments as well. Popp (2006) finds the relationship between natural disasters and macroeconomic key variables like saving, investments, fiscal and trade balances, human capital, physical capital and technology. Impact of

disaster is based upon its recovery process and types of nature of disaster. Results of this study suggest that climatic disaster have negative impact while geophysical[10] disaster have positive impact on the output growth in the long run due to destruction and reconstruction hypotheses.

Toya and Skidmore (2007) employ the data of 151 countries for the period of 1960-2003 and find that countries who have relatively higher per capita GDP experienced less human killings and monetary damages than the countries having lower per capita GDP. Degree of openness of the economies, higher education and income level are the measures of the developments for reduction in killing and damages related to natural disaster as they argued that developed countries having greater per capita income would assign greater proportion of the GDP for taking the important safety measures for reducing the effects of natural disaster.

Raschky *et al.* (2008) explore the idea that good management for sudden situation and better institutions diminish the impact of natural disasters. Results of this study suggest that disaster's related mortalities and damages caused by the natural disasters also depend upon the quality of governance and management system to meet with disastrous situation. They find that countries with better disasters management face fewer deaths from natural disasters.

Jonkman *et al.* (2008) estimates the floods damages in the Netherlands and find an integrated frame work for analyzing direct and indirect economic damages. Study concludes that the production is affected due to interruption of the floods related damages and loss of lives. The scale of the damages from the floods is different and depends upon floods prone area, coastal region and economy of the country. This study suggests proactive measures to anticipate the future flood-prone parts of the Netherlands in order to reduce the extent of potential damages and

[10] This term is used for hazard which originates from solid earth for example earthquake, mass movement and volcanic activities (Em-dat disaster data web.)

prevent a major catastrophe risk. Noy (2009) employs the data of 109 countries for the period of 1970-2003. Author investigates the macro economic impact of the natural disasters. Author reports that monetary and property damages adversely affect the GDP growth rate. Moreover, developed counties with greater literacy rate, and *openness* of trade, foreign reserves, domestic credit and income have the greater ability to bear with the disaster risk to the economy.

Padli and Habibullah (2009) analyze the relationship between economic impact of natural disasters and economic activities. They employ regression analyses for three sets of cross sectional data for the period of 1985, 1995, and 2005 of 73 countries and find that a negative correlation between per capita income of the country and impact of natural disasters. Natural disasters have fewer damages on the developed countries than poor countries, because developed countries adopt pre-disasters related precautionary measures. Severity of the disaster affects to determine the ability of the countries to cope with post disasters impact like strength of the events, economic damages and the vulnerability of the people. The study suggests that the poor countries that have moderate natural disasters but due to greater risk for socio economic vulnerability to the people face bigger impact such as large disasters. While the developed countries that have large disasters but have better preparedness to meet with sudden disasters face less impact.

Oh and Reuveny (2010) study the relationship between international trade, political risk and impact of disaster. Using data for 116 countries from 1985-2003 and suggest that gradual increase in frequency of disasters and political risk in importer or exporter countries would adversely effect on trade. World's economic output may be diminished as the frequency of climatic disaster like floods, cyclone increases over the time. Noy and Vu (2010) estimate macro-economic impacts of natural disasters on Vietnam's economy. They use the provisional

level data and the Blundell-bond general method of moments for primary and secondary output. Finding of the study suggest that disasters adversely affect the economic growth but in terms of monetary damages, it booms the economy in short run due to destruction and reconstruction hypotheses. Further the authors conclude that natural disasters have significantly different impact on different regions because every sector has different access to the reconstruction and rehabilitation funds through public and private sector. Cavallo *et al.* (2010) analyze the data of 196 countries and finds out that small and large disasters have different impact on output both in short run and long run. Key finding of this study suggest that output is adversely affected by extremely large disasters. Income distribution has a key role for determining the mortalities related to natural disasters such as the countries that have higher death from natural disasters experiences higher gini coefficient. High population density also leads the mortalities of natural disasters e.g. Japan experiences greater mortalities from natural disasters than less populated countries.

Ahmad *et al.* (2011) study the human response to the floods events of 2010 in Pakistan. Authors find that vulnerability to natural disasters and socio economic vulnerability of the people raises the importance of the disasters management. Infrastructure damages and human lives lost are the outcome of the floods. Direct damages of the floods can be called first disasters. On the other hand, other waves of damages such as destruction of houses and death of earning hands etc. generated from floods by the chain of cause and effect of the first disaster. These are the indirect damages remote from first disasters. These damages are called second disasters. To the extent of the magnitude, second disaster can be greater than first disaster. Tariq *et al.* (2012) investigate floods management and flooding behavior of Pakistan. This study finds that main source of flooding in the Indus Basin are monsoon rain falls. Crisis management and institutional setup has

been developed for flood hazard over the years. However, data indicate that there is no major reduction in the flood damages caused by the floods. Study suggests that inter-linkage of structural and non-structural measures with combined efficiency can optimize for more effective flood management. Sadia *et al.* 2013 investigate disaster's related mortalities on per capita GDP of Pakistan. They employ ordinary least square (OLS) using data of 1975-2009. Result of this study shows significant positive impact of disaster related killings, human capital and life expectancy on per capita GDP.

2.2) Conclusion from literature:

Impact of natural disaster remains ambiguous on economic growth but overall literature review documents negative impact. Interaction of the climatological and societal factors determines the extent of magnitude for the fatalities of the natural disasters. Literature suggests that better disaster management, population density, frequency of the disasters, corruption, inequality, per capita GDP, intensity of disastrous events, vulnerability of the people to natural disasters, pre and post disasters related precautionary measures determine the extent of magnitude of disasters fatalities. Furthermore, the poor countries that have faced moderate disasters but due to lack of better disasters management to meet with sudden situation, financial resources and increasing population density triggered high extent magnitude of fatalities like severe disasters for example poor and more corrupt countries are not able to meet with sudden disastrous situation and enforce better zoning and building codes. In addition, poor countries may not invest in other preventive measures from the natural disasters as well.

2.3) Contribution to the literature:

Although large empirical work is being devoted to check the impact of natural disasters on economic growth using panel, cross sectional and time series data analyses however floods related

fatalities and economic growth linkages are scant. But literature for Pakistan regarding floods covers human response to floods-disasters and floods management. Present work contributes to the literature by analyzing per capita GDP growth and floods-related fatalities linkages for Pakistan.

Chapter No.3

Theoretical Framework

Reliability of any work depends upon its theoretical groundings. This chapter develops logical and theoretical ground which is employed for empirical estimations in this work. This study investigates determinants of the extent of magnitude of floods related fatalities as an endogenous because it depends upon the vulnerability to the population, physical intensity and occurrences of the floods events. Furthermore, this work incorporates magnitude of the floods related fatalities impact on per capita GDP growth of Pakistan. Rest of the chapter is set up as follows: Section 3.1 provides construction and theoretical model for determinants of floods related fatalities magnitude. 3.2 section presents theoretical framework to analyze the impact of floods related fatalities on per capita growth. Selection of the main variables is given in section 3.3. Section 3.4 explains the data construction and data definition whereas section 3.5 develops econometric specification and section 3.6 discusses estimation methodology. Lastly, section 3.7 elaborates instruments to be used in the estimation.

3.1) Construction of the model that determines the magnitude of floods related fatalities:

Climate change is a global phenomenon and continuously rising carbon emission and GHGs increase the risk of uncertain climatic events[11] in future (Nordhaus 2007 ; Gamper-Rabindran and Jha 2004). IPCC intimates that the increasing trend has been driven by anthropogenic climate change impact (M. T. Poloczanska, *et al.* 2012). This work examines the floods related fatalities and economic growth nexus for Pakistan.

[11] See for detail impacts of climate change on growth and development part II from stern review report on the economics of climate change.

It is important to assert that floods as an event are exogenous but magnitude of floods related fatalities as an endogenous because it is determined within the system. Such as immediate effects of the floods are a function of vulnerability of the population, physical intensity and occurrences of the floods events (Ferreira 2010). The vulnerability of population depends upon the level of preparedness and mitigation activities. For instance, Director General of UNESCO Mr. Koïchiro Matsuura, emphasized the role of education and income in growing the capacity of the individuals and communities to reduce the risk of disasters (UNESCO Press Release). Such as school is a good place for formulation and implementation of the disasters preparedness policies and beginning emergency procedures. These mitigation activities are supposed to be function of socio-economic vulnerability to the people for example, higher income of the country enables the government to provide public facilities affectively (cf. McCarthy *et al*. 2001, ch. 18).

Toya and Skidmore (2007) identify the channel of disaster-income relationship. They suggest that private demand for safety nets increases due to rise in income of the people as higher income allows the people to reduce the risk by spending additional on precautionary method. With GDP growth increased, people may have better infrastructure, alarming system and floods resistant precautionary and defensive measure which may lessen floods impact. Ultimately, floods impact is minimized (Cavallo *et al*. 2010). Human encroachment into floods plain areas and land use changes particularly urbanization are assumed to contribute to the frequency and intensity of floods (IPCC 2007a, Chapter 3).

Thus present study indirectly measures the effectiveness and ability of the government to provide the public facilities through institutional and income variables. Public services provided by the government, may affect the floods-affected people directly and indirectly. Directly to provide disasters relief operations and through early warning system to keep the people at safe

place when floods occur and indirectly, by floods management related actions such as construction of levees, dams and bridges and enforcement of zoning regulations may influence the magnitude and probability of the occurrences of floods.

When floods occur, population exposure determines the number of mortalities both directly and indirectly. Higher population exposure is correlated with more death on provision of occurrence of floods. Magnitude of floods related fatalities is the outcome of socio-economic vulnerability to the people and frequency of the floods events. Socio-economic vulnerability to the people depends upon the per capita income of the people, and role of the government to meet with sudden situation, precautionary and alarming system of the country. Per capita income of the people is captured by per capita GDP growth. Role of the government to meet with floods situation is measured by the institutional indicator which measures the establishing of national disaster management authority (NDMA)[12]. This study uses intercept dummy to capture the NDMA role. Establishing of NDMA indicates one otherwise zero. Precautionary and alarming system of the country is measured by infrastructure variable. Lull and Reinhart (1972) and Robinson *et al*. (2003) find that area covered by the forest may reduce the intensity of the floods. So this work uses area covered by the forest (percentage of total area) to capture the intensity of the floods in the line of Susana **(**2011). Present study examines the variables that determine the extent of magnitude of floods fatalities. It can be formally expressed as,

Floods related fatalities (F) =f (YC, POP_DENS, FF, INFRA, ID, UF) _____ (1)

Where, *Yc* is per capita GDP growth, *POP_DENS* is the population density, *FF* represents frequency (occurrences) of floods in a year, *INFRA* indicates infrastructure, and *ID* is

[12] NDMA is main agency at the government to deal with Disaster Management Activities.

the institutional dummy, and *UF* refers to area covered by the forest. By transforming the variables in linear form floods related fatalities model in log form is stated as:

ln Floods related fatalities =f (YC, LNPOP_DENS, FF, LNINFRA, ID, UF) _____ (2)

3.2) Construction of the model for assessing the impacts of floods related fatalities on per capita GDP growth:

Natural disasters can affect the aggregate economy through its factors of production. Let's assume an economy in the steady state and climatic disaster like floods strike instigating the physical capital damages greater than human population injured. As a result, per capita capital stock reduces and per capita output of the economy from its steady state level also goes down (Toya and Skidmore 2007). After happening of the disaster, it is expected that economy is going through its recovery period. In this situation, more resources are allocated for the reconstruction and rehabilitation of the damaged capital stock. As a consequence there might be different channels for accumulation of funds for the reconstruction and rehabilitation of the damaged capital stock that can boost up the capital stock accumulation and technological progress due to knowledge spillover which accelerates the higher saving rate. After retrieval from the damages, economy returns back to its original equilibrium level of output.

Barro and Sala-i-Martin (1995) employ labor augmenting technological Solow model (Solow 1956) to investigate the impact of natural disasters. As this study focuses on the floods event only so it can affect the economy through production function which can be written as;

$Y=K^{á}F^{-\beta}AL^{1-\alpha+\beta}$

$\alpha > 0$,

Whereas floods related fatalities are assumed as burden over the economy so expected change in economic output with respect to floods fatalities would be

$\frac{\partial Y}{\partial F} < 0$

So, $\alpha + (-\beta) < 1$

Where F refers to floods-related fatalities.[13]

To determine the disasters impact on particular interest, Loayza *et al.* 2009 expands this analysis to investigate impact of natural disasters is given below;

$$Y=\alpha + \beta\mathbf{X} + \gamma DIS^{k} + \in_{\mathbf{t}}$$

Where, Y is a particular interest upon which disaster's impact examines;$\boldsymbol{X}$ refers to the variable that potentially effects on GDP like capital, labor, infrastructure etc. DIS indicates like a binary indicator as it is a measure of the direct damages from the disaster's happening such as number of people killed, number of people affected, or monetary damages while K is the type of the disaster such as floods, storm, earthquake etc.

As flood occurs, it disturbs the variables that potentially affect GDP such as the labor (L), capital (K), and the primary output[14] etc. consequently, per capita GDP growth changes. Present study examines the floods-related fatalities impact on per capita GDP growth. It can be formally expressed in the line of Loayz *et al.* (2009) as follows,

Yc = f (L, K, OE, EDU, INFRA, HEALTH, F)

[13] This study segregates floods related fatalities into floods affected people, damages done and people killed by the floods events.

[14] Primary output consists of agriculture, forestry and fisheries. See for detail "*The economics of natural disasters in a developing country: The case of Vietnam*" by Noy and Vu, (2010). In their study they uses primary output to analyze the impact of natural disasters.

Where, *Yc* is the per capita GDP growth, *L* is labor force participation rate, *K* refers to gross fixed capital formation percentage of GDP, *OE* represents to *openness of economies*, *EDU* is the education attainment, *INFRA* refers to infrastructure, *HEALTH* indicates number of registered medical staff and *F* represents to floods-related fatalities. Therefore, the production function to estimate the impact of floods related fatalities on per capita GDP growth is given as,

$$Yc = \alpha + \beta 1\ lnL + \beta 2\ lnK + \beta 3\ lnOE + \beta 4\ lnEDU + \beta 5\ lnINFRA + \beta 6\ lnHEALTH + \beta 7\ lnF \quad (3)$$

3.3) Selection of the main variables:

This section provides a note on selection and justification of the key variables. Section 3.3.1 documents the main variables that determine the extent of the magnitude of floods related fatalities and section, 3.3.2 elaborates variables to see the impact of floods related fatalities on per capita GDP growth.

3.3.1) Selection of the main variables to determine the magnitude of floods-related fatalities model:

To determine the extent of magnitude of floods related fatalities, this work uses the floods related fatalities as the dependent variable. Independent variables consist of population density, floods frequency, per capita GDP growth, infrastructure, institutional dummy and area covered by the forest (percentage of total area). Grothmann *et al*. (2006) suggest that better disaster management to meet with sudden situation reduces disaster related fatalities therefore, role of the institution related to disaster management is captured by using institutional dummy (ID). Establishing of NDMA indicates one otherwise zero. Thus present study expects negative coefficient sign of the institutional dummy (ID). Infrastructure and occurrences of floods are the

essential variables that determine the magnitude of floods related fatalities. Present work is measured low type of roads (percentage of total roads) as infrastructure variable. Pakistan Economic Survey segregates total roads in two types. Firstly, high type of roads and secondly, low type of roads. National highways, super high way, GT road which have heavy traffic are characterized as high type of roads while single and light traffic roads are characterized as low type of roads (Annual flood report 2012-2013). Numbers of telephone lines are used as proxy variable for infrastructure in various studies such as Canning *et al*. (1998), Limao *et al*. (2001) and Calderon *et al.* (2003) but majority of people in Pakistan now use mobile networks than land line(Annual report, 2013) [15] so number of telephone lines are not a good indicator for infrastructure. Hence, present study uses low type of roads rather than paved roads because large networks of low type of roads present in floods prone area. Better infrastructure and alarming system to meet with sudden shocks reduce the disaster related fatalities therefore expected coefficient sign of the infrastructure variable is negative. Occurrences of floods in a year indicate floods frequency (FF). Expected coefficient sign of floods frequency is negative because increase in occurrences of floods may reduce the floods related fatalities in the line of learning by doing hypotheses as described by Susana **(**2011). Grothmann *et al*. (2006) state that higher income enables the government to reduce the risk of the natural disasters by using additional costly safety measures which may diminish the disasters related fatalities. This work measures the role of the income to determine the magnitude of floods related fatalities by employing per capita GDP growth and expected coefficient sign of per capita GDP growth is negative.

[15] See for detail Pakistan telecommunication authority annual report 2013-2014

3.3.2) Selection of the main variables to analyze the impact of floods related fatalities on per capita GDP growth:

This section details the main variables used to examine the magnitude of floods related fatalities impact on per capita GDP growth. This study uses per capita GDP growth as the dependent variable and capital, labor, *openness of economies*, education, infrastructure, and health as the independent variables (Noy and Vu 2010). Core variables present in this model are the floods related fatalities and per capita GDP growth. GDP is the measure of the total national output which indicates the monetary value of all the goods and services produced normally in one year (Siddiqui *et al*. 2004). Intuitively, magnitude of the floods related fatalities can affect the national output through different ways, such as labor force (it may be unskilled or skilled) died in floods can negatively affect the GDP. Damages done by the floods also affect the national output. As the damages of the floods disaster may compel the people to shift their resources for reconstruction and rehabilitation purpose, ultimately it lessens the national output. High unemployment and low investment has already raised the poverty in Pakistan (Gazdar *et al.* 2004) so, due to frequent rise in flood events children may leave their schools to compensate floods damages and deaths of their earning family members. It would have negative impact on future human resources. Therefore, present work expects negative coefficient sign of floods related fatalities.

This study uses gross fixed capital formation percentage of GDP for capital variable. It has positive relation with per capita GDP growth such as more resources are assigned to raise the capital formation, it will enhance the per capita GDP growth (Sadia *et al*. 2013). Number of registered medical staffs is used as the health variable in this work. Bloom *et al*. (2004) describe that good health has positive impact on aggregate output. This study expects positive coefficient

sign of health variable. This work measures *openness* as the exports plus imports ratio to GDP and expects positive coefficient sign in the line of Halfbauer *et al.* (1994) and Ryckeghen (1998).

The existing literature has widely used enrollment data as proxy for education (Filmer *et al.* 1999; Corazzini A. J. *et al.* 1972) but this work uses education attainment. The reason is that schooling enrollment in a particular year has no effect on growth of this year because of time lag between future growth and enrollment. Enrollment data also does not account for drop out in a particular year. On the other hand, education attainment is the stock not a flow variable. So education attainment is better to capture the importance of the human skills and capabilities. Barro R. J. *et al.* (1994) and Lutz W. *et al.* (2008) state the positive relation between education attainment and GDP growth so, present study expects positive coefficient sign of education variable.

3.4) Data Construction:

This section elaborates data construction. Education attainment (average years of schooling, 15+) is used as proxy for education (Barro-Lee 2013 dataset). It is necessary to interpolate the data set therefore this study interpolates Barro-Lee (2013) data to fit the annual occurrences from E-view (Ferreira *et al*. 2004). This work constructs openness of the economies variables by adding export and import divided by GDP at US$. Data are extracted online from the version of world development indicators (WDI 2014). This study constructs the infrastructure variable as the low type of roads (as percentage of the total roads) in kilo meters. Data of total and low type of roads are taken from Pakistan Economic Survey. This work examines the studying impact of the floods fatalities magnitude as three different alternatives. First is number of people killed in floods event (KILL) percentage of population. Second is number of floods affected people (AFF) percentage of population and third is the amount of the direct monetary

damages (DAM) from floods to GDP ratio. Data of floods fatalities are taken from the online version EM-DAT disaster data base (EM-DAT 2014). Minimum value of the floods affected people, floods mortalities and monetary damages of the floods is zero otherwise positive. Time series data of the floods fatalities depends upon the occurrence of the floods events. To construct the annual the floods related fatalities data for taking log it is necessary to add one in floods affected people, floods-related mortalities and monetary damages done by the floods following Lazzaroni S. *et al.* (2013).

To capture the role of the institution relating to disaster management to meet with sudden situation, intercept dummy introduces. National disaster management authority (NDMA) sets up to meet with disastrous situation in 2006 indicates one otherwise zero. Present work constructs UF variable to the forest area, covering natural or planted trees of at least 5 meters, either it is useful or not but excepts tree in agricultural production systems for example, agro forestry systems and fruit plantations trees in urban parks and garden area percentage of the total land area.

3.4.1) Data definition:

Per capita GDP growth, labor force participation, population density, gross fixed capital formation percentage of GDP extract from the online version of world development indicators (WDI 2014). Floods frequency data are taken from the online version of the EM-DAT disaster data base 2014 (EM-DAT 2014). Variable, definition and data source are given in the table 2.

Table 2: Variable, definition and data source

Variable	Definition	Source
LNPOP_DENS	Log of the population density (people per sq. km of land area)	WDI, 2014
LNINFRA	Log of Low type of roads (as percentage of total roads) in kilo meter	Pakistan Economic Survey, 2014
LNL	Log of labor force participation rate	WDI, 2014 and Pakistan Economic Survey, 2014
LNK	Log of gross fixed capital formation (as % of GDP)	WDI, 2014
LNEDU	Log of education attainment	Barro-Lee, 2013
LNOE	Log of the openness of the economies	WDI, 2014
LNHEALTH	Log of the registered medical staff	Pakistan Statistical Yearbooks, 2014
UF	Area covered by the forest percentage of total land area	Pakistan Economic Survey, 2014
FF	Occurrences of the floods in a year	EM-DAT, 2014 (http://www.emdat.be/)
Yc	Per capita GDP growth % of annual	WDI, 2014
LNAFF	Log of floods affected people (percentage of population)	EM-DAT, 2014 (http://www.emdat.be/)
LNMORT	Log of floods-mortalities (percentage of population)	EM-DAT, 2014 (http://www.emdat.be/)
LNDAM	Log of floods monetary damages (to GDP ratio)	EM-DAT, 2014 (http://www.emdat.be/)

3.5) Econometric specification:

This work examines the variables that determine the extent of the magnitude of floods related fatalities. Furthermore, it investigates the floods-related fatalities impact on per capita GDP growth. Theoretical reasoning for including the main variables in the model is discussed in variables section. Present study considers the equations 2 and 3 to determine the econometric specification which is discussed in theoretical chapter.

As this study analyses the relation between per capita GDP growth and floods related fatalities. GDP growth rises due to production of output however production creates pollution.

Pollution not only produces environmental problems such as, extreme weather events but also reduces the quantities of the natural resources that can limit the growth (Nordhaus *et al.* 1996). Both per capita GDP growth and floods-related fatalities variables may produce double effect and might generate simultaneity. Haavelmo (1943) contributes to the econometric estimation by introducing the system of the equations for implications of the simultaneity. Haavelmo (1943) suggests that variables should be estimated as a system when it is assumed to be operating simultaneously. To find out the statistically simultaneity between wquation 2 and 3, this work applied J.A Hausman Speciation error Test.

3.5.1) Simultaneity Test:

First, this work estimates floods fatalities (consist of floods-damages, floods related mortalities and floods-affected people) on exogenous variables present in the model for each equation separately, which is called reduced form of equation and obtained residuals. This study estimates per capita GDP growth variable on floods fatalities including exogenous variables and calculated residuals. Simultaneity results from each equation are reported in table 3.

Table 3: Results-Simultaneity test

Variables	LNF_AFF	LNF_DAM	LNF_MORT
Resid	1.29 (1.31)	3.11 (3.34)	1.91 (2.02)

Above table shows that residuals of floods affected people (LNF_AFF), floods damages LNF_DAM) and mortalities of the floods (LNF_MORT) are not significant atleast 10% level respectively. Therefore statistically insignificant coefficient of the residuals supports the theoretical findings rejects the possibility of the simultaneity present in the equations in the line of Romer 2011. So in the context of this study, system of the equations would produce erroneous findings, hence this work estimates each equation one by one.

3.5.2) Exogeniety Tests:

Floods as an event are exogenous but fatalities caused by the floods are endogenous because flood-fatalities depend upon the socio-economic vulnerability of the people, magnitude of the floods event and the available protective measures in the country. As both floods related fatalities and per capita GDP growth variables are determined from the system therefore these equation 2 and 3 might have endogniety problem. Zhuang J. *et al*. (2007); Hallegatte *et al.* (2008); Vu T. B. *et al.* (2010) and Noy *et al.* (2010) treated disaster-related fatalities as an endogenous variable in their work. Therefore, in the concurrence of these works, present study assumes floods related fatalities as an endogenous variable. Further, Per capita growth is also considered as an endogenous variable in the line of Barro *et al.* (1991); Alesina *et al.* (1991); Mankiw *et al.* (1992); Barro *et al.* (2003) ;Chakraborty (2013) and Ehrlich *et al*. (2014). To statistically investigate endogeniety of floods fatalities and per capita GDP growth variables, Hausman Test is employed. Exogeniety results of the floods affected people, floods related mortalities, and monetary damages done by the floods and per capita GDP growth are reported in the tables 4.

Table 4: Result-Exogeniety test

Variables	LNF_AFF	LNF_DAM	LNF_MORT	Y_C
$\hat{w}$	1.84** (0.78)	1.89*** (0.45)	2.71** (1.32)	2.76*** (1.21)

Results of the exogeniety test indicate that predicted values of floods affected people and floods related mortalities are significant at 5 percent level while damages caused by the floods and per capita GDP growth are significant at 1 percent level respectively. So this work rejects null of exogeniety, and treats the floods-fatalities and per capita growth as the endogenous variables. This generates the problem of identification so an identification test is applied.

3.5.3) Identification Test:

To solve the problem of identification for equations 2 and 3 used in this study either equations are exactly identified or over identified order and rank condition of identification enlighten on this task. It is a necessary but not sufficient condition for identification. The following inequality is used for identification

$K - k \geq m - 1$

Where,

K = number of exogenous variable in the model including intercept

k = number of exogenous variable in the given equation

m = number of endogenous variable in the given equation

So order and rank identification condition for floods fatalities and per capita GDP growth for each model is demonstrated in table 5

Table 5: Result-Identification test

Order and rank of identification condition for determinants of floods affecties/ damages / mortalities magnitude.	7>2-1 (Over identified)
Order and rank of identification condition for floods fatalities triad impact on per capita GDP growth.	6>2-1 (Over identified)

Identification test indicates that floods-fatalities and per capita GDP growth equations are over identified so it takes us to employ 2SLS estimating technique. 'Two stage least square' estimation technique can also be applied for exactly identified but it is especially designed for over identified equations (Gujarati, D. 1978).

3.6) Estimation Methodology:

Present study uses time series data of Pakistan since 1972-2013. This work takes the floods-fatalities and per capita GDP growth as the dependent variables. Result of exogeniety test confirms the endogeniety present in this work. So this study finds Ordinary Least Square (OLS) inconsistent method of estimation because explanatory variable are correlated with the error term due to presence of endogeniety. Therefore endogeniety leaves this work for estimating these equations with Instrumental variables (IV) estimation approach. 'Two stage least square' estimation technique is widely used to resolve the endogenity problem in small sample size. Furthermore, another estimation technique to resolve the problem of endogeniety is the Generalized Method of Moments (GMM). GMM is used as an econometric technique to estimate the large sample size containing endogenous variables present in the panel equations. GMM remains consistent with the dynamic structure, due to presence of correlation between lagged variable and the error term (Nickel 1981).

As this study analyses the relationship between per capita GDP growth and floods-related fatalities. It might be possible to operate these variables simultaneously but result of the simultaneity test supports the view of the Romer (2011) and rejects the possibility of the simultaneity between these equations. So in the context of this study, system of the equations would produce erroneous findings, hence this work estimates each equation one by one. Results of the identification test show that both floods-related fatalities and per capita GDP growth equations are over identified. As this study estimates time series data with small sample size, 'two stage least square' is considered to be more efficient estimating technique. It takes this work to employ two stage least square (2SLS) as the estimating technique, ignoring simultaneity and estimates each equation one by one.

3.7) Instruments: Concept and Application

Efficiency of the 'two stage least square' depends upon the instruments used in the estimation. Right instrumental variables have two characteristics: firstly, they are uncorrelated with error term and secondly, they are correlated with endogenous variables (Ehrlich *et al*, 2014). This work uses internal instruments. These instruments consist of levels of the exogenous and lagged values of endogenous variables present in the equations. In this work per capita GDP growth and floods-related fatalities are the endogenous variables so lagged values of these endogenous and other exogenous variables present in the model are used as instruments.

Validity of the instruments is used to determine the consistency of the 'two stage least square' estimator. Sargan test of over-identifying restrictions determines the overall validity of the instruments. J-statistic has chi-square distribution where number of over identified restrictions is usually equal to the number of restrictions. It has null that instruments are valid. The validity of instruments is usually tested by j-statistic of Hansen (1982).

Chapter No.4

Empirical-estimation, Results and Discussion

Introduction:

Present work uses 2SLS estimation technique to analyze the determinants of the magnitude of floods related fatalities and its impact on per capita GDP growth of Pakistan. This chapter is structured as follows: summary statistics of the data are explained in section 4.1. Estimation, results and discussion thereof is elaborated in section 4.2 and 4.3 respectively. Lastly, misspecification test of residual analysis for models validation and instruments exogeneity are reported in section 4.4

4.1) Summary Statistics of the Data:

Table 6 provides descriptive statistics of the variables used in the study.

Table 6: Descriptive Statistics

Variables	Mean	Maximum	Minimum	Std. Dev.
Population density (people per sq. km of land area)	153.19	232.40	81.11	47.27
Floods frequency	1.64	7	0	1.60
Floods affected people (in persons)	1785177	20363496	0	3916591
Floods mortalities (in persons)	296	2113	0	441
Floods related monetary damages (in US$)	451544.7	9500000	0	1548540
Per capita GDP growth	2.16	6.60	-1.91	1.98
Low type roads (as % of total roads)	47.63	65.89	28.73	11.46
Gross fixed capital formation (% of GDP)	16.19	19.23	11.43	1.83
labor force participation rate (in percentage)	56.7	61.8	52.8	2.5
Number of registered medical staff(in persons)	128379	516738	5313	117107
Education attainment (average years of schooling)	3.41	5.89	1.69	1.30
Openness of economies	0.33	0.38	0.27	0.028
Area covered by the forest (% of land area)	3.08	4.58	2.23	0.61

These results indicate large variations across some variables. On average per capita GDP growth rate in Pakistan hovered around 2.16 or two percent approximately from 1972-2013. Minimum per capita GDP growth rate[16] -1.91 remains in 1972 while maximum GDP per capita growth 6.60 is seen in 1980[17]. Education (EDU) is taken by education attainment of Barro and Lee (2014). Floods affected people and monetary damages done by the floods have high variation than floods-mortalities with the average of 1785177 persons, 451545 US$, 297 persons and standard deviation 3916591 persons, 1548540 US$ and 442 persons respectively. Maximum number of people killed, affected and monetary damages done by the floods are recorded 2113 persons, 20363496 persons and 9500000 US$ respectively in the floods event of 2010. On average, low type of roads percentage of total roads have the value of 47.63 and standard deviation equals to 11.4. Area covered by the forest (percentage of total land area) has average value of 3.08 with lower dispersion attached to it (0.61). Maximum and minimum values of area covered by the forest (percentage of total land area) are 4.58 and 2.23 percent is documented for 1987 and 2011 respectively.

Education attainment gets maximum and minimum years of schooling 5.89 and 1.69 respectively. Education attainment, gross fixed capital formation (percentage of GDP) and openness of economies on the average are 3.41, 16.19 and 0.33 with lower standard deviation. Number of registered medical staff has minimum value of 5313 in 1972 and maximum value of

[16] This can be due to 1971 war. See for detail "*South Asian crisis: India, Pakistan, and Bangla Desh: a political and historical analysis of the 1971 war"* by Jackson, R. V. (1975).

[17] Reasons for attaining highly growth rate are: Firstly, Zia's rule basically changed the Pakistani society and economy by using his efforts to Islamize the society to raise the political supports and by mobilizing his efforts against the soviet occupation of Afghanistan. Zia made highly successful efforts to gain large external assistance from USA and Saudi Arabia around US $5-7 billion to the Afghan Mujahedins through Pakistan. Secondly, the agriculture sector in Pakistan expanded at twice rate than India due to the completion of two large dams and irrigation projects in 1980s which helped an unprecedented agricultural growth. Fertilizer and cement investments undertaken under Bhutto's regime also added to the economic output. Domestic production of nitrogenous fertilizer almost trebled during the first half of 1980s. [(Ahmed V. and R. Ahjad, 1994); (World Bank, 2002 *: An Interim Assessment)*; (Kemal, A. R. 2001)]

516738 in 2013 with the variation of 117107. On the average, labor force participation rate in Pakistan has 56.7 with variation of 2.5 percent.

4.2) Major findings of the Study: Description and Discussion

The estimation results of the present work are not directly comparable with the existing literature because mostly literature covers the combined effect of the natural disasters[18] on the economic growth, while this study is carried out only for the magnitude of floods disaster-related fatalities. Model estimation is done by using 'two stage least square' estimating technique. Equations with dependent variables per capita GDP growth and floods related fatalities are estimated. Floods related fatalities variable is estimated with three different dimensions *i-e.* floods-affected people, floods related mortalities and monetary damages done by the floods. Results are reported in table 7 and 8.

4.3) Results-estimation magnitude of floods related fatalities on per capita GDP growth:

Empirical estimation of equation 3 reported in column 1, 2 and 3 of table 7 indicates that floods affected people, and monetary damages done by the floods have significant negative effect on per capita GDP growth at 1% level. The findings of this study are in the line of Bieler (2006) and Popp (2006). Results of the floods related fatalities confirm the possibility of assigning more resources to the flood control that slow down GDP growth rate and assumed as the burden on the economy, further coefficient of labor, capital, education, infrastructure, and health in column 1, 2, and 3 of table 7 presents significant positive affect on per capita GDP growth in the line of Gamper-Rabindran and Jha (2004), and Noy and Vu (2010). In addition, coefficient of OE remains positive but insignificant. This finding is similar with Sadia *et al.*

[18] Natural disasters such as earth quake, floods and drought etc.

(2013). Plausible explanation of *openness* is put forward for justification of insignificant coefficient sign. It keeps non-linear relation between *openness* and economic growth. Openness or free trade can affect positively or negatively on the economic growth, for example a sudden *openness* from protectionism to free trade can slow down the economic growth (Lensik *et al* 1999).

Table 7: Results-estimation the magnitude of floods related fatalities-impact on per capita GDP growth

Dependent Variable (Yc) = GDP per capita growth

Dependent Variable	**YC** (1)	**YC** (2)	**YC** (3)
C	1.891*** (0.449)	1.861*** (0.451)	1.974*** (0.400)
LNK	0.0262** (0.0126)	0.022** (0.046)	0.062* (0.036)
LNL	0.434** (0.208)	0.440** (0.200)	0.453*** (0.173)
LNOE	0.044 (0.071)	0.0446 (0.068)	0.016 (0.030)
LNEDU	0.642** (0.266)	0.602** (0.246)	0.760*** (0.209)
LNINFRA	0.201** (0.094)	0.229** (0.095)	0.156* (0.092)
LNHEALTH	0.131*** (0.025)	0.126*** (0.023)	0.126*** (0.019)
LNF_AFF	-0.032*** (0.011)	---	---
LNF_MORT	---	-0.513 (0.398)	---
LNF_DAM	---	----	-0.038*** (0.013)
YC(-1)	0.488*** (0.107)	0.005** (0.002)	0.456*** (0.076)
R-squared	0.878	0.918	0.809
Prob(J-statistic)	0.573	0.231	0.674

Notes: The coefficient values are reported above the parenthesis and in parenthesis the standard errors are given where (*, **, ***) determines the significance level at 10%, 5% and 1% levels respectively.

It is evident from column 1, 2 and 3 of table 7 that floods related mortalities have insignificant negative effect on per capita GDP growth. Coefficient sign of floods related mortalities can be elaborated that mortalities in the floods events may be skilled or unskilled

people. Large families have very few earning hands to support their families particularly in floods prone regions therefore contribution of these people into economic output are insignificant. The other reason of insignificant finding of the floods related mortalities and per capita GDP growth can be explained in the form of labor theory which says that as the labor involved in production of output rises with the fixed amount of capital then marginal product (MP) will decrease but in the context of the present work it can be stated as the mortalities caused by the floods increases, it will reduce the labor force involved in the production of output. As the contribution of these people into the economic growth is negligible so MP (marginal product) of the labor force which contributes to the GDP does not considerably change.

Reason of the negative coefficient sign of floods related fatalities can be explained in the context of endogenous growth theory. Endogenous growth theory states that economic growth is the outcome of the endogenous forces such as investment in research and development; innovation and education, etc. Endogenous growth theory also emphasizes on externalities and spillover effects that can influence the economic growth. These externalities can be positive or negative depending upon its effects such as green technology, impact of natural disaster-events and so on (Martin R. *et al.* 1998). Pakistan faced many natural disasters in the past. These disastrous events may have positive or negative affect depending upon types and size of the natural disaster. After having faced those disastrous events, Pakistan has received financial assistance and foreign aids from the international community. It has provided an opportunity to change the old capital into new one. But statistics indicate that occurrences of floods events increase with the passage of time than the rehabilitation and reconstruction efforts made by NGOs and government with the financial assistance and foreign aids in response to the floods

events which are given by the international donors that can improve infrastructure and development of the rural areas.

By keeping in view the contribution of the agriculture sector into GDP, this work reveals the fact that agriculture contributes 21 percent share into GDP and holds the biggest employer of the labor force (Pakistan Economic Survey, 2012). Greenstone (2014) and Causes S. *et al*. (2014) suggest that floods may have positive or negative effects on agricultural output that depends upon the socio-economic and geographical conditions. It is also believed that flood damages the agriculture sector the most after occurrence of the floods. In addition, contributions of the agriculture sector into GDP slow down over the time *i.e.* due to droughts and floods events (Annual Floods report, 2013). All these factors indicate the slower economic growth after the occurrence of the floods.

4.4) Results-estimation determinants of the magnitude of floods related fatalities:

As established that floods affect the GDP growth of the country negatively through their impact on people, mortalities and monetary damages. This negative impact can be minimized if floods adverse effect on above mentioned three variables can be controlled. Against this argument, the present section outlines the results to identify the factors determining the extent of the adverse effects of floods in terms of floods-affected people, mortalities caused and monetary damages done.

Empirical estimation of equation 2 reported in column 1, 2 and 3 of table 8 indicates that per capita GDP growth and infrastructure have negative whereas floods frequency and population density turns to be significant positive determinants of the floods related fatalities triad. To capture the role of the institution to determine the extent of the magnitude of floods related fatalities, intercept dummy (ID) is used. Coefficient sign of the ID shows significant

negative effect to determine the magnitude of the floods affected people and floods related mortalities but it is measured as insignificant in the monetary damages done by the floods. The coefficient sign can be interpreted that NDMA is the Government institution to meet with sudden situation and may capture the better provision of public services during disaster relief operations. The main function of NDMA is to assist the people during the floods and put them into safe place. In addition, NDMA does not empower to construct and retrofit infrastructure such as bridges, dams and levees that can help to reduce the floods damages. That is why it reduces floods affected people and floods related mortalities significantly than the damages done by the floods.

Coefficient of UF remains negative but insignificant to determine the extent of magnitude of the floods-related fatalities triad (are reported in column 1, 2, and 3 of table 8) and confirming that it does not play significant role to reduce the intensity and severity of the floods. Reason of this finding is given as: Lull and Reinhart (1972) in their work find that forest reduces catchment flows as it evaporates more water rather, than the land is used and it is assumed that it reduces severity of floods through interception of removing heavy rainfall. These results suggest that forestry reducing the intensity of floods remains significant in case of small storm and insignificant during heavy rain fall. Robinson *et al*. (2003) also find that forest management from managed planation lessens the severity of floods is much less than that it was claimed. Present study uses both small and large floods related fatalities data so it is assumed that forestry may reduce the magnitude of floods related fatalities in small floods as Robinson *et al*. (2003) described in their work. But statistics of floods related fatalities show that Pakistan experiences frequently large magnitude of the floods related fatalities events[19]. It is also evident that Pakistan

[19] See for detail Annual floods Report, 2010.

has approximately five percent of the total forest to the total land area which is very small fraction that could not significantly reduce the intensity of floods. Therefore, forestry in Pakistan does not incorporate significant role for reducing the intensity of floods as it is expected.

Present work finds significantly positive coefficient sign of the floods frequency (FF) which is reported in table 8 to determine the magnitude of floods related fatalities. Coefficient sign can be interpreted that there is lack of "learning-by-doing" from past experiences of the floods events. Number of strategies are planned to reduce the magnitude of the floods related fatalities by the government such as basin wide planning, drainage, construction of temporary floods protection walls, preparation of emergency shelters, etc but could not be implemented (Annual floods Report 2010). Therefore, frequent rise in flood events increases payoff of the magnitude of the floods related fatalities.

Coefficient sign of the population density indicates significant positive impact to determine the magnitude of floods related fatalities. It can be explained as population density affects the floods loss both directly and indirectly. Inadequate housing and congestion increases the individuals expose to the floods events particularly in floods prone areas so, higher population density is associated to raise the floods affected people and floods related mortalities when the flood occurs. It also increases the potential for damages done by the floods. The result is similar with Susana**, (**2011).

Present work finds infrastructure variable significant negative impact to determine the extent of the magnitude of floods related fatalities (are reported in table 8). This finding is consistent with Wildavsky (1988), Hall and Street (2005), Jaharudin *et al.* (2009), Noy (2008), Toya and Skidmore (2007).

Table 8: Results-estimation determinants of the magnitude of floods-related fatalities.

Dependent Variable	**LNF_AFF Log of floods affected people (% of population)** (1)	**LNF_MORT Log of floods mortalities (% of population)** (2)	**LNF_DAM Log of monetary damages (to GDP ratio)** (3)
C	8.744 (7.845)	6.316 (5.678)	2.715** (1.322)
LNPOP_DENS	1.181*** (0.401)	3.193** (1.562)	3.976** (2.021)
YC	-1.840** (0.787)	-0.412** (0.191)	-0.034** (0.001)
FF	0.030*** (0.008)	0.0135*** 0.003	0.026*** (0.010)
LNINFRA	-1.361* (0.790)	-0.281** 0.132	-1.314** (0.645)
UF	-0.156 (.124)	-0.512 (.351)	-0.135 (.119)
ID	-0.022*** (0.007)	-0.060* 0.034	-0.016 (0.010)
R-squared	0.777	0.713	0.653
Prob(J-statistic)	0.719	0.170	0.157

Notes: The coefficient values are reported above the parenthesis and in parenthesis the standard errors are given where (*, **, ***) determines the significance level at 10%, 5% and 1% levels respectively.

It can be clearly viewed from column 1, 2 and 3 of table 8 that per capita GDP growth is a significant factor in reducing the impact of the magnitude of floods related fatalities in the line of Rasmussen (2004) and Raschky (2008). Susana**, (**2011) suggests the per capita GDP as the first approximation for the degree of safety measure that individuals can enjoy. Coefficient sign can be interpreted via disaster-development relationship following the Schumacher and Strobl (2008) such as rise in income not only raises the demand for safety but also enables the individuals to utilize costly precautionary measures to save from the natural disaster-impact. Higher level of income also provides the better opportunities for better medical care and emergency treatment to meet with disastrous situation. Better economic conditions further encourage the Government to do investment in the computer modeling of storms and early warning systems that enable mass evacuations and save lives. That is why richer nations typically have lower fatalities than poor nations (Sheets and Williams 2001).

4.5) Instruments Exogeniety and Misspecification Test:

'Two stage least square' estimation technique is based on the assumption that disturbance are uncorrelated with instruments. Sargan J stat test is used to test the over identification restrictions. It tests under the null hypotheses that all the instruments are exogenous. Large probability values of J-stat are needed to accept the null. Therefore, column 1, 2 and 3 of table 7 and 8 indicate large p-value of J-Statistic confirming that the instruments used in this work are exogenous.

To identify any misspecifications in our estimated models due to presence of serial correlation Breusch-Godfrey LM Test is used for equations 2 and 3. Results are reported in table 9 and 10.

Table 9: Diagnostic Serial Correlation LM tests determinants of floods-fatalities magnitude equation

Floods fatalities variable	Test Statistic	Prob.
LNF_AFF	0.3386	0.6217
LNF_MORT	0.7381	0.4710
LNF_DAM	0.4212	0.6592

Table 10: Diagnostic Serial Correlation LM tests of floods-fatalities impact on per capita GDP growth equation

Floods fatalities variable	Test Statistic	Prob.
LNF_AFF	0.4376	0.8035
LNF_MORT	1.6495	0.1990
LNF_DAM	0.8454	0.3313

We obtain insignificant p-values for each specification suggesting that residuals are uncorrelated.

Chapter No. 5

The Conclusion, Policy Implications, and Limitations of the Study

This study uses time series data to determine the magnitude of floods related fatalities and its impact on per capita GDP growth over period of 1972-2013. 'Two stage least square' estimation technique is employed to take into account the potential endogeneity problem. Instruments in this work include lagged values of the endogenous and level value of other exogenous variables present in the model. This work tests validity of the instruments by Sargan test. Breusch-Godfrey Serial Correlation LM Test is applied to check the residual autocorrelation for the validity of the model (Carkovic and Levine 2005). This study segregates the floods related fatalities into floods affected people, floods related mortalities and monetary damages done by the floods. The major conclusions are reported below:

This work finds that floods-related fatalities have significant negative impact on GDP per capita growth. In addition, GDP growth per capita, floods frequency, population density, infrastructure, and role of the disaster management institutes are important determinants of the magnitude of floods related fatalities.

The rest of this chapter continues to summarize the major findings are documented in section 5.1. Some policy implications are given in section 5.2. Lastly, limitations and future research directions of the study are elaborated in section 5.3 of this chapter.

5.1) Conclusion:

Natural disasters possess a vast strand of the literature but empirical studies of floods related fatalities and economic growth linkages remains scant. Present study empirically

estimates the determinants of the magnitude of floods related fatalities and also finds its impact on GDP per capita growth of Pakistan.

Composition of hypothesis stands with significant importance as it is concerned with a country's probability of frequent occurrences of floods events. To examine the endogeniety and simultaneity between GDP per capita growth and floods related fatalities Hausman Test is employed. The result of this study supported the views of Zhuang J. *et al*. (2007), Hallegatte *et al.* (2008), Vu T. B. *et al.* (2010) and Noy *et al.* (2010) that treated disaster related fatalities as an endogenous variable in their work.

Literature suggested that floods as an event are exogenous but fatalities of the floods are endogenous because flood related fatalities depend upon the socio-economic vulnerability of the people and magnitude of the floods event. In addition, Romer (2011) rejects the possibility of the simultaneity between economic growth and the impact of climate change. Present work estimates time series data with small sample size; therefore two stage least square (2SLS) is employed as the estimating technique and estimates each equation one by one.

Empirical findings confirm the floods-related fatalities as a burden on the economic growth which reduces the growth following the floods events. To determine the magnitude of floods related fatalities, floods frequency (FF) has a positive and robust impact on the floods affected people, floods related mortalities and damages done by the floods. The findings relating to the FF contradict the argument forwarded by Susana (2011). Our findings indicate that our region is experiencing the occurrences of floods frequently but there is lack of learning from the past floods events. Finding of this study confirms that socio-economic factors *i.e.* role of the disaster management institutions (ID), infrastructure (INFRA) and income (Y_C) have a significant role to determine the magnitude of floods related fatalities. This implies that socio-

economic factors do matter. Higher per capita GDP growth enables the government improving the infrastructure and alarming system as literature proposed that better economic condition reduces disaster-related fatalities due to allocating more resources for precautionary measures from natural disasters, otherwise fatalities may be increased. Negative coefficient sign of ID indicating the importance of the different institutions to determine the magnitude of floods related fatalities. Finding of INFRA supports the role of government to take the constructive measures for instance, construction of levees, floodwalls and dams.

Population density is highlighting the importance of these regions for implementing the floods resistant measures that are located specifically in flood plains regions. This study also stresses the role of forests on the prevention and reduction of the magnitude of floods related fatalities. We find that forests do not reduce the magnitude of floods related fatalities significantly.

Present work contributes to the literature by analyzing GDP per capita growth and floods related-fatalities linkages for Pakistan. It is important study as it has more scope for policy intervention than other natural disasters. In addition, it has its distributional implications also.

5.2) Policy Implications:

Study finds that floods related fatalities have a negative impact on per capita GDP growth therefore, it emphasizes the need to take these measures that contribute negatively to determine the magnitude of floods-related fatalities. Flood happens due to heavy rain fall and other phenomena, such as tsunami or high tide corresponding with greater than normal river levels therefor watercourses do not hold capacity to take excess water. Significant negative coefficient sign of INFRA to determine the magnitude of floods related fatalities suggest the government

and policy makers to employ both structural[20] and non-structural[21] flood mitigation measures because it assists as prerequisite for reducing the magnitude of floods related fatalities. Structural measures can be adopted through massive floods structure by constructing dams, drainage channels and flood protection dykes to store the excess water than needed. In addition, non-structural flood mitigation measures can also be made such as establishing of the early warning system, undertaking soil conservation and mapping of flood plain measures.

Strict laws should be employed to reside the people and constructing the buildings in flood plain areas. Significant negative coefficient sign of ID emphasizes the role of institutions to determine the floods related fatalities therefore, steps should be taken to the institutional reforms such as disaster management institutions. Finding of the population density (Pop_dens) emphasizes the policy makers and Government to focus on constructing floods resistant measures particularly in those areas that are located in floods plain regions especially near the bank of river jhelum, Chenab and Sindh. The increase of population in these regions has caused more floods-related fatalities.

Finally, GDP per capita growth is a significant negative determinant which suggests that higher economic growth will reduce the magnitude of floods related fatalities by enhancing the financial resources. It provides further opportunities to the government to invest in constructive and non-constructive floods resistance measures.

[20] Physical construction that minimizes or avoid possible impacts of hazards by applying the engineering techniques to achieve the floods-resistance structures or systems.

[21] Any measure uses knowledge, practice or contract than physical construction to lessen the risks and impacts of floods for example, education, laws, and policies etc.

5.3) Limitations of the study:

The magnitude of floods related fatalities-impact on per capita GDP growth and its determinants are studied. Pollution emission is the main determinant of the climate change. Pollution intensity originates as output is produced but climate change is the accumulation of GHGs over hundreds of years, therefore, pollution intensity is not taken to determine the magnitude of floods related fatalities in this study. Non-availability of the data for district and provincial level of floods related fatalities is a major constraint for making the graph of different floods prone areas that fixes this analysis all over the country. No consideration is given to define particular criteria for recording damages done by the floods with the passage of time consequently, secondary data of floods related fatalities might exhibit under or over estimates therefore it might create uncertainties in future.

By keeping in mind this background, future research should be done to have a deep look on the floods issue at the country level using micro data analysis of the magnitude of floods related fatalities, because it can describe a more elaborate picture. Anbarci *et al*. (2005) describes the ability as an important factor of the country to peruse the action against the magnitude of disaster-related fatalities. In addition, some other indicators such as corruption and ethnic tension that affect the ability of the country. It can also be investigated empirically to determine the magnitude of floods related fatalities in the line of Susana **(**2011).

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