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ECONOMIC IMPACTS OF THE 2010 FLOODS IN NORTH SINDH

A HICKSIAN COMPENSATING VARIATION APPROACH

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Preface

Present study has applied Hicksian Compensating Variation approach for empirical estimation of the welfare loss in the households of the four selected districts of North Sindh (Qamber Shahdadkot, Kashmore-Kandhkot, Jacobabad and Shikarpur) that were severely affected during flood 2010. The income and substitution effects were estimated from Marshallian demand curves. Slutsky equation is applied to isolate the income effect from the total effect to estimate the Hicksian demand equations. The total intervention estimated to be required was approximately PKR 61.16 billion in the four selected districts however the total intervention provided in the form of rescue, relief, rehabilitation, and reconstruction was equal to PKR 47.2 billion. A short fall of approximately PKR 15 billion was observed. The Hicksian Compensation required estimated per household per month is to the tune of PKR 11703 per month.

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List of Abbreviations

AJK	Azad Jammu and Kashmir
CRI	Climate Risk Index
EM-DAT	Emergency Event Data
FATA	Federally Administered Tribal Areas
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
GHG	Green House Gases
IDPs	Internally Displaced Persons
INGO	International Non-Governmental Organization
IPCC	Intergovernmental Panel on Climate Change
JHBSPH	Johns Hopkins Bloomberg School of Public Health
KPK	Khyber Pakhtunkhwa
NDA	National Disaster Management Authority
NGO	Non-Governmental Organization
PKR	Pakistan Rupee
UN	United Nations
UNOCHA	United Nations Office for Coordination of Humanitarian Assistance
US	United States
USAID	United States Aid for International Assistance
US$	United States Dollar
WCRP	World Climate Research Programme
WHO	World Health Organization
WMO	World Meteorological Organization

1. Introduction

Natural disasters and climatic changes leading to flash floods and temperature variations cause serious damages to the human and natural systems. The frequency of these disasters has been on rising trend during past decades (Diffenbaugh, *et al.,* 2005). These disasters can have heavy toll on the human systems particularly in rural areas where households mostly rely on agriculture based resources. Alongside studies have been evidently proving the long term impacts of floods and other disasters on the metal health and psychological disorders among the population in the disaster affected areas and the death rate in 2006 has been as double as in 2002-03 in the city (Kevin *et al.,* 2007). This may be due to the damage to infrastructure that reduced the access to the medical and health facilities in the city (Wang *et al.,* 2008). The researchers in this study investigated the disruption in the care/medication of the individuals with symptoms of mental disorders before and after Hurricane Katrina. The study proved that there was a serious failure in initiating the medication of individuals with new-onset mental disorders as a result of Hurricane Katrina.

The natural disasters and calamities disrupt the economic activities at local and sometimes at national levels given the severity of the events. The magnitude and the duration of the events indeed determine the cost of the calamities. Floods have longer duration with varying magnitudes whereas earthquakes have smaller duration of happening time. On the other hand the structure of the local economy, the area affected by such calamities and the time during which the event occurs. Events occurring during the night times may bring more economic and human losses than events occurring in day time when most people are alert and active.

These and many other factors make it difficult to estimate the accurate losses to the calamity hit areas. These costs may be in terms of the lost value of the wages for workers/jobs and thus output, destruction of the general property in public sector like roads, schools hospitals and other buildings and private property, human lives and the loss to transportation sector (Kliesen, 1995).

It is hard to calculate the damages of any natural disaster because of the types of the disasters vary and several factors like magnitude and duration of event, structure of the local economy and infrastructural development level, geographical location and the time of occurrence of the event either it is day or night.

In the 2010 flash floods caused by the heavy monsoon rains inundated 20% of Pakistan's total area and brought it under water (Juren & Khan, 2010). The total losses due to the direct damage to infrastructure, (including private and public sector buildings and roads) and indirect damage due to the loss in the key sources of livelihood such as livestock and standing crops and damage to the warehouses. The income loss to the households in flood affected areas was because of the direct damage to the standing crops and the livestock. Total population affected has been counted to 22 million across the area of 100,000 kilometers (NDMA, 2012).

According to the reports (NDMA, 2012) the most seriously flood affected component is the household economy. Whereas the greater impact of floods in Pakistan was visible in rural areas (69.5%) than in urban areas (33.3%). The households even 3 months after the floods, 66% of the households in these areas were not having enough income to buy essential food items and medicines.

The province of Sindh was severely affected with the damages of the flood. The summary of total estimated province or region wise damage is presented in the following Table 1.

Global Warming and Natural Disasters

Global warming or the climatic changes are the terms used in the sense when the average temperature of the planet earth is rising. Previous studies have been proposing that the average earth temperature has risen between 0.4 and 0.8 degree Cover the past 100 years. Over 50% of the change in temperature has occurred during last 50 years (IPCC, 2007). Further the (Field *et al.,* 2014) synthesis report claims that the scientists are certain with less than 5% chance of error that the global warming has been because of the human activities (anthropogenic) mainly the accumulation of greenhouse gases such as methane and carbon dioxide in the atmosphere. It is further an issue of concern that more than 50% of

the emitted carbon dioxide from burnt fossil fuels remains in the atmosphere. The other half is absorbed by the process of vegetation and oceans.

The idea that the global weather change is contributing towards worsening of the climate and severity of the natural disasters has been commonly believed by masses who are the non-experts in the field. (Leiserowitz, Maibach, & Roser-Renouf, 2012). Using the World Bank classification of low-, high-, and middle-income countries and the [Emergency Events Data] EM-DAT data, (Stromberg, 2007) find that low-income countries are home to one-third of the world's population but account for almost two-thirds of all fatalities. Another study (Kahn, 2005), studying the EM-DAT data from 1980 to 2002 from 73 countries responsible for vast majority of natural disasters using probit model. He found that rich countries do not face natural disasters as frequently as the poor countries due to the control of rich countries over infrastructural development and technology and geography, of course plays an instrumental role in determining the frequency of the natural disasters. That is to say that they can limit the rainfall before it leads towards floods. Like (Gaiha, & Hill, 2012) have concluded from the EM-DAT data analysis that countries which are land-locked, face less number of disasters. Using instrumental variables approach they took natural log of number of deaths and regressed on the characteristics of a country. The key assumption prevailing in the study was that the number of disasters in the period is endogenous. But another study (Stromberg, 2007) has been arguing that there is no correlation between level of development and the exposure to the natural disasters refuting the main conclusion of the (Kahn, 2005).

> "Global warming is partly to blame for these heavy rainfall events. Because warmer air can hold more moisture, heavier precipitation is expected in the years to come" (National Wildlife Federation, 2016).

Keeping in view the complex link and association between flooding and the climate change, authors have been finding out the channels through which climate change is causing heavy flooding in many countries. (Science, 2012a) report has been identifying five channels through which climate change/extreme weathers has been causing heavy rains and flooding in the world. These five channels as identified by the report are: 1) According to (IPCC, 2007), the temperature in the atmosphere is 0.75 degrees warmer than it was at the beginning of the century. Warmer atmosphere accumulates more moisture and the presence of more water tends to increase the volume of rainfall including other factors. 2) There

is growing evidence on the heavier rainfall historically due to climatic changes. This is described as follows:

"It is very likely that there has been an overall decrease in the number of cold days and nights, and an overall increase in the number of warm days and nights, at the global scale, that is, for most land areas with sufficient data." (Intergovernmental Panel on Climate Change 2012 page 111). 3) The (Science, 2012b) has predicted that the greenhouse gases emission has increased the risk of flooding up to 90%. However attribution of extreme events to the global rise in temperature may not be readily possible because of the absence of long range of data sets on flooding and climatic variations. 4) The rainfall in future tends to increase causing two types of flooding; one is the surface flooding when the rainfall is not absorbed into the ground. The river banks burst and cause river flooding. Other is coastal flooding that happens due to rise in the sea levels. (EEA, 2012) Predicts rise in both types of flooding in United Kingdom. 5) The patterns of using land as a human factor, are also contributing towards flooding. This is like building houses on flood plains and paving over natural surfaces are making people more vulnerable towards floods by blocking the natural path of rivers.

The way greenhouse gases trap energy in the upper atmosphere, they warm up the earth causing damage to the life and welfare of human beings. The accumulation of the greenhouse gases in the atmosphere are a direct result of the choices we make today and will affect our current and future living conditions.

In case of Pakistan, there have been a couple of studies who opine in existence of a link between global warming and the frequency and severity of natural disasters. Historically, the developed world has been responsible for polluting the environment for the very reasons of exploitation of resources and economic growth. Presently the same developed world is accusing the developing world particularly China for creating carbon foot prints. According to the *climate central* (Cooke, 2013) report "Pakistan is among the most vulnerable countries facing climate risks. Mechanisms need to be devised for greener, more resilient options for growth and sustainable development… the climate change clock is ticking too fast and the time to act is here and now" Marc-Andre Franche, the UNDP's Pakistan director. The report further quotes Pakistan Meteorological Department for erratic seasonal spells in the country. The years from 1999 to 2002, the country was hit with severe drought because of substantial drop in the flow of water in the Indus, the vital waterway of the country and a major source of 90 million people for their food production.

On the other hand, the years between 2010 and 2012, the country suffered one of its most severe floods in its history due to unusually intense monsoon rains. The banks of the Indus burst causing river and flash floods killing thousands and millions displaced (Cooke, 2013). According to the chief of Pakistan Meteorological Department, the rise in the heat waves and the rising temperatures has been observed in Indus Delta in recent years from the data gathered from 56 meteorological stations throughout the country. The temperature in Himalaya-Karakorum-Hindukush which hosts world's third largest ice deposits after north and south poles has been rising 1.5 degree Celsius more than the average rising temperature in Pakistan of 0.76 degree Celsius.

Flooding, Natural Disasters and Risk Management

According to (Intergovernmental Panel on Climate Change, 2012), glossary page number 5, the disaster risk is defined as follows:

> "The likelihood over a specified time period of severe alterations in the normal functioning of a community or a society due to hazardous physical events interacting with vulnerable social conditions, leading to widespread adverse human, material, economic, or environmental effects that require immediate emergency response to satisfy critical human needs and that may require external support for recovery."

The narrative of the studies conducted on the emergence of anthropogenic climatic changes and their impact have been widened from mere technological account to a holistic approach of risk reduction. Alongside, the vulnerability of communities towards various climatic and non-climatic stressors has been widely studied and explored. It is a complex phenomenon that encompasses various socioeconomic and political structures, cultural and ecological factors. (Field, *et al.,* 2014) have edited and drafted the report summary for the policy makers. The risk factor encompasses two important aspects: hazard and vulnerability. The hazard presents the intensity that is the extent and inundation depths and the probability of a flood scenario in a given region and timeframe. On the other hand, vulnerability analyses the impacts of a flood (Thieken *et al.,* 2008). One of the important determinants of vulnerability may be counted as the adaptive capacity of communities towards the disasters. This is the capacity and ability of the system that helps local populace and infrastructure mitigate the impact by moderating vulnerabilities. Studies have been done on the vulnerabilities and impacts and the adaptive capacities and definitional statements have already been extended in studies.

(WRI, 2007), (Füssel, 2007) and (Füssel, & Klein, 2006) refer the adaptive capacity "to the expression of the availability of a series of adaptation options, community capacities to implement these options, and demonstrating community's ability to anticipate, cope and recover from climate change impacts.

The accuracy of evaluation of flood losses depends upon the quantification of flood losses through loss functions. These loss functions are internationally accepted functions used as tools for precise estimation of the flood losses. These loss functions accurately quantify the loss in monetary values of the proportion of loss from the total value of the assets damaged. Commercial flood risk measurement models are used in the insurance business to quantify the potential damage and determine the value and pricing of the policy covers and decide about the reinsurance needs. The inventory on the review of the models used in the flood loss measurement is presented in the (Gerl, *et al.,* 2016). The study claims to be the most comprehensive review of flood loss estimation models with nearly a thousand vulnerability functions. Another study (WorldBank, n.d.) has presented various types of methodologies to measure the nature and risks associated with the possibilities of flooding in Malawi and Mozambique. According to the study both economies are highly dependent upon the natural resources and agriculture accounts for one third of the total output of the country. By all means, the flooding and other natural disasters significantly affect the general performance of the overall economy. The study applied probabilistic risk analysis to evaluate the impacts of the natural hazards. Further, the approach has been divided into six small modules:

- **Stochastic Weather Module:** Stochastic Weather Module or generator produces synthetic time series of weather data. These models aim at simulating realistic random sequences of temperature, precipitation and wind (Ailliot *et al.,* 2015).
- **Drought and Flood Hazard Module:** This module measures the variation of the intensity of natural disasters through space and time. This module may be used to estimate the severity and depth of the impact of floods given specific geographical location of the region like flood extent, depth and intensity. In addition, it also provides estimation of the probability of the reoccurrence of the same event within a year with similar characteristics.
- **Exposure Module:** this module helps understand the spatial characteristics of the assets at risk. In case of floods, most of the damages occur in agriculture sector in developing countries. The assets at risk may be the agriculture crop, its area and the production quantity in the given time period. Along with the assets

may include human and residential units, infrastructure exposed to the potential risk.

- **Vulnerability Module:** This module estimates the vulnerability of the assets and principal assets exposed to the disaster. It helps determine the monetary value of the production loss or damage given different stages in the crop cycle.
- **Direct Loss Computation Module:** This module helps measuring and estimation of the economy wide losses caused by the floods or other disasters. The asset loss is converted into financial loss.
- **Macroeconomic Module:** This module integrates the financial losses already estimated in previous module with the national accounts and economic indicators like international trade, GDP and growth rates in economy.

Given the above discussion on the risk management, it may have been observed from the reviewed studies that there has been a pile of studies in recent decades on the patterns of climate change, frequency of occurrence of the natural disasters and the extreme weather conditions in disaster prone regions of the world. Though several studies have indicated various models with strong and precise characteristics and features, yet still some degree of uncertainty has remained unmeasured as indicated in (Gerl *et al.,* 2016).

Frequency of Natural Disasters in Pakistan: Historical Evidence

The chronology of floods affecting Pakistani region can be traced back to 1950 when first flood braved Pakistan with affecting nearly 10,000 villages and washing out 17920 square kilometers and claiming a toll of 2190 lives as human loss[1]. The records with Federal Flood Commission (Federal Flood Commission of Pakistan, 2014) suggest that there have been at least two dozen floods (of low and high intensity) but unfortunately, not all records and data is available from the government or nongovernmental organizations online databases. Following table presents facts and figures about the floods in past years in Pakistan and the claimed losses and human lives. The list of years when Pakistan was braved from floods is given for 22 years namely; 1950, 1955, 1956, 1957, 1959, 1973, 1975, 1976, 1977, 1978, 1981, 1983, 1984, 1988, 1992, 1994, 1995, 2010, 2011, 2012, 2013 and 2014. However, unfortunately the data on all years flood is not readily available in

[1] Federal Flood Commission cited in [Retrieved from].

systematic form. Table 1 provides the historical record of the available data on the floods in Pakistan, number of fatalities and the villages affected from 1950 to 2014. According to the following table 1, the most severe floods from the loss of lives point of view and the number of villages affected were seen in 2010 with approximately 6000 fatalities and 20 million people affected directly or indirectly by the flood. In 1950, the second most severe flood was seen with 2190 fatalities and 10,000 villages damaged fully or partially. However, if the number of villages affected is counted then 1955 flood was more severe than that of 1950 with 28,000 villages damaged. It may be noted here that the data on floods and damages thereby are cumulative data of India and Pakistan provided by the Indian Red Cross. The third worst flood was seen by the country in 1977 with 1354 fatalities. Unfortunately, the data on the villages destroyed has not been available in the record of Flood Commission or Pakistan Weather Portal.

Table 1. *History of Floods and Loss of Human Lives in Pakistan (1950-2014)*

S.No.	Year	Fatalities	Villages affected
1	1950 (Shabbir, n.d.)	2,190	10,000
2	1955[2]		28,000
3	1956	160	11,609
4	1957	83	4,498
6	1973	474	9,719
8	1976	425	18,390
9	1977	1,354 (Elizabeth, 2006)	-
10	1978	393	9,199
14	1988	508	1,000
15	1992	1,008	17,553
17	1995	591	6,85
18	2001	219	50
19	2003	484	4,376
20	2004	85	47
21	2005	59	1,931
22	2007	918	2 million+
23	2010	6,000	20 million
24	2011	434	8.9 million

Source: Pakistan Weather Portal[3]

Flooding is the presence of large amount of the water over the land that affects the normal human activities. It occurs due to overflowing of rivers, known as the river flooding. If the flood caused by heavy rainfall, then this type of flood is known as the flash floods. Further, if there is unusual flow of water from sea on the land then it is known as the ocean flooding. It has been

[2] (UNOCHA, 2007) Figures given by Indian Red Cross
[3] [Retrieved from].

generally quoted in the international disaster database that the frequency of natural disasters in recent decades has increased than last decades. Quoting the database, the average occurrence of natural disasters during 1994 and 1998 was 428 per year but the same average increased to 707 in 1999 and 2003 (International Disaster Database, [Retrieved from]). These disasters had a heavy toll on poorest people in developing countries due to lack of housing, transportation and other systematic management facilities (Food and Agriculture Organization, 2011). There have been several studies on the causes and consequences of floods in the Pakistan. Keeping in view the causes of floods and manmade disasters, a dominant opinion among the studies remains of the climatic change and its impact on the overall eco system of the country. The detailed discussion on climatic changes and their impact of natural disasters will appear shortly however there are studies that have been devoted to the welfare losses of the floods and other natural disasters. The floods in 2010 were caused by the heavy monsoon rainfall from July to September 2010. Indeed, monsoon is the season that is most awaited for in an arid region of Pakistan. However, the highest rainfall of the decade was recorded in 2010 that began and continued in the areas of Baluchistan in first spell. In the second spell in last week of July and continued in first few days in August, the rains started in Khyber Pakhtunkhwa (KPK) with similar or even higher severity. These rains really created unequalled floods in all major, secondary and tertiary rivers and canals in Punjab, Sindh and Baluchistan.

Present study has estimated the damages to the society in selected four districts of North Sindh namely, Kandhkot-Kashmore, Jacobabad, Shikarpur and Qamber-Shahdadkot. These districts suffered the highest loss in terms of people, village and the infrastructure and standing crops affected. The change in the welfare at household level is estimated using Hicksian Compensated Variation. For that matter household basket of goods of frequent consumption has been taken to estimate the household demand equations. Marshallian Demand Estimations, Substitution and Income Effects and isolation of Income from Substitution effect has made us possible to estimate Hicksian Compensating Variation. After Compensation per household required is estimated per household to bring them to their initial level of utility before flood, total compensation is estimated that is required to bring people of the region to their initial level of utility. PKR 61.16 billion was the estimated compensation required in all selected districts. The intervention from government institutions and the nongovernmental organizations provided has been equal to PKR

47.2 Billion. The gap of 22.81% or PKR 13.95 Billion remained. One limitation of the study is the presence of corruption in the streams of expenditures. How much is allocated and how much is actually spent on the relief, rehabilitation and rescue of the flood stranded people. Further the set of semi-structured questions were asked from the sample villages in the selected districts. Two villages were taken under convenient nonprobability sampling. The qualitative analysis was done for the purpose of counter verification of the quantitative analysis and empirical results. The qualitative analysis went hand in glove with the empirical analysis.

The selection of Sindh province and the selected four districts of the north Sindh is based on the extent of damage in all respects in these districts is highest among all districts suffered losses from the flood.

Organization of the Study

The present study is organized in following way. Chapter one is devoted for introductory part of the study. It includes a detailed account of the natural disasters and the climatic changes with empirical evidences from various studies. The chapter also takes into account the historical trend in the flooding and climatic changes and the global warming. Studies on the flood impacts and natural disasters include risk management factor that appears before occurrence of the disasters. A brief account of the issue has been included in the introductory part.

Second chapter takes into account the flood impact and the losses in all provinces and the federally administered areas of the country. This chapter would also present a detailed picture of flood losses according to sectors and subsectors and the government intervention and risk management systems prevalent in the country. The rescue and rehabilitation challenges, due to lack of facilities in the country side and far flung areas, is also discussed in detail. Another aspect of the flood losses is the distortionary impact of floods on crop production and the food shortages of rice, wheat and other growing crops in the region.

Third chapter takes into account the details of the reviewed literature on floods, controlling of the damages to maximum extent, early warning systems working in the country and the vulnerability of the households and individuals. Studies on the losses and types of studies on risk measurement, damage to the infrastructure, roads, hospitals and schools have been scrutinized extensively. Types of losses, remedies and the studies that have thoroughly inferred in to the establishment of early warning systems and risk management to avoid vulnerabilities of the

exposed population and assets are also discussed. Further, the chapter includes the discussion on the methods of estimation of all types of losses and the complications and uncertainties involved.

Fourth chapter is dedicated to the discussion on the proposed methodologies used by various authors for measurement and estimation of losses caused by the floods and other natural disasters. There can be tangible and intangible losses along with psychological impacts on the population and migration effects. All of the studies included in the chapter present their approaches with their novelty. The chapter presents the novelty and uniqueness of the present study and its relevance to the other studies as a major contribution to the existing body of knowledge in the estimation of welfare losses due to floods.

Fifth chapter presents the regression results of the Marshallian demand quantities, income and substitution effects and the compensation required per household per district per year is presented.

Sixth chapter presents the qualitative analysis based on the semi structured interviews from the selected villages from the sample districts. A comparative note on the quantitative and qualitative results would be included in the chapter for clear understanding of the results from both approaches.

Seventh chapter is presenting the conclusion of the whole study, recommendations and policy implications of the study if its key findings are taken and heard in the government corridors.

2. The Background of Study and the Problem

Present chapter comprises of two components. First part is dedicated to the flood phenomenon, the losses and damages that take place due to floods in a global perspective. First part also discusses causes; natural as well as the human; of the floods and other natural disasters. In the end of first component, history, losses and dynamics of the disasters in Pakistan in historical context are deliberated in detail. Second component is divided into two parts. First part undertakes a detailed discussion on food security, health, displaced populations, energy infrastructure and agriculture in general for the whole country. Second part discusses the selected study area (four districts), flood damages and profile of districts. The district-wise losses, district profile, sectoral damages would be presented here.

Floods and climate change in Pakistan

The key to the life in Pakistan is the River Indus. This mighty river originates from Tibetan plateau flowing through the disputed territory of Jammu and Kashmir and whole lot of 2000 miles reaches in Sindh and out in the Arabian Sea. The river Indus is the mighty river that fulfills the water needs of the agriculture sector of Pakistan. The trans-boundary of the Indus river basin has a total area of 1.12 million square kilometers dispensed between four countries namely Pakistan, India, China and Afghanistan. This makes the river as the 12th largest river in the world. (Ministry of Finance, 2015) Pakistan has 47% of the total area, India 39%, China has 8% and Afghanistan 6%. Indus basin stretch starts from the mountains of Himalaya in the north to the dry alluvial plains of

Southern province of Sindh in Pakistan finally flowing out into the Arabian Sea. The total area covered by the basin in Pakistan is 520,000 square kilometers that is roughly equal to the 65% of the country's territory (Pakistan Meteorological Department, 2010).

Agriculture sector is the second largest sector of the country that caters the employment needs of the country as high as 42.2% of the total job market (Hameed, 2007). In addition, it contributes almost 20% in the GDP of the country by producing cash crops that earn hefty amounts in the foreign reserves and provide line of raw materials to the agro-industrial sector like cotton, rice and sugarcane etc. The quandary of the situation is that the most important sector of the economy does not determine its produce on solid scientific and technological footings but on the weather conditions. The uncertainty of the performance of the agriculture sector remains a vital fact. Only the favorable weather conditions determine the produce of the agriculture sector. There have been studies and reports on the variations and the extreme weather conditions in the country. According to the *wunder blog: Weather underground"* [4] *and Pakistan Meteorological Department* [5] the highest temperature recorded in Asian continent was in Mohen jo Daro near Larkana Sindh on 26th May 2010 at 53.5 Degree Celsius. Following excerpt has been copied from the website of Pakistan Meteorological Department

> "Record breaking extreme heat observed in the plain areas of Sindh and Baluchistan on Wednesday. Most plain areas of the country remained in the grip of Loo today. Highest maximum temperature was recorded *53.5°C in Mohenjo-Daro* and 53 in Sibbi, 52.5 in Jacobabad, Larkana and Padidan.52 in Nawabshah, and 50 in Rahimyar Khan, Dadu and Sukkur" (Lead Pakistan, 2010).

On the other side, the highest rainfall in Pakistan was recorded on 23rd July 2001 in Islamabad of 620 mm that continued for 3 consecutive days that broke the 100-year record of rain fall in the city (UN International Strategy for Disaster Reduction, 2007).
According to Pakistan Meteorological Department cities of Pakistan have been seeing temperatures above 50-degree C frequently since 2010. These rising temperatures are a symptom of climate change in the country. According to the Lead (a nongovernmental NGO) climate change is defined in the following way:
"A change of climate that is directly or indirectly related to human activity that alters the composition of the global atmosphere and

[4][Retrieved from].
[5][Retrieved from].

which is in addition to natural climate variability over comparable time periods" (Lead Pakistan, 2010). The report further continues discussion on the possible impacts of climate change. The major impact of global warming and the climate change is the extreme weathers and frequent and more intense storms, tornedoes, floods and droughts happening all over the world. The world is suffering 400 to 500 various types of natural disasters every year on average. On the other hand the same was only 125 just 35 years back in 1985 (Lead Pakistan, 2010). The impact on Pakistan has been severe despite of the fact that Pakistan is contributing very little in the Green House Gas (GHG) emissions in the world. It is speculated that Pakistan would face negative effects of global warming and climate changes in multiple ways. First due to the melting down of the glaciers in Himalayan mountain range, the flooding will rise but will be followed by decreased river flows over time due to the disappearing glaciers. Secondly, fresh water for drinking and other household uses would decline affecting the biodiversity and availability of fresh water for human beings. Thirdly, the territories of Pakistan, especially the coastal areas are considered under threat due to rising sea level and rising chances of flood from sea as well as the rivers. Fourth, the food security and hunger may rise due to the falling per acre productivity in the country sue to the climate change. Being a predominantly an agriculture based socio-economic structure; the country may face hunger and food shortages in near future. Last but not least is the socioeconomic disturbance due to climate change and low productivity that may lead to social and economic unrest inside the country (Sönke, Eckstein, Dorsch, & Fischer, 2015). Despite of the challenges, it is still that Pakistan is not in the list of many developing countries that are most at risk due to climate change. Though these countries are not directly responsible for the climate change yet due to geographical locations and the fragility of their socio-economic structure, these countries would suffer most. These countries are, for example, Philippines, China, Thailand, Mexico, Brazil etc. (Sönke *et al.,* 2015).

According to the German Climate Risk Index[6] report (Sönke *et al.,* 2015) Pakistan is counted in the top 10 most affected by the natural

[6] "The Global Climate Risk Index (CRI) developed by Germanwatch analyses the quantified impacts of extreme weather events4 —both in terms of fatalities as well as economic losses that occurred—based on data from the Munich Re NatCatSERVICE, which is worldwide one of the most reliable and complete data bases on this matter. The CRI examines both absolute and relative impacts to create an average ranking of countries in four indicating categories, with a stronger emphasis on the relative indicators (see chapter "Methodological

disasters caused by the climate change in the world. These countries in the long term index have high ranking because of the incomparable catastrophes in the near past. The top three countries in the bottom ten countries list in the climate risk index are Honduras, Myanmar and Haiti. Pakistan is ranked 8 in 1995-2014 whereas its number was 10 in 1994-2013 worsened by two ranks. The table is presented here for reference:

Table 2. *The Long Term Climate Risk Index (CRI) list of 10 most affected countries from 1995-2014*

	CRI (1995-2014)	CRI (1994-2013)	CRI Score	Death Tol	Deaths per 100000 inhabitants	Total loss in M (US $ PPP)	Loss per unit GDP %	No. of events (1995-2014)
	Ranks							
Honduras	1	1	11.33	302.75	4.41	570.35	2.23	73
Myanmar	2	2	14.17	7137.2	14.75	1140.29	0.74	41
Haiti	3	3	17.83	252.65	2.76	223.29	1.55	63
Philippines	4	5	19.00	927	1.1	2757.30	0.68	337
Nicaragua	5	4	19.00	162.3	2.97	227.18	1.23	51
Bangladesh	6	6	22.67	725.75	0.52	2438.33	0.86	222
Vietnam	7	7	27.17	361.3	0.44	2205.98	0.7	225
Pakistan	8	10	31.17	487.4	0.32	3931.40	0.7	143
Thailand	9	11	32.33	164.2	0.25	7480.76	1.05	217
Guatemala	10	9	32.5	83.35	0.66	407.76	0.5	88

Source: (Reliefweb, 2014)

The situation of climate change and the subsequent catastrophes in the countries has been increased during 1995-2014 from 1994-2013. Higher the CRI score for a country, higher would be the risk and the climatic state of the affairs is alarming. An examples quoted in the same report (GCISC, 2006) clearly weighs the risk and the climatic change and its toll on the country and the inhabitants is visible from the fact that low rainfall in march 2014 created a situation of drought and threatened the country of food security in already a poor country. On the other hand, extraordinary monsoon rain and floods in the month of September of the same year affected more than 2.5 million inhabitants and 130000 houses (katcha and Pacca) and 1 million acres of cropland. (GCISC, 2006) the total number of farmers affected reached as high as 250,000 due to loss to their fodder, standing crops or the grass.

According to the Global Change Impact Studies Centre Islamabad Pakistan the major concerns for the climate change in Pakistan include increased variability of monsoon, projected recession of glaciers in Himalayan mountains, threat to the flows in

Remarks" for further details on the calculation). The countries ranking highest are the ones most impacted and should see the CRI as a warning sign that they are at risk for either frequent events or rare, but extraordinary catastrophes."

Indus River System, increase in deforestation and loss of biodiversity, health risks and others (Sönke *et al.,* 2015). The reports enlist some of the vulnerabilities of climatic change in Pakistan. These include increased occurrence of extreme events in last 20 years; catastrophes during 2010 and 2011 floods, large scale cloud burst rains in the main cities of the Pakistan, floods frequency during last two decades, worst drought during 1999 in Thar Desert in Sindh and intense heat waves throughout the country during last decade (IPCC, 2014).

Impact of Climate Change

The severity of climate change in terms of extreme events and catastrophes and their frequency is the immediate impact of the climate change. In absence of adaptability in the local system to the changing environment conditions, the inhabitants are seriously vulnerable to the potential damages and losses of these events. Poor and developing countries like Haiti, Myanmar, or Pakistan being poor countries have been truly vulnerable to the wide spread impacts of these disasters. Studies suggest (Climate.nasa.gov, n.d.) that the economic growth along with the population growth also determine the impacts of climate changes. Large size of economy like US, the relative damage of $ US 1 B does not mean a significant amount but the damage or loss of the same amount in a poor or developing country would mean a lot for the national exchequer.

Similarly, population size when number of deaths is taken as relative to the population, in case of large population the impact ratio would be less than in case of a country where small population size is and where impact ratio is larger. In case of floods, the reduced drainage capacity of the country leads towards more vulnerability and the losses then in a country with large drainage capacity. The drainage capacity in a country can vary according to the pattern of use of land. The sources on the climate change and weather research institutions have been delineating following immediate consequences of the climate change and global warming.

According to (EPA, 2015), the rise in the temperature is the immediate consequence of the global warming, the estimated change in the temperature 2.5 to 10 degree Fahrenheit till next century. The rise in the temperatures may be a blessing for some regions and bad for the other regions. The lengthier frost free regions will offer larger cropping and growing seasons. In western America, due to climate change is affecting ecosystems and agriculture. The farmers across the US observe lengthened growing

seasons since 1980 (Hashmi *et al.,* 2012). The chronology of severe events and the frequency of disasters bring a clear picture as the consequence of the climate change.

The world climate changes and the environmental effects will definitely affect the people and the ecosystem in many ways. In recent decades the emergence of strong hurricanes and harsh heat waves have been a manifestation of the climate change and have been proven as deadly and life threatening. They have some positive impact as well. The longer growing seasons in some parts of the world (like some parts of US as mentioned above paragraphs) is a good omen for farmers and agriculture output. Nevertheless, the impacts on the earth as it is getting hot and hotter, the negative impacts would offset those modest positive ones. Here it may be a good idea to see that the global warming and the climate changes are not the same. Here global warming refers to the increase in the average temperature near the earth's surface and climate change is the larger clique of events and changes go hand in glove with the global warming. These changes in the patterns of the seasons and spells of the weather, mutations in the oceans and melting ice and snow, and impact on ecosystems due to climate change (IPCC, 2014).

Natural Disasters in Pakistan: Historical Perspective

According to the study (Federal Flood Commission of Pakistan, 2014), the major reason for the floods in Pakistan has been the heavy and concentrated rainfall in the river catchments along with snowmelt flows. Sporadically, downpour currents emerging from the Bay of Bengal cause pressure buildups that usually lead towards heavy downpour in the Himalayan bases. Further, the Indus river system observes serious and destructive floods in its all or main rivers due to weather spell variations in the Arabian Sea (Seasonal Low) or the Mediterranean Sea (Westerly Wave).

According to the climate experts from World Climate Research Programme (WCRP) and the World Meteorological Organization (WMO), the extreme events and weather incidents are strongly related with the changes in the change and it's a major driving force behind occurrence of the floods in the Pakistan. And it is also claimed that the weather conditions change are the key players in the "unprecedented sequence of extreme weather in Pakistan" in months of July and August 2010 (Kronstadt, Sheikh, & Vaughn, 2010). The (IPCC) has also warned that human made changes in the climate have a serious ability to cause these disasters happen more frequently. The study of IPCC has concluded that "it is very likely that hot extremes, heat waves and heavy precipitation events

will continue to become more frequent." It warns: "the floods of the kind that hit Pakistan may become more frequent and more intense in the future in the same region and other parts of the world". The detailed table on year wise loss of the lives, damages to the villages, and the area inundated is presented in following table 3:

Table 3. *Summary of flood losses during 1950-2010 in Million US $, lives lost, villages affected and area under water 1950-2010*

Year	Direct Losses (US M $)	Lost Lives	Villages Affected	Area under water
1950	488.05	2190	10000	17920
1955	378.4	679	6945	20480
1956	318.2	160	11609	74406
1957	301	83	4498	16003
1959	234.35	88	3902	10424
1973	5134.2	474	9719	41472
1975	683.5	126	8628	34931
1976	3485.15	425	18390	81920
1977	337.55	848	2185	4657
1978	2227.4	393	9199	30597
1981	298.85	82	2071	4191
1983	135.45	39	643	1882
1984	75.25	42	251	1093
1988	857.85	508	100	6144
1992	3010	1008	13208	38758
1994	842.8	431	1622	5568
1995	376.25	591	6852	16686
2010	10000	1985	17553	160000
Total	29184.45	10152	127375	567132

Source: (USAID, 2014a)

According to the above table the intensity of loss to human lives or damage to the villages, area under water and the valuation of the flood loss in million US $ has been on rise. Following graphs show independently the monetary losses, human lives, villages affected and the area under water.

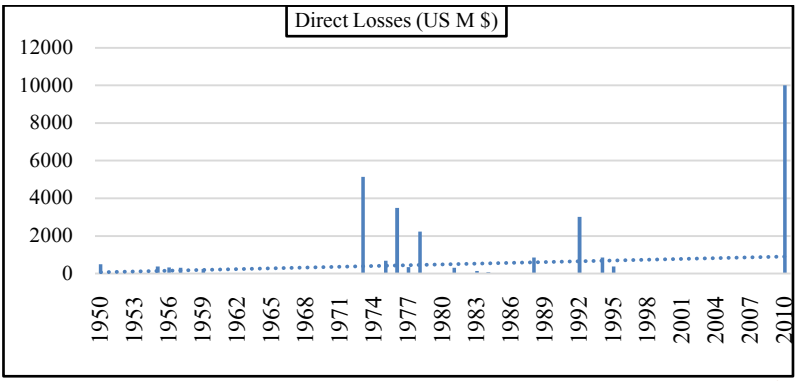


Figure 1. *Summary of Loss in floods during 1950-2010 in million US $*
Source: (Federal Flood Commission of Pakistan, 2014)

Figure 1 shows the total loss in million US $ in the floods. The total loss due to floods has been consistently increasing during the time period of 1950-2010. The trend line of the graph shows slightly increasing trend. Despite of the improvement in the infrastructural development and construction in the rural areas along with alignment of the river banks, the loss in terms of million US dollars has been rising. Similar situation appears when the number of human lives lost in the floods during the time period. The number of lives lost in 1950 and 2010 floods has been significantly larger than any other flood during the time period. If we look at the individual years, 2010 flood has been the most severe and fateful for the whole of the Pakistan. Figure 2 has been presenting the data and the trend line.

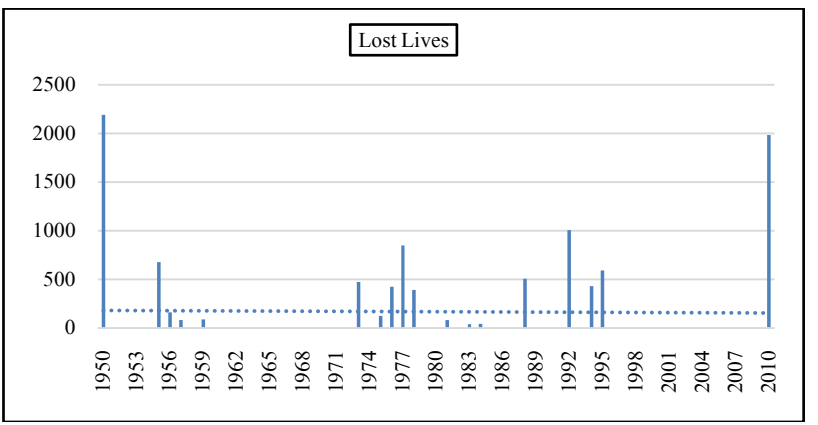


Figure 2. *Summary of loss of lives in floods during 1950-2010*
Source: (Federal Flood Commission of Pakistan, 2014)

Figure 3 presents the number of villages affected in the floods during 1950-2010 years. The trend in the damage to the villages is slightly declining. Nevertheless, if we look at the individual years, the number of villages affected in 1976 floods and 2010 floods has been similar. This confirms the increasing intensity in the flood disasters during the last 60 years.

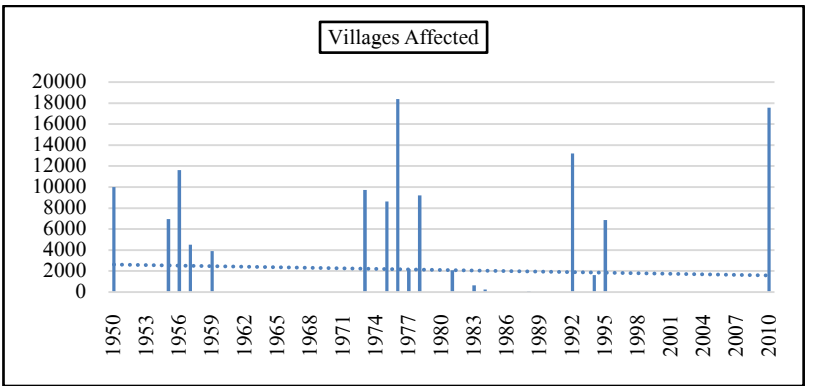


Figure 3. *Summary of number of villages affected in floods during 1950-2010*

Source: (Federal Flood Commission of Pakistan, 2014)

Figure 4 given below presents the figures in square kilometers that went under water during the floods. The figure in 2010 is the highest in number that went under water and damaged the standing crops, houses and livestock. Year 2010 is standing out when the area under water is covered with any other floods in any other year.

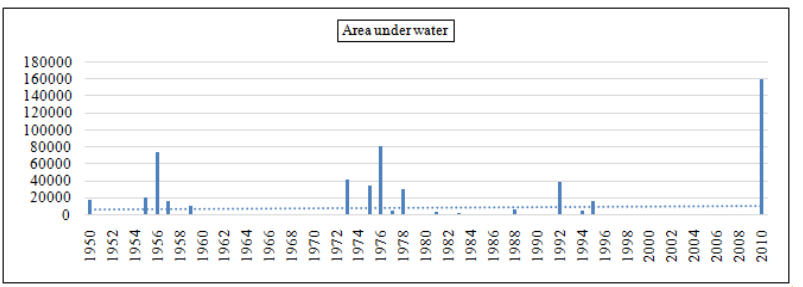


Figure 4. *Summary of the area in square kilometers affected in floods during 1950-2010*

Source: (Federal Flood Commission of Pakistan, 2014)

While looking at the data on the flood disasters in the country, one can understand the severity of the disasters has been increasing in all types of losses and damages.

Flood 2010 Facts

Widespread flooding affected as many as 20 million of people and inundated an area of 160,000 square kilometers equal to the size of American state of Florida (Memon, 2014). The occurrence of flood at such a large scale has led towards several issues and questions like damages and the recovery, rescue and rehabilitation of the people in the flood affected areas. In addition, it is imperative also to bring those flood affected people back in the arena of economic activities. Keeping view, the nature and scope of the study.

Flood 2010 and Food Security

The analysis of situation of food security can be done from four perspectives (Memon, 2014):

1. **Availability:** The availability of food items in sufficiently large amounts or quantities for general public. The food can be made available either through domestic production or by importing.
2. **Access:** Access of general public to the available food quantities through socio-economic and political arrangements in the society.
3. **Utilization:** This refers to the strength of body to utilize, absorb and make use of the nutrients which are made available. This includes sanitation, availability of clean drinking water and health facilities. Unhealthy stomach would not be able to utilize the nutrients provided to it through food.
4. **Stability:** It is the sustainability in the supply of the food items in the society without fear or worry of losing it due to any extreme circumstances or mis-happening.

According to a joint study and survey by World Health Organization (WHO) and Johns Hopkins Bloomberg School of Public Health (JHBSPH) in partnership with Health Ministry in Pakistan, the flood affected population in most of the areas had at least similar or slightly improved access to health, water or sanitation facilities; nevertheless, the it was highlighted that 24.3% of the population did not have adequate quantity of water for cooking and drinking (NDMA, 2012).

The situation of food security after flood 2010 has severely worsened and has badly affected the communities in the flood affected areas particularly in rural parts of the country. The same report reveals that shortage of disposable funds in the households was the key issue where food security had serious impacts. It is

indicated that the number of households lacking sufficient disposable funds to buy enough of the staple food and essential items reached 60% of the total households surveyed. The average household monthly income per households in pre flood times was reported as PKR 10900 per month. However, the survey recorded PKR 2600 (US $31) as the average household income per month with 75% of the population (households) living under PKR 5000 per month. In pre flood times, only 24% of the households lived at under PKR 5000 per month (OCHA, 2012).

Following table presents a summary of flood affected population's access to the facilities during and after flood 2010.

Table 4. *Reported Access to Services since the Flood*

Service	Percentage of Households access		
	Better	Same	Worse
Water	10.3	50.2	39.5
Sanitation/Toilets	4.1	44.7	51.3
Health Care Access	18.4	42.7	38.6
Health Care quality	16.8	42.3	40.9
Pregnancy Services	14.3	51.7	34.0
Education Access	9.5	64.2	26.3
Education quality	8.1	61.9	30
Food access	7.6	21.2	71.2
Food Quality	2.7	22	75.3
Household Income	1	11	88

Source: Pakistan Floods 2010: Impact Assessment (WHO and Ministry of Health)[7]

According to the table 4, 88% of the household's income sources have been worsened and food quality and food access both have severely and equally badly affected due to flood 2010 in the country. However, in case of other facilities like health care and education, the figures show some improvement in access and quality due to the international and government interventions. Further, (World Health Organization, 2011) report suggests that approximately 2.5 million people were hungry and food insecure. The hunger was also partly because of the hike in the commodity price. On average food prices had gone high by 20 to 25% whereas the income of the households had gone down by 10% to 15%.

Health

According to a report of Multisector Initial Rapid Assessment prepared by OCHA (Memon, 2014), some 32% of the communities that were affected by flood were without health facilities because of damage to the basic health units and other health related buildings. The key health problems highlighted by the informants in the survey conducted by UNOCHA were malaria (95%);

[7] Also cited in (Memon, 2014)

diarrhea (93%); skin infections (82%); cough, cold with fever (68%); and measles (18%).

The below figure 5 shows the health related issues highlighted in the flood affected areas in the country after 2010 floods. Most of the diseases widespread among the communities affected by flood are results of mosquito bites related or contaminated water usage or contact to the polluted and contaminated water or weather impacts. These diseases are in general common among communities who live in the flood affected areas.

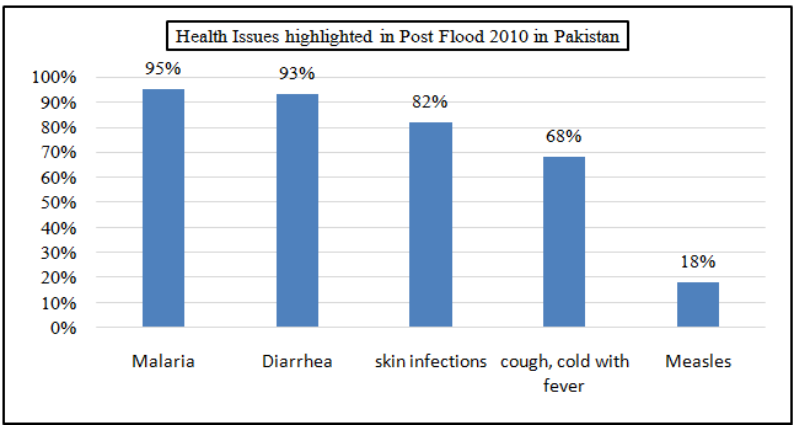


Figure 5. *Health Issues highlighted in Post Flood 2010 in Pakistan*
Source: (UNOCHA 2012).

Displaced Populations

The displaced population due to the mega flood in 2010 has been estimated up to 10% of the total population at the height of the crisis (World Health Organization, 2011). According to the reports, there were approximately 20 million persons were displaced from their towns, villages and rural areas to the dry lands in flood 2010. These internally displaced persons (IDPs) mostly took shelter in the primary and secondary schools in the nearby towns and cities as safer places. This further aggravated the situation of education even in the settled areas (Pakistan Floods 2010: Impact Assessment, 2011). According to another report (Kronstadt *et al.,* 2010) most of the displaced persons live in the temporary settings like tents, schools and other shelters. The survey recorded 54.5% of the households after being displaced from the flood affected areas lived in permanent structure such as a house or apartment, 32.5% remained in a temporary structure (such as a tent) and 7.1% lived in a school, warehouse or similar building. On the other side, the percentage of people living in the

camps arranged for the internally displaced persons was only 12.3% of the households.

Following table gives a glimpse on the number of houses damaged (minor, significant or fully destroyed and the percentage of internally displaced persons in the camps and out of the camps.

Table 5. *Damage to Homes, IDP vs. Non-IDP Residents*

	IDP Camp	Non-IDP Camp	Total
	%	%	%
No damage	1.8	6.2	5.6
Minor Damage	4.6	11.7	10.9
Significant damage	11.1	31.2	28.8
Destroyed totally	82.5	50.9	54.8
Total	100	100	100

Source: (Kronstadt *et al.*, 2010)

The survey registered 88.6% of the households remained out of their areas for 2 weeks after the floods. Out of them 17.6% of the flood affected persons left their regions and rest of the persons remained in the same area but at safer places.

Agriculture

Approximately 60% of the export earnings are a results of the agriculture produce in the country. Some of the cash crops are directly exported to other countries and some are used in the agro industrial units like cotton for further value addition.

According to the surveys and damage assessment reports, the damage to the farm irrigation waterways is approximately as high as 58%. The flood not only destroyed the standing *khareef (summer crop, fall harvest)* but also due to standing water in the fields, the affected farmers could not cultivate *rabi crops* (winter crop, spring harvest) thus denying them of the income as their primary source of financial amounts is agriculture worsening the already poor lives of the farmers (Juren & Khan, 2010).

About 80% of the standing crops and 91% of communities' fodder stock were lost in the flood water. Nonfarm workers in the agriculture workers were equally affected alongside of the farmers. According to the survey the 24% of the households were related with the nonfarm activities in the flood affected areas.

The report further summarizes the losses to the standing crops as per the assessment of UN and FAO as follows:

> "Damage assessments by U.N. agencies led by the FAO estimate that about 3.3 million hectares countrywide of standing crops, including rice, maize, cotton, sugarcane, fruit orchards and vegetables, have been damaged or lost completely due to flooding, with about 1.3 million hectares affected in the four hardest hit provinces.49 This represents

about 14% of the total cropped area in 2008.50 The cereal crops of the current Kharif or monsoon season (including rice, maize, sorghum, and millet), planted in May/July and scheduled to be harvested from September onward, typically account for approximately 35% of the annual national cereal production. Reports from FAO and the Asian Development Bank have estimated that as much as 25% of the cotton crop has been affected. Pakistan consequently may be a net importer rather than an exporter of cotton in 2010 in order to support its textile industry. Substantial losses of important export crops such as cotton, sugarcane, and rice, will have a large negative impact on the country's trade balance and household incomes, while losses in the production of staple cereals will exacerbate household food security issues in the country" (Dawn, 2008).

Flood Damages in Pakistan: Province wise and Sector wise

Damages in all over Pakistan

Pakistan is a low income country with large chunks of population living in the rural parts of the country with their dependence mainly on agriculture activities like cropping, livestock and fisheries. The River Indus along with its tributaries Kabul, Swat, Jhelum, Chenab, Ravi, Beas and Sutlej is the source of agriculture production for 90 million Pakistanis. When river flooding occurs, the banks of the river Indus or its tributaries burst and cause flooding across the country. Due to heavy torrential monsoon rains in 2010, the level of water in rivers soared and caused floods in the country. Following table 6 is presenting the summary of the province wise and area wise damage in Pakistani rupees and US dollars in million and the percentage loss in each area. According to the Preliminary Damage and Need Assessment by Government of Pakistan in collaboration with Asian Development Bank and United Nations on Flood 2010, the total quantifiable loss in the flood 2010 is equal to the hefty amount of $10.056 Billion or PKR 854.770 Billion.

Table 6. *Total Estimated Damage due to Flood 2010 in provinces and parts of Pakistan*

Province/area	Damage Costs		Percentage
	PKR Million	US $ Million	
AJK	7,303	86	0.85
Baluchistan	52,676	620	6.16
FATA	6,271	74	0.73
Gilgit-Baltistan	4,165	49	0.49
KPK	99,625	1,172	11.66
Punjab	219,272	2,580	25.65
Sindh	372,341	4,380	43.56
Federal Cross Cutting Sectors	93,117	1095	10.89
Total	854,770	10,056	100

Source: *Preliminary Damage and Need Assessment by Government of Pakistan in collaboration with Asian Development Bank and United nations on Flood 2010* (Kronstadt *et al.,* 2010) PKR = Pakistani Rupee.

According to the table 7 and figures 6 and 7 the maximum losses due to the floods 2010 happened in the province of Sindh that is PKR 372,341 m (US $4,380 m) which is equal to 43.56% of the total flood damage cost in the country. On the other hand, the other areas suffered the remaining 56.5% losses with 0.85% loss in the AJK, 6.16% in Baluchistan, 0.73% in FATA (Federally Administered Tribal Areas, 0.49% in Gilgit-Baltistan, Khyber-Pakhtunkhwa 11.66%, Punjab 25.65% and 10.89% in the Federal Cross Cutting Sectors like governance etc.

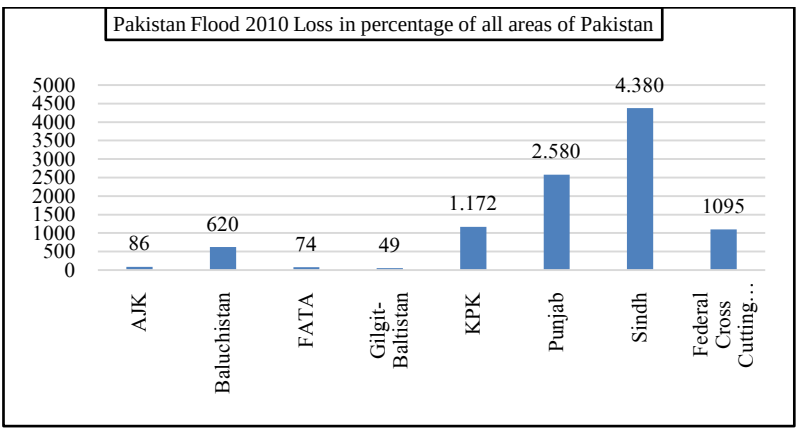


Figure 5. *Pakistan Flood 2010 Losses in Million US Dollars*
Source: Preliminary Damage and Need Assessment by Government of Pakistan in collaboration with Asian Development Bank and United nations on Flood 2010 (Juren & Khan, 2010).

The damage of the flood varied between the sectors with major damages to the livestock and standing crops in agriculture sector and damaged houses in rural areas.

Given that the region is characterized by extreme poverty in an agrarian society where the life in a whole relies upon cropping, harvesting and livestock, floods seem to be a horrific incident washing away all of the sources of livelihood from people around. The agriculture income in rural areas stems from cropping of wheat (40% of total area), rice (14%) and cotton (12%) in Pakistan (Javed, 2014). The share of areas in the flood damage in 2010 is presented in the following pie chart.

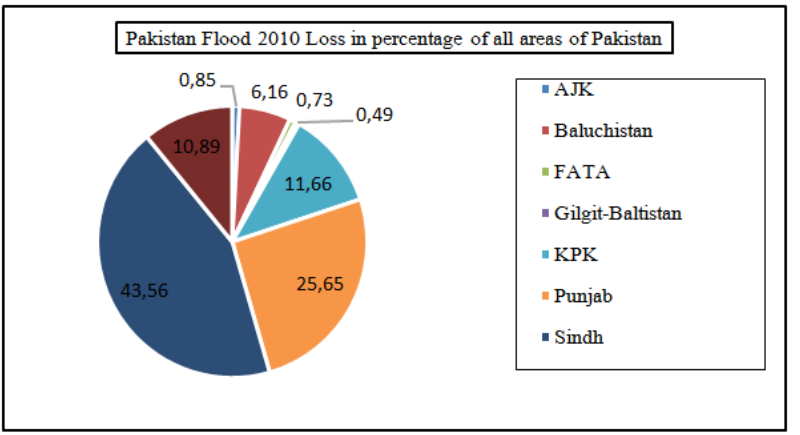


Figure 6. *Pakistan Flood 2010 Loss in percentage of all areas of Pakistan*

Source: Preliminary Damage and Need Assessment by Government of Pakistan in collaboration with Asian Development Bank and United Nations on Flood 2010 (Juren & Khan, 2010).

Sectoral Description of the Flood Damage

According to Preliminary Damage and Need Assessment by Government of Pakistan in collaboration with Asian Development Bank and United nations on Flood 2010, the major loss during the floods had been to the economic sector followed by physical and social infrastructures in the country. Out of total loss of US$10.056 billion, 59.66% of the loss has been suffered in the economic sectors. These economic sectors are agriculture, livestock and fisheries, private sector and industries, financial sector. In these sectors more than 84% of the damage in the economic sector is suffered by the agriculture sector.

Table 7. *Summary of Flood 2010 Estimated Damages in Pakistan by Sector and subsectors*

S. No	Sector	Total Damage PKR Millions	US $ Millions	Percentage Sectoral	Percentage Total
I	Social Infrastructure				
	Housing	135,014	1,588	81.48	15.80
	Health	4,223	50	2.55	0.49
	Education	26,465	311	15.97	3.10
	Sub Total	165,702	1,949	100	19.39
II	Physical Infrastructure				
	Irrigation and Flood Management	23,600	278	13.74	2.76
	Transport and Communication	112,911	1,328	65.6	13.21
	Water Supply and Sanitation	9,306	109	5.41	1.09
	Energy	26,300	309	15.28	3.08
	Sub Total	172,117	2,024	100	20.14
III	Economic Sectors				
	Agriculture, Livestock and Fisheries	428,804	5,045	84.08	50.17
	Private Sector and Industries	23,931	282	4.69	2.8
	Financial Sector	57,251	674	11.23	6.7
	Sub Total	509,986	6,001	100	59.66
IV	Cross Cutting Sectors				
	Governance	5,976	70	85.76	0.7
	Environment	992	12	14.24	0.12
	Sub Total	6,968	82	100	0.82
	Grand Total	854773	10056		100

Source: Preliminary Damage and Need Assessment by Government of Pakistan in collaboration with Asian Development Bank and United nations on Flood 2010 (Juren & Khan, 2010).

Above table 7 presents the breakup of total flood 2010 damages into four major sectors namely, Social Infrastructure (Housing, Health and Education), second Physical Infrastructure (Irrigation and Flood Management, Transport and Communication, Water Supply and Sanitation and Energy), third, Economic Sectors (Agriculture, Livestock and Fisheries, Private Sector and Industries and Financial Sector) and fourth Cross Cutting Sectors (Governance and Environment). According to table 7, the maximum damage happened to the economic sectors (59.66%) that include Agriculture, Livestock and Fisheries (50.17%), Private Sector and Industries (2.8%) and Financial Sector (2.8%).

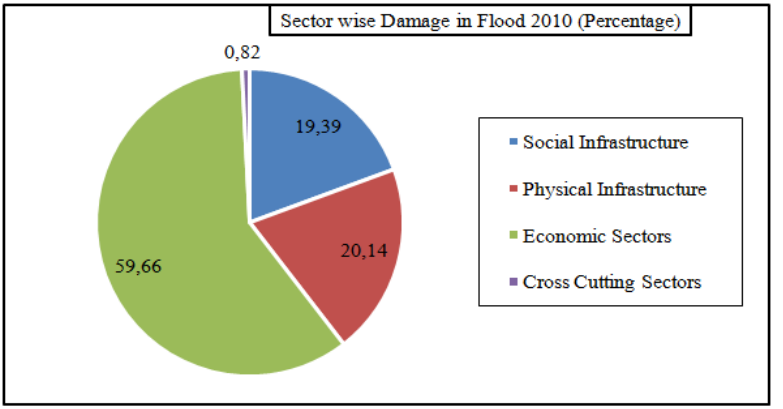


Figure 7. *Sector wise Damage in Flood 2010 (Percentage)*
Source: Preliminary Damage and Need Assessment by Government of Pakistan in collaboration with Asian Development Bank and United nations on Flood 2010 (Juren & Khan, 2010)

The graph 8 clearly shows that the heaviest loss due to damage has been to the economic sectors like agriculture, private industry and financial sector. This economic sector is indeed the focus of the present study where agriculture income and the quantities demanded of the selected household items has been estimated. Further distortions in the commodity market because of floods have also been discussed in the upcoming chapters.
The damage in the subsectors of the sectors presented in the figure 8 are also presented in the following four figures (9-12).

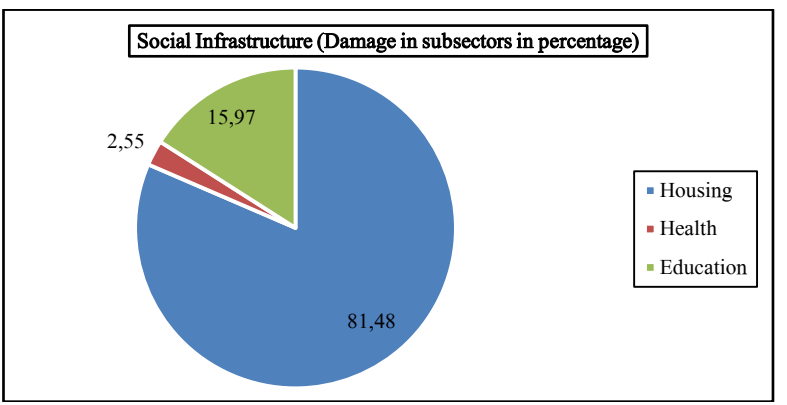


Figure 8. *Social Infrastructure: damage in Housing, Health and Education*
Source: Preliminary Damage and Need Assessment by Government of Pakistan in collaboration with Asian Development Bank and United nations on Flood 2010 (Juren & Khan, 2010).

Social infrastructure in the country includes the housing facilities privately owned by the population, health facilities, and the education access and availability in the flood affected areas. Rebuilding and reconstruction of the destroyed houses has been the key part of the intervention by government, nongovernmental and International donors (UNOCHA, 2010). In social infrastructure, the highest loss has been to the housing (katcha or non-cemented and pacca or cemented) that is 81.48%. The second highest has been in the education sector 15.97 and third is health sector 2.55%.

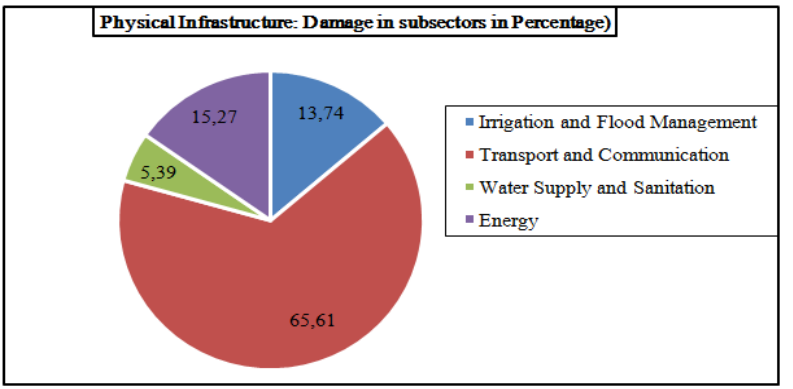


Figure 9. *Physical Infrastructure: Damage in Subsectors in Percentage*
Source: Preliminary Damage and Need Assessment by Government of Pakistan in collaboration with Asian Development Bank and United nations on Flood 2010 (Juren & Khan, 2010).

The damage in the physical infrastructure has also been significant. The highest damage to the physical infrastructure has been in the transport and communication system. Due to flood water, the road transport and fiber optic along with the telephone lines were severely damaged. The loss to the transport and communication is the 65.61% of the total loss in the physical infrastructure. The second highest is in the energy sector 15.27% of the total loss in the physical infrastructure followed by irrigation and flood management (13.74%) and water supply and sanitation (5.39%).

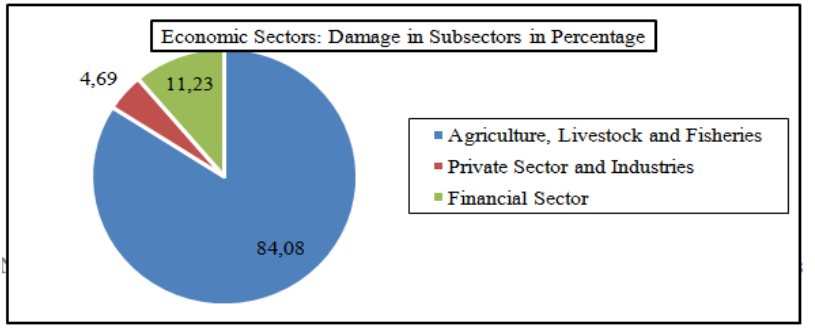


Figure 10. *Economic Sectors: Damage in Subsectors in Percentage*
Source: Preliminary Damage and Need Assessment by Government of Pakistan in collaboration with Asian Development Bank and United nations on Flood 2010 (Juren & Khan, 2010).

Figure 11 displays the flood loss and damage in the subsectors of the economic sector. The subsectors included in the economic sector are agriculture, livestock and fisheries, second private sector and industries and the third is the financial sector. The highest loss (84.1%) of the total loss in Agriculture, Livestock and Fisheries subsectors. This is 60% loss in the overall damage of flood 2010) in the economic sector has been in the agriculture, livestock and the fisheries. Flood water washed away all the standing crops and killed animals which are a key resource of income for the farmers in the rural areas of the countries. Second highest loss is in the financial sector (11.23%) with damaged or destroyed bank buildings and equipment in the branches in the flood affected regions. Third is the loss in the private sector and industry with a loss of 4.69%.

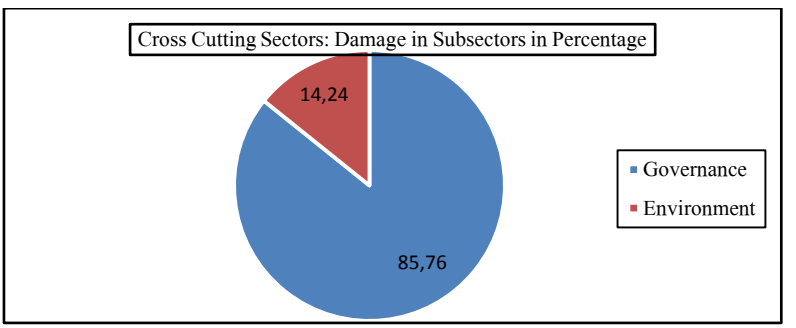


Figure 11. *Cross Cutting Sectors: Damage in Subsectors in Percentage*
Source: Preliminary Damage and Need Assessment by Government of Pakistan in collaboration with Asian Development Bank and United nations on Flood 2010 (Juren & Khan, 2010).

Fourth sector is the cross cutting sectors. The governance and the environment are the two subsectors. The highest loss in this has been to the governance (85.76%) and 14.24% loss is recorded in the environment.

Flood Damage: Selected District-wise

Four districts of north Sindh have been selected for the analysis. These districts are; Kashmore-Kandhkot, Shikarpur, Jacobabad, Shikarpur and Qamber-Shahdadkot. The sole criteria of selection of these districts are the intensity of losses due to flood in these districts in the country. All four districts are economically agriculture base with major crops of rice, wheat and livestock with few sugarcane farms (UNOCHA, 2010). Following table presents the summary of the flood damage in the four selected districts in number of affected villages; persons affected damaged houses and affected crop area and killed cattle heads. The table presents the summary of the flood damages from the surveyed data on the number of villages and persons affected, crop area damaged (in acres) and the number of *Katcha* (mud) and *Pacca* (cemented) houses damaged during flood. The statistics reveal that the four districts under study cover 55.41% of the total number of villages affected, 46.73% of the total persons affected, 69.07% of the crop area of the province and 46.77% of the total number of houses damaged in the province. Further, in case of the cattle heads the total impact is 24.03% in the selected districts, that is 24.03% of the total cattle heads died in the province happened in the selected four districts. This suggests that the scope of the study is sufficiently large for generalizability of the results over the whole province. The above paragraphs have been delineating the extent of the damage caused due to the floods 2010 to the social and physical infrastructure and the housing, agriculture and livestock as the key sources of the household livelihood in the province.

Table 8. *Flood Damages (2010) on villages, crop area, Persons affected and Houses damaged in selected districts in Sindh Province*

		Kashmore	Shikarpur	Jacobabad	Qamber Shahdadkot	Total (Percent)	Sindh Total
Villages Affected	Number	1000 (13.74%)	1,359 (18.68%)	1,123 (15.43%)	550 (7.56%)	4,032 (55.41%)	7,277
Persons affected	Number	615,000 (8.8%)	778,000 (11.13%)	892,500 (12.77%)	980,500 (14.03%)	3,266,000 (46.73%)	6,988,491
Crop Area Affected	Acres	400,124 (16.31%)	110,189 (4.49%)	687,000 (28.0%)	497,380 (20.27%)	1,694,693 (69.07%)	2,453,503
	Katcha (mud)	74,545 (8.84%)	94,303 (11.13%)	108,182 (12.77%)	118,848 (14.03%)	847,089 (46.73%)	847,089
Houses Damaged	Pacca (cemented)	18,636 (8.93%)	23,576 (11.29%)	27,045 (12.95%)	29,712 (14.23%)	98,969 (47.41%)	208,772
	Total	93,190 (8.825%)	117,890 (11.16%)	135,239 (12.81%)	148,574 (14.07%)	494, 847 (46.77%)	1,055,961 (100%)
Cattle Heads	Number	17,500 (6.67%)	838 (0.32%)	615 (0.23%)	44,039 (16.80%)	62,992 (24.03%)	262,183

Source: *MapAction* (UNOCHA, 2010).

The table 8 given above presents a detailed picture of the intensity of the damages in the four selected districts for analysis. In case of the number of villages affected, 45.41% of the total numbers of villages affected in the province are affected in any of the four districts. The highest loss in the number of villages damaged is in the district of Shikarpur (18.68%). If the number of persons affected in the flood 2010 is taken as a bench mark for the intensity of flood damage, then the selected four districts have been suffering more than any other region in the country. Almost 46.73% of the persons affected due to flood in Sindh are in one of the four districts. The highest number of persons affected (14.03%) of the total persons affected in the province are from Qamber-Shahdadkot district.

In terms of the crop area affected in acres then highest number of acres affected is in the Jacobabad District that stands at 28%. The crop area affected in the selected four districts is 69.03% of the total area affected in the whole province. In case of the houses damaged (cemented and non-cemented), approximately 46.7% of the total houses damaged in the province are in any of these four districts. The highest number of damaged houses is from the district of Qamber-Shahdadkot that is 14.07%. While looking at the cattle heads perished, it makes 24% of the total perished cattle heads in the province. The highest cattle heads (16.80%) damage has been recorded in Qamber-Shahdadkot.

Following graphs show the percentage share of the flood damage in all the four districts in all heads of loss.

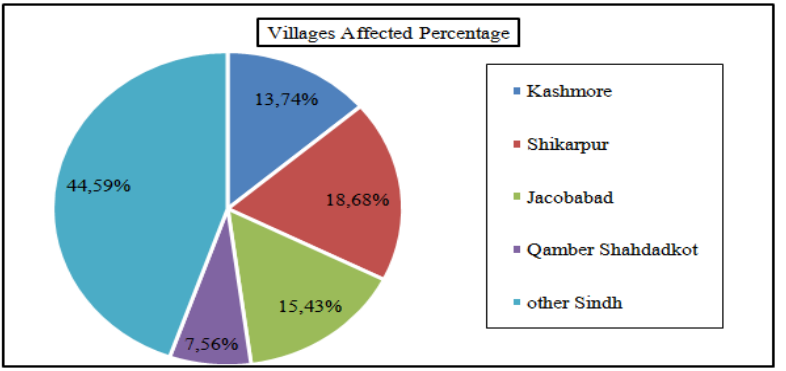


Figure 12. *The number of villages affected in the selected four districts (in percentage) of the total villages affected in Sindh*
Source: *MapAction* (UNOCHA, 2010).

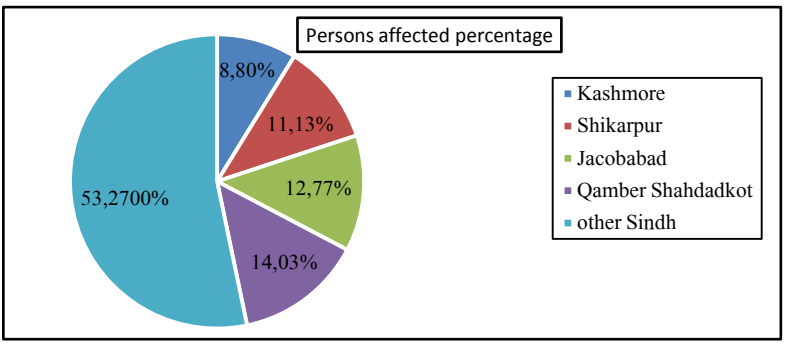


Figure 13. *The number of persons affected in the selected four districts (in percentage) of the total persons affected in Sindh*
Source: *MapAction* (UNOCHA, 2010).

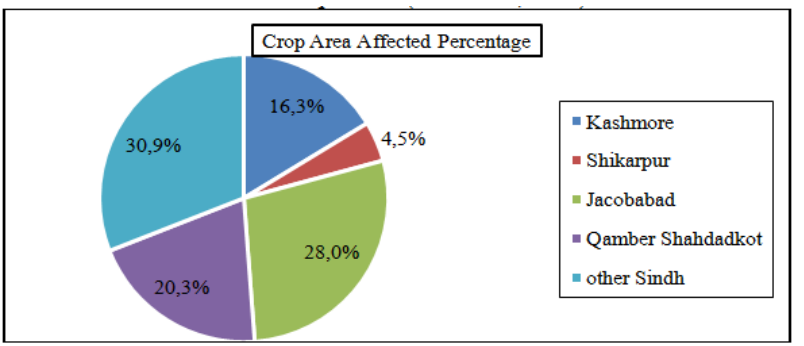


Figure 14. *The acres of crop area affected in the selected four districts (in percentage) of the total acres affected in Sindh*
Source: *MapAction* (UNOCHA, 2010).

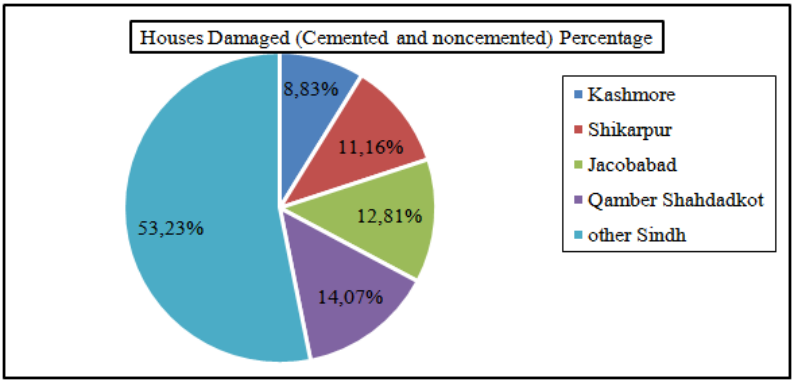


Figure 15. *The acres of crop area affected in the selected four districts (in percentage) of the total acres affected in Sindh*
Source: *MapAction* (News, 2012)

The above given graphs and the tables present a multi-faceted scenario of the damages in the country. The country's damages due to flood are divided into sectoral and subsectoral categories. Further, the highest loss in the country has been suffered from the southern part of the country. In the province of Sindh the highest damage caused by the floods has been in the selected four districts of the province. The majority of the inhabitants in the region is involved in cropping of rice, wheat, sugarcane and cotton and keep livestock for their livelihood. Following table 9 presents the major occupations, agriculture output of the main crops of the country produced in the selected four districts. In the post flood survey for the qualitative analysis, it was verified that the trend of cropping in the selected districts has not changed. However, the quantities of the crops may vary by small amounts.

Table 9. *Agriculture Output (2014) of important crops and livestock for selected Districts*

	Wheat	Cotton	Rice	Sugarcane	Cattle
			Tones		
Kashmore-Kandhkot	94.2	-	280.6	2.5	190,872
Jacobabad	37.7	-	294.7	5.4	507,240
Shikarpur	88.2	0.5	348.9	0.9	
Qamber-Shahdadkot	89.3	-	288.8	9.7	229,617

Source: *MapAction* (Malik, 2011)

According to the above table 9, the selected four districts' key crops are wheat and rice. They also keep cattle for their livelihood and some of the areas in these districts grow sugarcane but the amount of sugarcane is not significant because there are not close sugar mills in the area. The highest rice is grown in the district

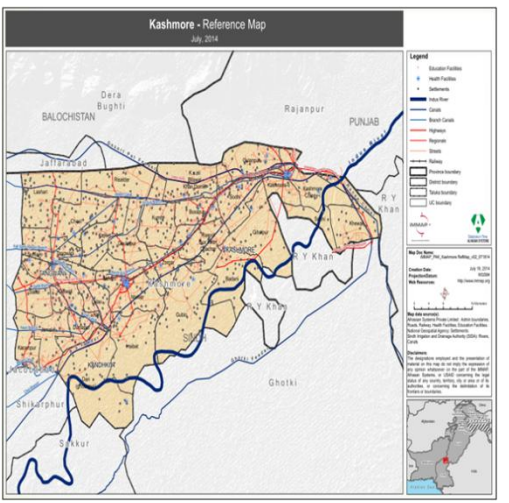
Shikarpur with 348.9 tones followed by Jacobabad 294.7 tones and Qamber-Kandhkot with 280.6 tones. Whereas highest wheat is grown in Kashmore-Kandhkot district with 94.2 tones followed by Qamber-Shahdadkot with 89.3 tones, Shikarpur with 88.2 and Jacobabad with 37.7 tones.

Profile of Selected Districts

Following subsections present the profiles of the selected districts for the study.

Kashmore-Kandhkot

Kashmore-Kandhkot is one of the 29 districts of Sindh province. Its total area is 2682.46 square kilometers. The district comprises of three talukas or subdivisions: Kashmore, Tangwani and Kandhkot. The capital city of the district is the Kandhkot. The district is situated in the northern part of the Sindh province. According to the unofficial statistics, the population of Kashmore-Kandhkot in 2011 was recorded as 1.207 million people that was increased by 76.5% from 0.684 million in 1998 (the year when the last official census was recorded) (USAID, 2014a). The districts southern side meets Indus River and western side borders with the district of Shikarpur.



Its eastern part is connected with the district Rajanpur of Punjab Province across the Guddu Barrage on the River Indus. In the north of the district the district Sibbi of Baluchistan is located (USAID, 2014a) This geographical location of the district gives it a unique culture, living and trading conditions while being on a junction

connection Sindh, Baluchistan and Punjab Provinces. The 65% of the population is associated with farming and cattle rearing and trading. The presence of rice mills as the agro-industrial base together with agriculture generates employment opportunities for the inhabitants of the district. On the barrage of Guddu, Pakistan's second largest power generation plan is situated that generates and distributes electricity to different parts of the country. The district is basically a semi tribal area with several Baloch tribes residing in the district. The main spoken language is Sindhi. In its sense of connectivity and proximity of the city centres in the province, it is treated as the far flung district of the province. Though the transportation through road is fast and smooth, the city development and public utilities in the district are in very poor condition. The known major reason for the worst human crisis during flood 2010 was the unavailability of health and rescue facilities and transport. The detail on the administrative units of the district and the number of rural and urban mouzas in the district is given in following table 10.

Table 10. *Administrative Units and number of rural and urban mouzas in Kashmore-Kandhkot*

S.No.	Sub division	Number of Mouzas				
		Rural	Urban	Semi Urban	Unpopulated	Total
1	Kandhkot	35	3	3	2	43
2	Kashmore	54	1	2	-	57
3	Tangwani	42	3	-	-	45
	Total	131	7	5	2	145

Note: Mouza Statistics of Sindh 2008, Agriculture Census Organization (USAID, 2014a)

The distance of Kashmore to Sukkur (a major and nearest city and trading hub in the region) is 149 kilometers via N-55. The flood losses in the district have already been given and discussed in previous sections on the district flood loss. The detailed reference map by USAID is given on the next page.

Further the source of irrigation in the district is presented in the following table.

Table 11. *Mouzas Reporting Source of Irrigation: Kashmore-Kandhkot*

Administrative Unit	Number and Percent of Rural Populated Mouzas	Canal	River	Tube wells
Whole District	136 (100%)	120 (88%)	38 (28%)	33 (24%)
Kashmore	56 (100%)	55 (98%)	12 (21%)	31 (55%)
Kandhkot	38 (100%)	27 (71%)	15 (39%)	2 (5%)
Tangwani	42 (100%)	38 (90%)	11 (26%)	-

Source: Mouzas Statistics of Sindh, Agriculture Census Organization

From table 11 it is clearly shown that the majority of the irrigation in the district is done through canal system. The canal

system is connected with Guddu barrage. However there are a number of tube wells in Kashmore and Kandhkot subdivisions of the district.

Jacobabad

The total area of the district is 5278 square kilometers. The name of the district originated from the name of a British General Brigadier General John Jacob, who was the commandant of the Sindh Horse at that time (1847). The geographically the district is located at the Centre of the Baluchistan province in its north, in its east is the district of Kashmore-Kandhkot, Larkana and Shikarpur districts are in its south and Qambar Shahdadkot district is in its west. The district consists of three talukas or subdivisions namely; Jacobabad, Garhi Khero and Thul. The distribution of the urban and rural mouzas in the three talukas is given as under in table 12.

Table 12. *Administrative Units and number of rural and urban mouzas in Jacobabad*

S.No.	Sub division	Number of Mouzas			
		Rural	Urban	Semi Urban	Total
1	Jacobabad	53	2	3	58
2	Gharhi Khero	57	1	2	60
3	Thul	92	1	3	96
	Total	202	4	8	214

Note: *Mouza Statistics of Sindh 2008, Agriculture Census Organization* (USAID, 2012b).

According to the reports this district has been with one of the finest canal irrigation systems with two main barrages; one from the Kashmore and the other from the Sukkur. The district has main canals of Kheerthar originating from Sukkur Barrage, The Pat Feeder Canal, Begari Canal and the desert or Shahi Wah canal. According to the statistics, 98% of the rural mouzas are irrigated through canal system. Following table 13 presents the summary of the source of irrigation in the district.

Table 13. *Mouzas Reporting Source of Irrigation: Jacobabad*

Administrative Unit	Number and Percent of Rural Populated Mouzas	Canal
Jacobabad District	210 (100%)	206 (98%)
Jacobabad Taluka	65 (100%)	54 (96%)
Gharhi Khero Taluka	59 (100%)	58 (98%)
Thul Taluka	95 (100%)	94 (99%)

Source: Mouzas Statistics of Sindh, Agriculture Census Organization.

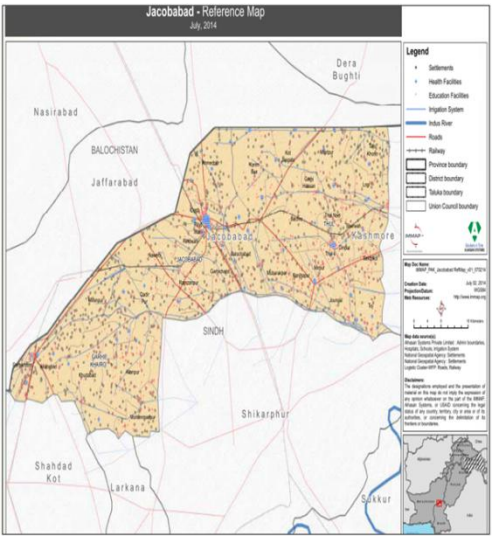


Figure 16. *Reference Map of Jacobabad (USAID, 2014a)*

The estimated population of the district in 2013 has been 1.1032 million including male and females. Given the birth rate of 2.35, the population has increased from 0.742 million in 1998 to 1.1032 in 2013 (USAID, 2012a). More than 80% of the population is associated with agriculture (cropping or livestock. It has a major cattle market in the region. The land of the district is leveled and flat. The fertility of the land and the blessing of the Indus, the cropping in the two seasons, rabi and khareef continues without gap. The major crops are rice, barley and wheat.

Shikarpur

The Shikarpur district is the plain area formed by the Indus River. Geographically is surrounded by Jacobabad, Thul and Kandhkot from its north. River Indus and the district of Khairpur lies on its south. On the west is the Larkana district and on the east is the Indus and the district of Sukkur. The district has extreme weather conditions in summers and winters. It has a rich history and heritage. The district comprises of four talukas, namely; Shikarpur, Lakhi Ghulam Shah, Garhi Yaseen and Khanpur. The administrative division and the number of rural and urban mouzas in the district is given in the following table 14.

Table 14. *Administrative Units and number of rural and urban mouzas in Shikarpur*

Administrative Units	Number of Mouzas			
	Rural	Urban	Semi Urban	Total
Shikarpur	45	2	2	49
Khanpur	48	2	1	52
Garhi Yaseen	88		2	93
Lakhi Ghulam Shah	44	2	4	51
Total	225	6	9	245

Source: Mouzas Statistics of Sindh, Agriculture Census Organization.

The district agriculture activities mainly depend upon the canal irrigation like Jacobabad. Table 15 given below presents the summary of the source of irrigation in the district.

Table 15. *Mouzas Reporting Source of Irrigation: Shikarpur*

Administrative Unit	Number and Percent of Rural Populated Mouzas	Canal
Shikarpur	234 (100%)	211 (90%)
Khanpur	49 (100%)	41 (84%)
Garhi Yaseen	90 (100%)	90 (100%)
Lakhi Ghulam Shah	48 (100%)	33 (69%)

Source: Mouzas Statistics of Sindh, Agriculture Census Organization.

The estimated population of the district Shikarpur in 2010 has been 1.182 million male and females of all ages. 48.55 % of the total population of the district is dependent. The dependent population is considered as less than 15 years of age or widowed or divorced population.

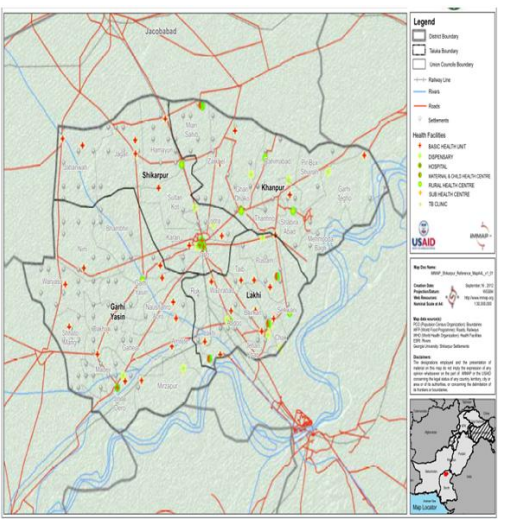


Figure 17. *Reference Map: District Shikarpur (USAID, 2014a)*

The average household size is 5.9 members in a family. In the district majority of the working population is associated with the farming (56%) and Casual work/labour (35%) as the key source of livelihood. The average monthly per capita income of the district is estimated at PKR 1473/month[8] which is less than the average national per capital income of PKR 1504/month (USAID, 2012a). In the district of Shikarpur, the agriculture land ownership is extremely skewed as approximately 80% of the population does not own any land. The major crops of the district are wheat and rice.

Qamber-Shahdadkot

In 2005, two talukas; Qambar and Shahdadkot; of district Larkana were merged together to make one district. Baluchistan province lies on its north-west and Larkana district lies on its east. District Dadu is on its south and Shikarpur and Jacobabad lie in its north east. All four districts including Qambar-Shahdadkot have identical climate of extreme seasons. The district consists of seven talukas or subdivisions. The administrative division of the district and the rural and urban mouzas are given in the following table 16:

Table 16. *Administrative Units and number of rural and urban mouzas in Qambar-Shahdadkot District*

Administrative Unit	Rural	Urban	Partly Urban	Total
Warah	29	1	9	44
Qambar	56	0	5	61
Qubo Saeed Khan	34	0	4	38
Shahdadkot	35	1	3	39
Sujawal Junejo	31	1	0	32
Mir Khan	37	1	0	38
Nasirabad	21	0	9	30
Total	243	4	30	283

Source: Mouza Statistics of Sindh 2008, Agriculture Census Organization

64 kilometers of the Ratodero-Gawader Motorway is passing through the district giving it a facility of smooth and fast logistics with nearby districts in the region. The sukkur barrage is the main source of irrigation in the district. The number of canals and branches from the barrage are Ghar Wah, Noor Wah, Shahdadkot Branch, Tanwary, Patooja, Kot Shahbeg, Qubo, Saifullah Magsi Branch, Edan, Begari, Dhori, Rabbi, Koor Dato, Koor Shah. 96% of the irrigation is done through canals in the district. Following table shows the total irrigated area of district Qamber-Shahdadkot by canals and other modes.

[8] Socio-Economic Baseline Survey of Shikarpur District (2010), Rural Support Programme Network (RSPN) Islamabad

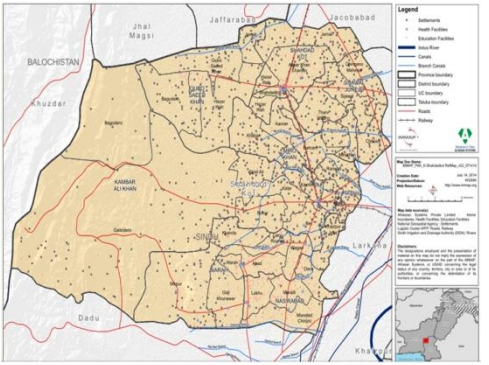


Figure 18. *Reference Map: District Qamber-Shahdadkot (USAID, 2014a)*

Table 17. *Mouzas Reporting Source of Irrigation: Qambar-Shahdadkot*

Administrative Unit	Number and Percent of rural populated mouzas	Canals	River	Tube wells
Whole District	273 (100%)	263 (96%)	2	3 (1%)
Warah	38(100%)	32 (84%)	1	3 (8%)
Qambar	61 (100%)	58 (95%)	1	0
Qubo Saeed Khan	38(100%)	37 (97%)	3	0
Shahdadkot	38(100%)	38(100%)	0	0
Sujawal Junejo	31 (100%)	31 (100%)	0	0
Mir Khan	37 (100%)	37 (100%)	0	0
Nasirabad	30 (100%)	30 (100%)	0	0

Source: Mouza Statistics of Sindh 2008, Agriculture Census Organization

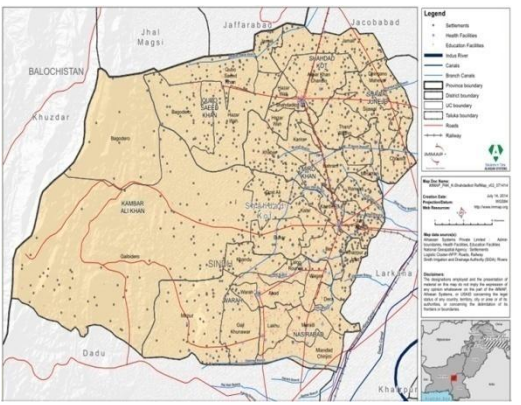


Figure 19. *Reference Map: Qambar-Shahdadkot District (USAID, 2014a)*

In the year 2008-09, the 99% of the cultivable land was sown and irrigated through canals and tube wells (Cançado, Brasil, Nascimento, & Guerra, 2008). The estimated population in the district as per 2013 estimations is 1.304 million male and female. 71% of the population of the district lives in rural settings as is the case with most of the districts in the province. The dependent

population in the district is around 50% and 50% is the working population. The main source of livelihood and employment is the agriculture related activities. 94% (male) of the labour force and 74% (female) is associated with agriculture sector be it cropping or livestock (Blaikie, Terry, Ian, & Ben, 1996). The major crops in the district are rice, wheat, jowar, grams. Along with the agriculture sector, the livestock is also a major subsector of the agriculture sector that provides employment opportunities to the population. Qambar-Shahdadkot district is declared as the food secure district.

Research Questions

Keeping in view the above discussion, following questions have been listed as the basis of the study

1. How floods 2010 have affected the consumption patterns and thus the welfare changes in flood affected population (households) in North Sindh.
2. How to measure the Hicksian Compensating variation to bring the utility of affected population (households) to the initial level irrespective of which consumption bundle is consumed.
3. How much was the intervention from government and other donor agencies in the flood affected area?
4. Was the intervention sufficiently large? How much was the estimated gap?
5. How perception of flood affected population is developed about intervention in post flood era?

Hypotheses

1. Consumption pattern and thus welfare of flood affected households (consumers) has changed during pre- and post-flood eras.
2. Income effect from the overall effect on the household consumption would be less than the substitution effect due to the wide spread poverty in the region.
3. Public sector institutions performance remained poor than private sector (NGOs, INGOs etc.)
4. The total intervention does not seem to be at par with the required intervention in the flood affected area.

Objectives

1. To identify the household bundle of consumption goods in flood affected areas.
2. To estimate the household consumption patterns in flood affected areas.

3. To estimate Marshallian demand equations of households in the selected districts.
4. To estimate Hicksian Compensating required by households to reach initial level of utility U_0.
5. To identify the Public interventions in post flood era.
6. To identify the private interventions (NGOs, INGOs etc.) in post flood era.
7. To compare public and private sector interventions.
8. To highlight the estimated amount of cash required per household to come to the initial level of utility.
9. To conduct focus group discussions in limited scope to highlight the perception of the population in flood affected area regarding claimed intervention by government and other donor agencies.

3. Literature

The literature associated with the flood and other natural disasters has been reviewed and classified into two types of the studies: first group of the studies take up the research on the risk of occurrence of the floods or natural disasters and their relevance to the losses and damages. The vulnerability of the communities, risks associated with the intensity of damages, exposure of the sections of society and infrastructure and human lives exposed to the ills of disasters. The models and approaches have been discussed in this group of studies that deal with the measures taken before any floods or the disasters takes place. The second group of studies includes the impacts of floods and other disasters on the human beings, infrastructural damage, commodity market distortions due to demand and supply disequilibria and price distortions, direct and indirect losses, welfare effects of the disasters on the households and business activities, health issues and the impact on the rural economies in developing countries. The floods have serious and severe consequences for the rural economies of the poor countries because of their vulnerabilities and exposure to the hazards of the disasters. Following sections present a detailed account of both of the groups of studies and their relevant discussions.

Risk Management

The risk measures the uncertainties embedded in the occurrence of the events. The measurement of the degree of uncertainty becomes very important when costs of damages or losses in terms

of human lives lost are too high. In case of natural disasters, the measurement of risk becomes imperative due to the intensity of expected human loss or infrastructural and developmental toll is very high.

The assessment of the risk associated with the natural disasters is always done in the context of the nature of the even and the basic attributes of the population in a certain geographical location with degree of exposure and vulnerability (Blaikie *et al.,* 1996). In this context the equation developed in (Blaikie *et al.,* 1996) for measurement of the risk of natural disasters brings in the vulnerability and the hazard.

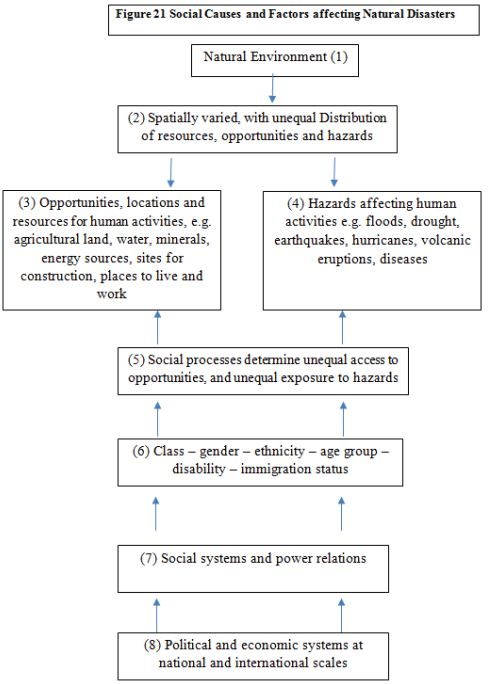
Risk = Hazard x Vulnerability (1)

The variable of "hazard" here has implications on the chance of occurrence of a flood event and its intensity in its main physical characteristics measured in terms of flow velocity, flood depth and duration. On the other hand the vulnerability in equation 1 refers to the measurement of the latent factors leading towards the damage due to the area's proximity to the natural disasters and the capacity of the population to recover from the losses. This has a direct bearing on the social and economic arrangement of resources in the region (Blaikie *et al.,* 1996).

Numerous parts of the social environment are effortlessly perceived: individuals live in incompatible financial circumstances that oblige them to possess quarters and places that are influenced by regular natural dangers, be they the outpouring fields of waterways, the slants of volcanoes or seismic tremor zones. Nonetheless, there are numerous different more subtle political and financial components that underlie the effect of risks. These include the way in which resources, wage and access to the resources, for example, learning and data, are dispersed between various social gatherings, and different types of separation that happen in the designation of welfare and social assurance (counting relief and resources required for recovery). It is these factors that connect the present investigation of disaster/debacles that are probably brought on for the most part by normal risks to more extensive examples of social life and living patterns in the public eye. These two viewpoints – the common and the social – can't be isolated from each other: to do as such welcomes an inability to comprehend the extra weight of regular perils, and it is unhelpful in both comprehension of the debacles and accomplishing something to anticipate or relieve them.

In addition human activities and practices can alter physical and biotic happenings, even sometimes infrequently numerous miles away (e.g. deforestation adding to flooding the downstream) or numerous years after the fact (e.g. the presentation of another seed or animal, or the substitution of one type of engineering for another, less protected, one). The aspect of time measurement is critical in another way too. Social, financial and political procedures are themselves frequently changed by a catastrophe in ways that make a few people more helpless against an outrageous occasion later on. Putting the beginning of fiasco in a more extended time span in this manner raises issues of intergenerational equity, a moral question brought up in the verbal confrontations around the significance of "economical" advancement. The "natural" and the "human" factors are, along these lines, so inseparably bound together in all disaster circumstances, particularly when seen in an expanded time and space structure, that fiascos can't be comprehended to be "natural" in any direct way. (Anderson-Berry, 2003)

Following flow chart may present a social causality and human interaction in the natural disasters (Source: (Clark, *et al.,* 1998).



In assessing the chance of any disaster, the social generation of helplessness should be considered with in any event a similar level of significance that is committed to comprehension and tending to regular dangers. Communicated schematically, our view is that the hazard confronted by individuals must be viewed as a cross-cutting mix of vulnerability or helplessness and the hazard or the danger as discussed already. Debacles are a consequence of the association of both; there can't be a disaster if there are hazards however helplessness or vulnerability is practically (or hypothetically) zero, or if there is a vulnerable populace yet no hazard[9]. "Risk" alludes to the common occasions that may influence better places separately or in blend (coastlines, slopes, tremor shortcomings, savannahs, rainforests, and so on.) at various circumstances (period of the year, time of day, over return times of various span). The risk has

[9] The explanation may be that the element of 'Risk' might be existing because the natural process may be able to generate such events. However in presence of some extreme natural even (e.g. an actual hurricane or landslide), with little or no vulnerability associated with population or region, the chances of a disasters are negligible.

shifting degrees of power and severity[10]. Although our insight into physical causal instruments is inadequate, some long aggregations of records (for instance of sea tempests, tremors, snow torrential slides or dry seasons) permit us to determine the factual probability of many dangers in time and space. Be that as it may, such learning, while fundamental, is a long way from adequate for computing the real level of hazard. We are contending that the danger of catastrophe is a compound capacity of the regular risk and the quantity of individuals, portrayed by their fluctuating degrees of helplessness to that particular peril, who involve the space and time of presentation to the peril occasion. There are three components here: hazard (calamity), helplessness, and danger, whose relations we think that it is advantageous to schematise in a pseudo-equation: R = H x V.

The dynamic way of helplessness focuses on three variables: the geophysical environment, the assembled environment, and attributes of the populace that make different sections pretty much powerless. A few near synopses have tended to powerlessness' different definitions (Cutter, 1996), (Weichselgartner, 2001) (Timmerman, 1981) Weichsel *et al.,* (2004). From these viewpoints, the essential purpose of flight gives off an impression of being founded on whether weakness is an efficient condition measured by the level of potential or genuine misfortune (Cutter, *et al.,* 2000), or a characteristic of people or gatherings, described by a scope of factors that influences introduction and adapting capacities (Chakraborty, Jayajit, & Tobin, 2005). Because of the connections between methodologies, powerlessness explore has advanced to incorporate introduction models that distinguish defenseless conditions influencing individuals or places notwithstanding outrageous regular occasions, estimations of societal resistance and additionally versatility, and also a reconciliation of the two with an emphasis on place weakness (Emrich, 2000). One of the difficulties intrinsic in research of this kind is the fluidity of social weakness. Such helplessness not just changes as indicated by the development of individuals and the advancing way of the human condition, yet it can likewise be influenced by adjusting only one of its parts (Tobin, Bell, & Whiteford, 2006) and (Panizza, 1991). Powerlessness in this setting has been defined in an assortment of routes and there is a broad writing here (see for instance, (Susman, Paul, Phil O'Keefe, 1983), (Wisner, Ben, Piers Blaikie, Timothy Cannon, 2004);

[10] To know more about the physical processes and extreme events see (David, 1993) and (G. A. Tobin et al., 2006).

(Oliver-Smith, 1999), (Chakraborty, Tobin, & Montz, 1997; Tobin, 1997). Some acknowledged key determinants incorporate access to learning, political power, social capital, systems and life savers, versatility, assets and acknowledgment (Wisner, Ben, Piers Blaikie, Timothy Cannon, 2004); (Clark, *et al.,* 1998) and (Mejia-Navarro, Mario, Ellen E. Wohl, 1994).

Components, for example, age, versatility, and salary have been referred to regularly, as have the geophysical qualities of one's area (Chakraborty, Tobin, & Montz, 2005); (Norris, 2002) (Phifer, 1989); (Chakraborty, Tobin, & Montz, 1997; Tobin, 1997); (Chakraborty, Tobin, & Montz, 2005). Different factors paralleling these topics and normally utilized as a part of social powerlessness ponders incorporate sexual orientation, race/ethnicity and instructive fulfillment, and in addition physical-basic characteristics like lodging sort and tenant versus proprietor possessed living arrangements. How these factors play out with regards to uprooted people, notwithstanding, is hazy. While much research has been done on defining helplessness and reporting spatial contrasts (Cutter, Boruff, & Shirley, 2000), less work has been embraced on observing changes after some time. A portion of this is expected to difficulties in achieving concession to what ought to be utilized as markers of vulnerability, despite the fact that issues are additionally connected with finding reasonable factors that can be followed dependably after some time at a proper spatial scale. For sure, spatial varieties in geo-physical hazard, in presentation to danger, and in staying sort have frustrated outcomes (Blaikie *et al.,* 1996); (Kousky, 2012). While much consideration has been given in the writing to ideas of weakness and to different elements that serve to define or decide levels of helplessness, vulnerability stays in the matter of how the influencing factors play out over the short and long haul. This could be especially vital on account of people made destitute as they endeavor to recoup from their misfortunes. Documentation of changing powerlessness after some time can help in the improvement of element reactions.

In order to understand the mechanism of risk in the context of the present vulnerability analysis; two models of disaster have been utilized by (Rose, 2012).

First model is known as the “The Pressure and Release model” (or also known as the PAR model). The model is a simple tool that predicts, assesses and presents a true picture of vulnerable people when they are hit by the natural disasters. Though it may be the case that the social processes may be even remotely connected with the disaster itself, the disaster effects are seriously rooted in the

social processes of the people in the disaster prone or affected areas.

The fundamental rule of the model is the notion that the disaster happens to be the intersection point of two opposing forces: first is the force of the social processes that generate vulnerability in the society on one side, and the natural disaster (natural disaster may sometimes unfold slowly in a natural process) on the other. The impact of the disaster on the inhabitants of the region is always positive and direct. The pressure on the populace increases with the rising pressures from either side (higher vulnerability or higher severity of the hazard). For the sake of the conceptualization of the idea of 'release', the disaster will be less in intensity when the vulnerability is reduced.

The second model is known as the 'Access Model'. From perspective approach, the second model may even be considered as the extended version or the detailed approach of the first model. In effect it is an expanded analysis of the principal factors in the PAR model that relates to human vulnerability and exposure to physical hazard, and focuses on the process by which the natural event impacts upon people and their responses. It is a more magnified analysis of how vulnerability is in principle at the beginning generated by economic, social and political processes.

Welfare Loss

There are several studies who have estimated welfare losses in the rural areas because of the floods and other natural disasters. (Rose, 2012) has reviewed literature on the welfare effects of the natural disasters and cited work of (Adler, 2004) quoting that the welfare of the households may be estimated in two ways: ex post (as compensation required to avoid loss) or ex ante (evaluation of the uncertainty in monetary terms). Further, the study (Messner *et al.,* 2007) suggestively extends the argument that though the hypothetical welfare measures may be enlightening yet a comprehensive and wide ranging analysis of the welfare is often challenging that may not be possible empirically without the number of assumptions and generalizations. In this situation when the society is neutralized to the prevailing risks, the ex-ante welfare may be measured through estimation of the economic losses to the population.

The utility functions in the flood or other disaster affected areas may be depending on the state policies and the degree of intervention. These utility functions tend to change in a post-disaster decision so the ex-ante estimations of the preferences may

not be same as the ex post estimated preferences.[11]. Therefore a more comprehensive and holistic estimation would rather take consideration of these possibilities. In each of the case of utility change, the positive utility change may take place among the disaster affected populations if they are convinced that if they are victims they will receive substantial aid. Similarly the increase in anxiety or any other negative emotions and fear of the disasters may lead towards to loss in the utility. This can be measured and included in the cost-benefit analysis when the researcher has a specific objective to consider it (Dutta, Herath, & Musiake, 2003).

Another study (Fafchamps, 2003) has also provided guidelines for flood damage estimation meant for the practitioners of governments authorities as well as the nongovernmental organizations and the executing authorities dealing with ex-ante flood damage evaluation. In case of agriculture damages, classification of damages due to flood can be done in to three categories as (Dercon, 2005) has been suggesting. They are damages to the farm houses, farm infrastructure and farm product. In a developing country setting, the agriculture damage may shrink to the loss of livestock and standing crops that is the sole source of livelihood for the farmers. These farmers are mostly from the poor households and their ability to cope with the risks and uncertainties of natural disasters make them even more vulnerable. (ADB, 2010a) and (Zaidi, 2005) have concluded in their research that the problem of flood damage exaggerates for the poor households who are not insured and governmental arrangements have not been sufficient in rural areas in developing countries.

Tenancy and the share cropping has been the deep-seated feature of agrarian society in the province. The social and economic vulnerability of the inhabitants of the province of Sindh is evident from the empirical studies (Creti, 2004) such as poverty rate in the rural part of the province in 2010 has been recorded as 53%. The fundamental trigger behind such enormous poverty rate in the rural parts of the province has been known as the concentrated land holding in the hands of few giant landlords (share of landholding of 25 acres or above is 88% that is highest in the country in contrast the same is 38.6% in Punjab and 21% in KPK and 81.4% in Baluchistan). Further, (Zyck, Mosel, Khan, & Shabbir, 2015) has highlighted that fact that the share of Sindhi districts in the bottom quartile has risen from 23.5% in 1970s to

[11] Given the situation that people wrongly weigh the risk before a flood hits the region, then ex ante effectiveness, accomplished through insurance contracts, may not remain same as ex post efficiency. The ramifications of this for government calamity help are talked about by (Jaffee, 2012).

35.2% in 1990s. Though the land reforms introduced in the country have not been very successful in effectively impacting the socioeconomic fiber of the whole country.

Distortion in Commodity Market

In addition to the damage to the infrastructure and the loss of human lives, the floods and other natural disasters affect the commodity markets hence distorting the price and the supply of the commodities particularly food items in the central and the regional markets. The analysis of the markets in the post flood times is very important in the sense that the governments and other intervention agencies about their action plans for recovering of the normal market functioning. The analysis of the commodity markets normally begins with the review of the market value of chain, supply of services and the impact on the environment. The value chain seemingly brings consumers, middle men and the retailers in the network as the major stakeholders and service providers (Creti, 2004).

The first distortionary impact on the commodity market starts from the damage to the warehouses of the food items at the wholesale market. Secondly, the remaining stored items available in the ware houses don't reach the market as a whole due to the damage to transport and communication sources due to floods.

The region's commodity market was severely distorted in terms of supply-demand gaps and price distortions. To understand the market distortions, it is imperative to have an eye upon the economic resources of livelihood in the region. The districts selected for the study namely Kashmore, Jacobabad, Shikarpur and Qambar-Shahdadkot are dominantly agriculture based with majority of the occupations of the inhabitants agriculture and livestock affiliated.

District Sukkur is the major trading hub in the region with provision of junction of the three provinces (Sindh, Punjab and Baluchistan) immediately and the highways to connect the Khyber Pakhtunkhwa (KPK). It is the major commodity market in the region. The province is having 8 million acres of crop land irrigated by the River Indus (Merz, Kreibich, Schwarze, & Thieken, 2010). The production travelling from the Punjab and KPK (the upper two provinces) to the other two provinces have to pass through Sukkur and vice versa.

As indicated by Large Wholesale Traders, Sukkur market is viewed as the biggest in Pakistan as far as the exchange of goods and streamline of the trading activities is considered. Large Wholesale Dealers have enormous warehouses where they can

keep their commodities for at least a month. These Traders in the nearby districts like Shikarpur and Jacobabad have generally little storage room contrasted with their partners in Sukkur, fundamentally in light of the fact that the trading activities and the exchange flow of the goods in these smaller cities is lower than it is in Sukkur (Parker, Green, & Thompson, 1987).

The damage to the houses (both *Katcha* or mud and *Pacca* or cemented), cattle heads perished and the loss of the standing crop in the fields led towards loss of livelihood and stable stream of the income flows to maintain the economic living.

On the other side, the overall losses in agriculture and livestock created shortage of food and nonfood items causing price distortions. This ultimately affected the household budget shares spent on the household consumption and welfare loss. Moreover, flood damages have been classified in several studies as direct and indirect damages. The direct damages are defined as the losses which happen after the physical contact of flood water with humans, infrastructure, property or any other physical objects. Whereas the indirect damages are produced from the immediate impacts and occur – in space or time – outside the flood event (Smith & Wards, 1998). See for example (Jonkman, 2007) and (Duiser, 1989) for further classification of both impacts in tangible and intangible damages contingent on whether the losses can be monetarily assessed.

However the interpretations of each type of losses differ vehemently (Waarts, 1992). The assessment of loss of human life (the direct intangible loss) has been very tricky to be evaluated and involves complex models and systems of equations like (Jonkman, 2007) or (ADB, 2010b) using 1953 data on floods in Netherlands (also cited in (ADB, 2010b). Further these models have been incorporating the behavioral losses (for non-marketed values etc.) falling in the category of intangible damages of the natural disasters. Macroeconomic losses are assessed on the basis of the future valuation of the individuals in the context of their contribution in the economic production of the region/country.

Rural Economy Effects

Tenancy and the share cropping has been the deep-seated feature of agrarian society in the province.

The social and economic vulnerability of the inhabitants of the province of Sindh is evident from the empirical studies (Zaidi, 2005) such as poverty rate in the rural part of the province in 2010 has been recorded as 53%.

The fundamental trigger behind such enormous poverty rate in the rural parts of the province has been known as the concentrated land holding in the hands of few giant landlords (share of landholding of 25 acres or above is 88% that is highest in the country in contrast the same is 38.6% in Punjab and 21% in KPK and 81.4% in Baluchistan) (Dutta *et al.,* 2003).

Further, (Fafchamps, 2003) has highlighted that fact that the share of Sindhi districts in the bottom quartile has risen from 23.5% in 1970s to 35.2% in 1990s. Though the land reforms introduced in the country have not been very successful in effectively impacting the socioeconomic fiber of the whole country.

Yet those reforms have failed more miserably in Sindh reflected from the extreme divide between the land holding by farmers and the big land lords (feudal). In case of agriculture damages, classification of damages due to flood can be done in to three categories as (Dercon, 2005) has been suggesting. These are damages to the farm houses, farm infrastructure and farm product. In a developing country setting, the agriculture damage may shrink to the loss of livestock and standing crops that is the sole source of livelihood for the farmers. These farmers are mostly from the poor households and their ability to cope with the risks and uncertainties of natural disasters make them even more vulnerable. (Shaikh, 2011) and (Mankiw, 2007) have concluded in their research that the problem of flood damage exaggerates for the poor households who are not insured and governmental arrangements have not been sufficient in rural areas in developing countries.

4. Method and Model

Present study is an attempt to empirically measure the Hicksian Compensating Variation using household demand equations of the selected household food items frequently consumed by the households in the selected districts. The Hicksian compensating variation is estimated from the Marshallian demand equations. Income and substitution effects are isolated from the total effects on the budget shares to isolate the income effects of the total change. This is done because the Hicksian Compensating Variation is estimated by changing the consumption bundles given income and keeping utility fixed. The core idea behind the study is that the utility of the flood affected households has changed due to their losses in income and damage to their houses and perished livestock and the destroyed standing crops. Hicksian Compensating Variation is measured amount that is required for each household in the selected districts to bring them to the initial level of utility level in pre flood times.

Ordinary Least Squares Method is used to run the regressions on the selected demand equations. The details of the model are given as under. Basic features of the model are borrowed from (Lipsey, 1975).

Estimation of Demand Equations

Ordinary Least Squares Method or also know the Linear Least Squares Method is applied to estimate the demand equations and the consequent household demand quantities of the selected goods given in following table.

Table 18. *Selected food items frequently consumed by households*

Number	Food Items
1	Wheat Demand
2	Milk Demand
3	Rice
4	Moong Demand
5	Chicken Demand
6	Beef Demand
7	Fish Demand
8	Banana Demand
9	Apple Demand
10	Potato Demand
11	Tomato Demand
12	Onion
13	Other Veg Demand
14	Sugar Demand
15	Gram Demand
16	Chilies Demand

Source: Selected commodities for regression analysis from HIES/PSLM data of various years.

The demand equations have been estimated according to the conventional law of demand. In theory of Demand (Suen, 2000), price has negative impact on the demanded quantity of a normal good. On the other hand, income has a positive impact on the demand. The prices of substitute goods have a positive impact and that of the complementary goods has negative impact on the quantity of demand.

The general form of demand equation is given as under in equation 2.

$$Q_d = \alpha_0 - \alpha_1 P_{self} + \alpha_2 P_{subs} - \alpha_3 P_{comp} + \alpha_4 Y + \varepsilon \qquad (2)$$

For the purpose of avoiding stationarity of the data series, the time series has been transformed in to natural log form.

In equation 2, the Q_d is the quantity of a good demanded by an individual or a household. α_0 is the intercept of the demand equation that measures the impact on the demand quantity that is the result of changes in the factors other than the included variables. α_1 is the coefficient that would be estimated to measure the impact of change in the price of the selected good by one unit on the change in the quantity demanded of the selected good. In a general setting, this is the slope of the demand curve (*ceteris Paribas*). α_2 and α_3 measure the unit change in the quantity demanded of the good due to a one unit change in the price of substitute goods and complementary goods respectively. The P_{self}, P_{subs},and P_{comp}, are the prices of the good, its substitute and the

complementary goods respectively. α_4 is the coefficient of the income, disposable income of an individual, per capita income or the household income that has a positive impact on the demand for a good. That is, higher the income of individuals or households, higher would be the demand for the normal good[12].

Present study is an attempt to measure the welfare loss of the households in the selected districts of Sindh therefore the estimated demand equations for the selected goods would be helping in assessing the consumption patterns of the households in the flood affected areas.

Theoretically, the effect on the demand emerges from two effects: Income effect and the Substitution effect. Consumers look for cheaper goods when the price of a goods is increased in relation to the other good (substitution effect). On the other hand, as consumers' income is affected their overall consumption of goods is falling.

Household Expenditure Function

The analysis of household expenditure function starts at the point where consumer of the household choosing among bundles of goods. The choice an individual or the household makes is a function of two things: (1) preferences of the households depicted using indifference curves, and (2) the financial ability to buy or the purchasing power that is depicted through the analysis of budget constraint.

Household expenditure for two goods can be shown through household expenditure function as appears in equation (3):

$$e = \sum_{i=1}^{n} P_i X_i \tag{3}$$

Or in an expanded version for "n" number of goods is given below in equation (4)

$$e = P_1 X_1 + P_2 X_2 + \ldots\ldots\ldots + P_n X_n \tag{4}$$

Each expenditure level has identical slope of –p1/p2, but different horizontal and vertical intercepts e/p1 and e/p2. The equations (III) and (IV) are also known as the budget constraint. Budget constraint maps the possibility of a household or an

[12] The analysis of the giffen or inferior goods is out of scope of this study

individual to buy certain combinations of the consumption bundles. Following figure 22 presents the budget constraint for bundles of normal goods X and Y which are available at prices P_x and P_y. Consumer / household's total income is denoted by I.

The space under the negatively sloped line is the area that represents the purchasing power of the individual to be able to consume different combinations of the good X and Good Y given income I and prices P_x and P_y.

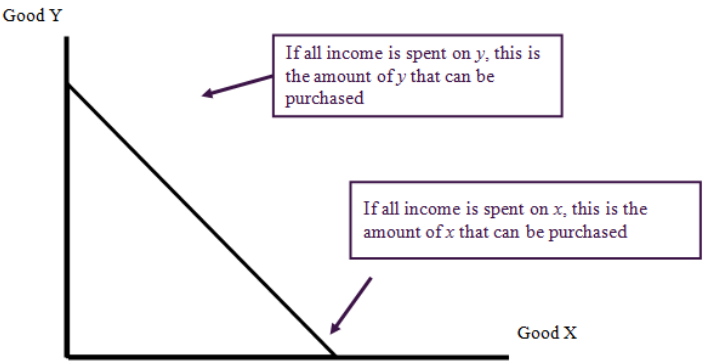


Figure 20. *Budget Constraint when household is consuming combinations of Goods X and Y*
Source: (Böhm, Volker, & Haller, 1987)

The negatively sloped budget constraint depicts the negative Marginal Rate of Substitution or the rate at which some amount of one good can be substituted for some sacrifice of less consumption of the other good. The corner points on horizontal and vertical axes as indicated in the graph show if the consumer allocates all of her income for consumption of one good and zero for the other good. Mathematically the relationship can be shown in the hypothetical equation of budget constraint for two goods X and Y in equation 5.

$$I = P_1X_1 + P_2X_2 \qquad (5)$$

The horizontal intercept when the consumer prefers to consume all of good X_1 and zero of good X_2 would be easily calculated from equation (5) that is I/P_1 and good X_2 is I/P_2.

The Marginal Rate of Substitution or the slope of the Budget Constraint can also be derived from equation (5).

$$\frac{I}{P_1} = X_1 + \frac{P_2}{P_1} X_2 \quad (6)$$

$$X_1 = \frac{I}{P_1} - \frac{P_2}{P_1} X_2 \quad (7)$$

$$X_2 = \frac{I}{P_2} - \frac{P_1}{P_2} X_1 \quad (8)$$

From 7 and 8 the intercepts of good 1 (X_1) and good 2 (X_2) can be derived as I/P_1 and I/P_2 and $-P_2/P_1$ and $-P_1/P_2$ with negative signs are the slopes of the budget constraint. Therefore MRS (Marginal Rate of Substitution) can be estimated using first differential of 7 and 8 equations. Mathematically MRS for the two goods can be calculated in the following way:

$$MRS = \frac{\partial X_1}{\partial X_2} = -\frac{P_2}{P_1} \quad (9)$$

or

$$MRS = \frac{\partial X_2}{\partial X_1} = -\frac{P_1}{P_2} \quad (10)$$

In other words, the MRS is equal to the ratio of the two prices which is the relative prices of the two goods.

Despite all simplicity of the budget constraint it does not tell about the optimal bundle. The optimal bundle is the combination of the quantities of the two goods where the consumer or the household derives maximum utility from the given purchasing power. Here is the point where indifference curve analysis enters in the consumer choice theory.

For each expenditure function, there is corresponding indifference curve (Varian, 1992) that shows the combination of the two goods between which the consumer is indifferent and derives same utility as far as she is on the same indifference curve.

Indifference Curve Analysis and Optimal Choice

An Indifference Curve is the graph that is the locus of points where consumer is indifferent to the two goods and she derives the same utility as far as she is on the same indifference curve. The

assumptions of indifference curve include that the consumer maximizes her utility across the bundles of consumption she prefers. Higher the indifference curves, higher are the presumed utility of the consumer.

Mainly the indifference curves are applied to represent the patterns of potentially observable demand curves over the consumer choice of bundle of consumption goods (Varian, 1992).

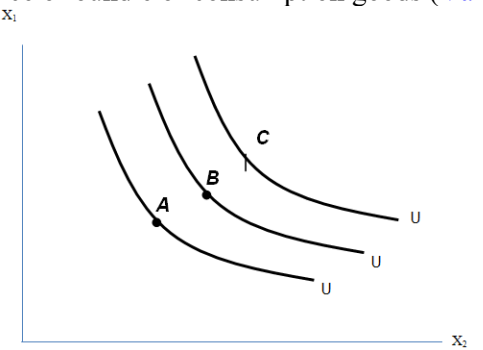


Figure 21. *Indifference Curves showing the preferences of the consumers for combinations of X_1 and X_2*

Apparently, the indifference curves shown in the figure 23 above depict different levels of utility. At point A on the lowest indifference curve, the consumer derives utility equal to U_1. That is lower than that of the utility of U_2 at the higher indifference curve and so on. Therefore A point A consumer derives U_1 utility that is less than U_2 and U_2 is less than U_3.

Properties of Indifference Curve

The first property held by the Indifference curve is that it can only be defined in the nonnegative quadrant of the quantities of the commodities.

The second property of the Indifference Curve is that it is negatively sloped. This is because of the decreasing Marginal Rate of Substitution of one good for the other good.

The third property of the Indifference curve is the completeness such that the all points on one Indifference curve are having the same utility level. This is so that the consumer is indifferent between different bundles of consumption on the same indifference curve. This property further implies that the indifference curves can never intersect each other because that would be violating the property of completeness and the non-satiation would be violated of the indifference curves.

The fourth property of the Indifference curve is that these are transitive with respect to the distinct Indifference curves. In other

words, if A is strictly preferred over B and B is strictly preferred over C then it can be inferred that A is strictly preferred over C also.

It can be shown in symbols in following way:

If $A>B$ (A is strictly preferred over B) and $B>C$ (B is strictly preferred over C) then it will hold that $A>C$ (A is strictly preferred over C).

The fifth property of the Indifference curve is that it is strictly convex for normal goods. If the property of convexity is violated, it will imply that every decrease in the consumption of one good will follow higher additions of the other good in consumption to maintain same level of utility.

The indifference curve analysis is combined with the consumer demand functions to find out the optimal bundles of the consumer choice. The ratio of the change in the total utility (marginal utilities derived from the two goods) is the slope of the indifference curve. As given below:

$$-\frac{\Delta X_1}{\Delta X_2} = -\frac{MU_2}{MU_1} \tag{11}$$

Following section is devoted for a detailed discussion on the optimal choice of consumption bundles.

Expenditure Function and Optimization Problem

Taking hypothetical indifference curves from figure 23 and combining with that of the budget line in figure 22 resolves the issue of optimal choice of consumption bundles. The combined graph is presented in the following figure 24. The optimal bundle is on the tangency between the budget constraint and the indifference curve.

This means that for the optimal bundle the slope of the IC is equal to the slope of the budget constraint. Marginal Rate of Substitution = Ratio of two prices

This condition gives a central result of consumer theory:

$$\text{MRS} = -\frac{\text{mU}_2}{\text{mU}_1} = -\frac{\text{p}_2}{\text{p}_1} \quad \Rightarrow \quad \frac{\text{mU}_1}{\text{p}_1} = \frac{\text{mU}_2}{\text{p}_2} \tag{12}$$

The optimal bundle is the one which equalises the marginal utility per $ spent.

If you were to receive an extra $ of income, your marginal utility will be the same regardless of where you spend it.

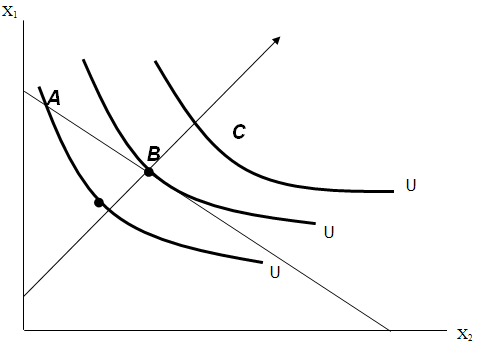


Figure 22. *Indifference Curves showing the preferences of the consumers*

In figure 24 above, various indifference curves are available in front of the consumer with one budget constraint. The optimal choice of the consumption bundle can be realized at the point where the slopes of the two curves (budget constraint and the indifference curve) can be same. Secondly, it should also be noted that the consumer always wants to maximize her utility to be on the highest possible indifference curve given the budget constraint. Graphically in figure 24, two such points can be obtained where the slopes of the two curves are same at point A and point B. However point A is falling on lower indifference curve and derives lower utility (U_1) whereas point B falls on the higher utility curve deriving higher utility level (U_2). Therefore point B is the optimal choice of the consumer in this case. Here point B is satisfying two conditions: one it assumes same slopes of both the curves and second, it satisfies the tangency condition. The tangency condition of Indifference Curve and expenditure function ensures that the fixed level of utility derived from consumption of bundle (given budget line) is possible at minimum expenditure.

Mathematically, in general form, x is consumed with minimum expenditure:

$$X = \min e(p,u) \tag{12}$$

Therefore, the least cost bundle of X_1 and X_2 are given as under:

$$X_1 = X_1^h(e,u) \tag{13}$$

$$X_2 = X_2^h(e,u) \tag{14}$$

Here h stands for "Hicksian".

Given the least cost bundles X_1 and X_2, the expenditure function would be written as follows:

$$X^h(e,u) = P_1 X_1^h(e,u) + P_2 X_2^h(e,u) \qquad (15)$$

This is because; the Hicksian demand follows expenditure function as given here:

$$e(p,u) = \min p.x \qquad \textit{subject to the constraint } u(x) \geq u$$
$$X = \min e(p,u)$$

This is true for all p values much larger than zero and all positive attainable utility levels.

Following the previous slide mathematical derivations of the household expenditure function and optimization problem, the graph shows the minimum expenditure depicted by the budget line (qualifying the tangency condition) and the indifference curve (X^h). At this point the household can attain the given utility level with minimum expenditure done.

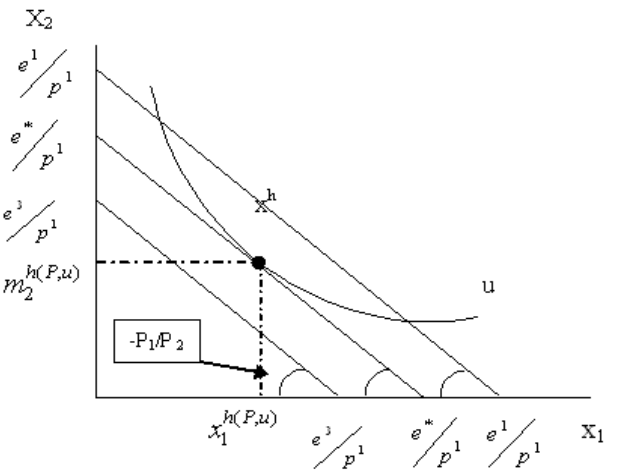


Figure 23. *Optimal Bundle choice using budget constraint and indifference curve map and household expenditure*

At X^h the consumer minimizes the expenditure to attain the optimal bundles of the goods at given utility [(X_1^h(P, U)]. Hicksian demand curves are derived and based on the fact that the consumer is supposed to be at the same level of utility as she was before any

change occurred instead of bundle being the function of income and prices, it is function of utility and prices.

Income and Substitution Effects

To estimate the Hicksian Demand Equations, the total effect on consumption (Expenditure function) may be split in to two effects: Income and Substitution Effects.

Substitution Effect

Due to the change in the price of a good, the consumer's consumption bundle combination changes as the relative prices of the two goods change. If price of a good rises, it becomes relatively expensive in comparison to the other good. Therefore the relatively expensive good is substituted by the cheaper good. In other words, now the combination of two goods would be changed and one unit of good one will now be traded for a different quantity of the other good than before. This effects of the change in the relative price is known as the substitution effect.

Income Effect

Due to the change in prices the real income of the consumer or household changes. In case of the rise in price, the real income falls therefore the consumer is not able to maintain her utility and the consumption patterns change too. The effect is measured as the difference between what we call the intermediate consumption and the final consumption.

The two effects are shown in following figure 26.

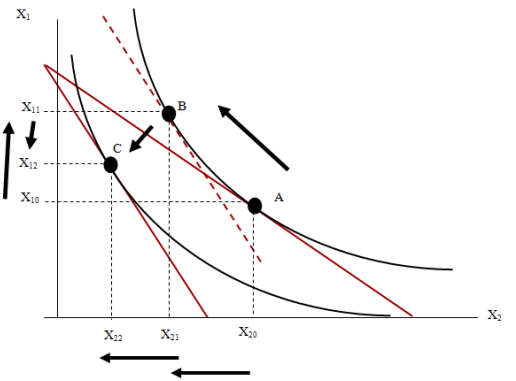


Figure 24. *Graphical Description of Income and Substitutions Effects [(Varian, 1992)].*

As in the figure 26, the initial point of optimal choice of consumption bundle is at point A. at point A initial budget line is tangent to the initial indifference curve driving utility U_1. The

consumer consumes X_{20} of good X_2 and X_{10} of X_1. With the rise in the price of X_2 the purchasing power of the consumer changes and a new budget line emerges (shown with dashed line) and consumer bundle shifts from A to B. The movement of the consumption bundle from A to B is the income effects that has happened because of the impact of price change on the real income of the consumer. The second impact is the change in the price of good X_2 has increased the relative price of good X_2 in terms of good X_1. This causes a movement of the consumption bundle from B to C because consumer is substituting the relatively expensive good with the relatively cheaper good. The budget line tilts inwards on horizontal axis. A new indifference curve is not determining the new consumption bundle that holds lower utility level than the initial indifference curve. This movement from B to C is known as the substitution effect. The mathematical general form of the total, substitution and income effects is given in the following equation

$$\frac{\partial x_i}{\partial p_i} = \frac{\partial x_i^{\,s}}{\partial p_i} + X_i \frac{\partial x_i}{\partial y_i} \tag{16}$$

Slutsky Equation

Slutsky Equation (Hicks, 1939) is estimated relate the changes in the Marshallian (uncompensated Demand) with that of the Hicksian Compensating Demand. The Slutsky equation separates the total effect in to two effects: substitution and income effect. From equation (16), following equation presents the total effect and the subsequent parts of the effect in general form:

$$\frac{\partial x_i}{\partial p_i} \cdot \frac{p_i}{x_i} = \frac{\partial x_i^{\,s}}{\partial p_i} \cdot \frac{p_i}{x_i^s} + X_i \frac{\partial x_i}{\partial y_i} \cdot \frac{y_i}{x_i} \cdot \frac{p_i}{x_i} \tag{17}$$

The above equation may be presented in a more precise form to give the function in Slutsky form. Following equation differentiates the two effects of the total effect:

$\frac{\partial x_i^{\,s}}{\partial p_i}$ is the substitution effect and $X_i \frac{\partial x_i}{\partial y_i}$ is the income effect.

In elasticity terms, the same can be written in following way [Equation (18)]:

$$\eta_p = \eta_p^s + X_i.\eta_i.\frac{p_i x_i}{y_i} \quad (18)$$

Hicksian Compensating Variation

The concept of Compensating Variation is the measure of change in utility. It refers to monetary value of utility. In other words it measures the amount that is required by a household or an individual to attain the initial level of utility after a change in the price or product quality (EMMA, 2010). It was introduced by Jon Hicks in 1939 (Kronstadt *et al.,* 2010) that is the reason it is named after him as "Hicksian Compensating Variation". Mathematically, it can be calculated using household expenditure as follows:

$$CV = e(p_1, u_1) - e(p_1, u_0) \quad (19)$$

Data Source and the Type of Data

Following are sources from the data for the study was taken:

- Household Income & Expenditure Survey, Federal Bureau of Statistics, Government of Pakistan. 2004 onwards.
- Budget Analysis, Finance Department, Government of Sindh. 2010-2015
- Annual Report, NDMA 2010, Government of Pakistan
- Early Recovery Report, UNOCHA, 2012.
- Detailed Needs Assessment of Flood 2010, Asian Development Bank.

5. Econometric Results and Interpretation

Estimated Marshallian Demands

The Marshallian demand equations are estimated for the selected 15 goods as mentioned in table 18. Following table presents the regression results of the demand equations of the selected goods. Given signs of coefficients, F statistics and their p-vales and the size of R^2 all results are having high generalizability power and reliable. All coefficients are significant at less than 5% degree of significance.

Table 19. *Estimated Demand Equations for the selected food items (2004-2013)*

S.No.	Wheat Demand	Unstandardized Coefficient		t(sign.)	R^2	F (Sign)
		B	Std. Error			
1	Constant	4.084	0.197	20.726 (0.00)	0.946	35.149 (0.000)
	Ln_P_Wheat	-0.374	0.075	-4.970 (0.003)		
	Ln_P_Rice	0.469	0.075	6.249 (0.001)		
	Ln_HH_M_Income	0.027	0.025	1.067(0.032)		
	Milk Demand					
2	Constant	3.655	1.381	26.537 (0.0)	0.317	15.08 (0.000)
	Ln_P_Milk	-0.012	0.022	-0.530 (0.0)		
	Ln_P_Butter	1.050	1.827	0.574(0.002)		
	Ln_HH_M_Income	0.0000057	0.001	0.334(0.001)		
	Rice Demand					
3	Constant	2.877	0.142	20.200(0.000)	0.969	61.693 (0.009)
	Ln_P_Rice	-0.639	0.049	-12.96(0.000)		
	Ln_P_Wheat	0.624	0.056	11.043(0.000)		
	Ln_HH_M_Income	0.009	0.014	0.642(0.045)		
	Moong Demand					
4	Constant	0.826	0.440	1.874 (0.0)	0.76	17.2 (0.000)
	Ln_P_Moong	-0.610	0.432	-1.411(0.00)		
	Ln_P_Masoor	0.96	2.062	0.951(0.0)		
	Ln_P_Other veg.	0.639	2.135	0.721(0.0)		
	Ln_HH_M_Income	0.052	0.072	0.768(0.0)		

	Chicken Demand					
5	Constant	1.009	0.221	4.563	0.724	8.247 (0.004)
	Ln_P_Chicken	-0.666	0.209	-5.432		
	Ln_P_Fish	0.628	0.193	5.188		
	Ln_HH_M_Income	0.023	0.031	0.740		
	Beef Demand					
6	Constant	0.487	0.569	0.855 (0.001)	0.82	9.35 (0.000)
	Ln_P_Chicken	0.788	0.521	0.701 (0.00)		
	Ln_P_Beef	-0.75	-0.469	-1.513 (0.001)		
	Ln_HH_M_Income	0.054	0.077	0.701 (0.00)		
	Fish Demand					
7	Constant	0.914	0.075	4.89 (0.0)	0.994	171.89 (0.00)
	Ln_P_Fish	-0.35	0.21	12.179 (0.0)		
	Ln_P_Chicken	0.923	0.069	13.461 (0.0)		
	Ln_P_Beef	0.948	0.062	5.047(0.0)		
	Ln_HH_M_Income	0.012	0.010	1.178(0.0)		
	Banana Demand					
8	Constant	0.605	0.741	8.911 (0.0)	0.85	16.599 (0.00)
	Ln_P_Banana	-1.385	0.370	-3.739(0.0)		
	Ln_P_Apple	1.097	0.317	3.460(0.0)		
	Ln_HH_M_Income	0.036	0.04	0.890 (0.0)		
	Apple Demand					
9	Constant	3.565	1.687	2.113 (0.0)	0.29	80.14 (0.0)
	Ln_P_Banana	1.231	0.843	1.460 (0.00)		
	Ln_P_Apple	-1.073	0.721	-1.448(0.00)		
	Ln_HH_M_Income	0.077	0.092	0.845 (0.001)		
	Potato Demand					
10	Constant	0.482	5.641	0.086 (0.0)	0.50	36.5 (0.00)
	ln_P_potato	-0.304	2.016	-0.151 (0.0)		
	ln_P_onion	0.629	3.295	0.191 (0.0)		
	ln_P_other_veg	0.638	2.661	0.240 (0.0)		
	Ln_HH_M_Income	0.146	0.203	0.721 (0.0)		
	Tomato Demand					
11	Constant	0.395	5.074	0.078 (0.0)	0.62	21.04 (0.00)
	Ln_P_Tomato	-0.532	0.742	-0.425 (0.0)		
	ln_P_potato	0.745	1.813	0.411 (0.0)		
	ln_P_onion	-0.456	2.963	-0.154 (0.0)		
	ln_P_other_veg	-0.218	2.394	-0.091 (0.01)		
	Ln_HH_M_Income	0.132	0.183	0.721 (0.0)		
	Onion Demand					
12	Constant	1.983	0.134	14.753(0.08)	0.96	50.629 (0.00)
	ln_P_potato	0.006	0.048	0.117(0.00)		
	ln_P_onion	-0.044	0.079	0.563(0.00)		
	ln_P_other_veg	-0.094	0.063	-1.474(0.00)		
	Ln_HH_M_Income	0.003	0.005	0.72(0.00)		
	Other Veg Demand					
13	Constant	1.936	0.99	1.954 (0.00)	0.97	37.915 (0.00)
	ln_P_potato	0.205	0.354	0.580 (0.00)		
	ln_P_onion	0.367	0.578	0.634 (0.00)		
	ln_P_other_veg	-0.756	0.467	-1.617 (0.00)		
	Ln_HH_M_Income	0.026	0.036	0.721 (0.00)		
	Sugar Demand					
14	(Constant)	2.409	1.814	1.328 (0.00)	0.78	55.84 (0.00)
	ln_P_sugar	-0.275	0.135	-2.041 (0.0)		
	ln_P_tea	-0.789	0.434	-1.817 (0.0)		
	Ln_HH_M_Income	0.102	0.085	1.196 (0.0)		
	Gram Demand					
15	Constant	1.807	1.948	0.928 (0.00)	0.91	79.2 (0.00)
	ln_P_gram	-0.777	1.396	-0.556 (0.00)		
	ln_P_Moong	0.128	0.773	0.166 (0.00)		

	ln_P_masoor	0.525	0.533	0.984 (0.00)		
	Ln_HH_M_Income	0.068	0.094	0.721 (0.00)		
	Chilies Demand					
	Constant	1.261	0.689	0.642 (0.0)		
	Ln_P_Chilies	-1.175	4.446	-0.264 (0.0)		
16	ln_P_potato	0.619	0.132	3.276 (0.0)	0.95	25.69 (0.00)
	ln_P_other_veg	0.877	0.164	0.010(0.0)		
	LN_HH_M_Income	0.080	0.083	0.721 (0.00)		

Source: Regression results using HIES/PSLM data for various years

Following table 20 presents the total estimated quantities in kilograms that the households are purchasing of the selected goods in a month.

Estimated Marshallian Demanded Quantities in KGs

Table 20. *Estimated Marshallian Demanded Quantities in KGs (2004-2013)*

	1	2	3	4	5	6	7
	Wheat	Milk	Rice	Moong	Chicken	Beef	Fish
2004	149.88	69.29	10.39	89.71	2.52	3.06	2.33
2005	101.67	54.18	18.91	140.07	2.42	3.32	2.43
2006	136.15	46.37	12.57	137.17	2.35	3.45	2.57
2007	130.84	54.18	13.28	138.55	2.41	3.28	2.43
2008	131.58	54.18	13.31	140.07	2.42	3.32	2.43
2009	113.17	57.38	17.11	197.47	2.44	3.26	2.31
2010	162.74	46.37	9.94	138.46	2.36	3.48	2.57
2011	132.80	54.18	13.35	142.57	2.44	3.38	2.44
2012	131.58	54.18	13.31	140.07	2.42	3.32	2.43
2013	131.58	54.18	13.31	140.07	2.42	3.32	2.43

8	9	10	11	12	13	14	15	16
Banana	Apple	Potato	Tomato	Onion	other veg	sugar	Gram	Chilies
68.49	2.76	82.41	1.47	5.19	4.48	27.25	7.03	17.17
73.90	2.64	142.28	0.98	4.93	4.02	27.40	7.88	19.05
76.67	2.57	127.35	0.96	5.01	3.70	40.93	7.51	16.31
73.34	2.60	137.98	0.96	4.93	4.00	26.82	7.77	18.73
73.90	2.64	142.28	0.98	4.93	4.02	27.40	7.88	19.05
70.53	2.67	224.00	0.77	4.66	4.05	17.01	8.34	24.16
77.17	2.61	130.74	0.98	5.01	3.72	41.69	7.60	16.55
74.81	2.71	149.52	1.03	4.93	4.06	28.36	8.06	19.57
73.90	2.64	142.28	0.98	4.93	4.02	27.40	7.88	19.05
73.90	2.64	142.28	0.98	4.93	4.02	27.40	7.88	19.05

Source: Regression results using HIES/PSLM data for various years

According to the table 20, the estimated quantities that the households bought in 2010 have been significantly less than the previous years except few goods.

Estimated Budget Shares and Welfare Loss

The budget share spent on the consumption of selected goods has been falling as a result of the flood disaster and the loss of source of livelihood. This may be partially because of market

distortions in terms of price discrepancies due to the shortage of supply and partially because of the income sources lost. Following table presents the summary of the estimated budget shares.

Table 21. *Summary of estimated monthly budget shares of households in selected districts*

	1	2	3	4	5	6	7	8	9
	Wheat	Milk	Rice	Moong	Chicken	Beef	Fish	Banana	Apple
2004	1.43	1.63	0.90	1.86	0.30	0.07	0.35	1.75	0.42
2005	1.43	1.22	0.90	2.10	0.31	0.04	0.39	1.90	0.43
2006	1.47	1.39	0.92	2.02	0.28	0.03	0.39	1.87	0.40
2007	1.54	1.48	0.96	2.14	0.31	0.04	0.40	1.94	0.44
2008	1.51	1.44	0.94	2.10	0.31	0.04	0.39	1.90	0.43
2009	1.66	1.47	1.03	2.48	0.35	0.05	0.42	2.09	0.50
2010	1.50	1.51	0.90	1.99	0.28	0.03	0.39	1.84	0.40
2011	1.46	1.40	0.91	2.03	0.30	0.04	0.38	1.85	0.43
2012	1.51	1.44	0.94	2.10	0.31	0.04	0.39	1.90	0.43
2013	1.51	1.44	0.94	2.10	0.31	0.04	0.39	1.90	0.43

	10	11	12	13	14	15	16		Year-on-Year
	Potato	Tomato	Onion	other veg.	Sugar	gram	Chilies	Total	Percentage Change
2004	7.02	1.19	2.30	2.15	4.96	1.08	2.91	46.98	
2005	10.51	0.99	2.27	2.04	5.02	1.14	3.16	54.18	15.34
2006	10.12	0.98	2.25	1.92	5.80	1.12	2.94	52.87	-2.42
2007	10.90	0.98	2.31	2.07	5.14	1.14	3.22	55.72	5.39
2008	10.51	0.99	2.27	2.04	5.02	1.14	3.16	54.18	-2.76
2009	15.51	0.87	2.33	2.18	4.48	1.22	3.86	66.68	23.07
2010	9.83	0.99	2.22	1.91	5.67	1.12	2.90	51.70	-22.47
2011	9.94	1.01	2.21	2.00	4.83	1.14	3.07	51.93	0.45
2012	10.51	0.99	2.27	2.04	5.02	1.14	3.16	54.18	4.34
2013	10.51	0.99	2.27	2.04	5.02	1.14	3.16	54.18	0.00
	Average								54.26

The budget shares spent on the selected goods in 2010 have been also shown a fall in the demanded quantities due to their loss in assets, wealth and income sources. The average cumulative loss in the budget shares spent on the goods has been equal to 22.47% as shown in the last column (year on year percentage change) in above table 21.

Estimated Budget Shares and Welfare Loss

By closely looking at the last column of table 21 given above, the budget share spent on the selected items by the rural households in the selected districts has declined significantly in the year 2010. Almost all of the goods observed decline in expenditure except on sugar (increased from 4.48 PKR in 2009 to 5.67 PKR in 2010).

Last column with heading "Total" presents the total budget share of a rural household spent on the selected goods (food items) in a given year.

On average the selected basket of goods covers 54.26% of the household budget which is a reasonable cover offered by the study.

The last column is presenting the year on year percentage change in the total household budget share allocated for the selected food items. The estimated fall in the allocated budget share has shown a fall of 22.5% in the year 2010.

This is quite significant fall in the household budget share due to the flood damages, which reflects an immediate loss in the household welfare due to the flood damages in standing crops and livestock as a major source of rural livelihood.

The study, however, does not quest for the estimated causes of fall in the budget shares. It may be because of the loss in the income or because of the rise in prices due to the shortage of supply of selected items. It has been estimated that the rise in wheat as a major staple food item in the district Sukkur (Closest district to Kashmore, Jacobabad and Shikarpur and a major trading hub of the region) due to the shortage of food items in 2010 is 17% (from PKR 240 to PKR 280 per 10 KG) (NDMA, 2012). Another study suggested that the rise in Consumer Price Index in September 2010 is recorded as high as 15.7% (Report, 2012).

Given the statistical evidence on the rise in inflation during year of 2010, it may be carefully predicted that the fall in the budget share on the selected food items may be partly attributed to the rise in consumer price index.

Estimated Income and Substitutions Effects

Substitution Effect: The substitution effects estimated from the demand equations for the selected food items are given as under:

$$\frac{\partial x_i^{\,s}}{\partial p_i}$$

Table 22. *Summary of Substitutions effect coefficients estimated through Marshallian demand*

1	2	3	4	5	6	7	8	9	10
Wheat	Milk	Rice	Moong	Chicken	Beef	Fish	Banana	Apple	Potato
-0.37	-0.012	-0.64	-0.61	-0.666	-0.75	-0.35	-1.385	1.231	-0.304

11	12	13	14	15	16
Tomato	Onion	other veg	Sugar	gram	Chilies
-0.532	-0.044	-0.756	-0.275	-0.777	-1.175

Following table presents estimated Income Effect for the selected goods.

$$X_i.\eta_i.\frac{p_i x_i}{y_i}$$

It may be observed after a close observation it may be known that the income effect is small relative the substitution. This is the phenomenon when the poorest households demand equations are estimated where demand is more responsive to prices rather than income.

Table 23. *Summary of Income Effect coefficients estimated through Marshallian demand*

1	2	3	4	5	6	7	8	9	10
Wheat	Milk	Rice	Moong	Chicken	Beef	Fish	Banana	Apple	Potato
0.03	0.0000057	0.01	0.052	0.023	0.054	0.012	0.036	0.077	0.146

11	12	13	14	15	16
Tomato	Onion	other veg	Sugar	Gram	Chilies
0.132	0.003	0.026	0.102	0.068	0.08

Hicksian Estimated Demand

Hicksian Demanded Quantity is estimated from the Marshallian demand quantity after subtracting the income effect.

Following equation is the general form of the Hicksian Demand:

$$Q_d^H = Q_d^M - (\eta_Y.Q_d^M)$$

Here income elasticity η_Y times Marshallian demanded quantity is subtracted from the Marshallian demand quantity to isolate the demand from the income effect.

The estimated Hicksian Demand Quantities for all selected goods are presented in the next section.

Hicksian Estimated Demanded Quantities in KGs

The Hicksian demand for the selected goods are estimated as per the model presented in the previous chapter in equation (XIX). Table 24 presents the summary of the Hicksian demanded quantities for the selected goods in KGs per month.

Table 24. *Hicksian Estimated Demand quantities in KGs per month*

	Wheat	Milk	Rice	Moong	Chicken	Beef	Fish	Banana
2004	130.92	69.29	10.17	71.01	2.47	2.88	2.30	58.82
2005	89.74	54.18	18.42	108.33	2.37	3.11	2.41	63.30
2006	119.24	46.37	12.29	106.20	2.31	3.23	2.54	65.58
2007	114.71	54.18	12.98	107.21	2.36	3.08	2.40	62.84
2008	115.34	54.18	13.00	108.33	2.37	3.11	2.41	63.30
2009	99.61	57.38	16.68	150.02	2.39	3.06	2.28	60.51
2010	141.84	46.37	9.74	107.14	2.32	3.26	2.55	66.00
2011	116.38	54.18	13.04	110.16	2.39	3.16	2.41	64.05
2012	115.34	54.18	13.00	108.33	2.37	3.11	2.41	63.30
2013	115.34	54.18	13.00	108.33	2.37	3.11	2.41	63.30

	Apple	Potato	Tomato	Onion	other veg	Sugar	gram	Chilies
2004	2.55	43.28	1.40	5.16	4.31	19.45	6.16	13.68
2005	2.45	68.99	0.99	4.91	3.88	19.55	6.85	15.05
2006	2.39	62.76	0.96	4.98	3.58	28.03	6.54	13.05
2007	2.42	67.21	0.96	4.90	3.86	19.17	6.76	14.82
2008	2.45	68.99	0.99	4.91	3.88	19.55	6.85	15.05
2009	2.47	101.65	0.79	4.63	3.91	12.74	7.22	18.73
2010	2.42	64.18	0.98	4.98	3.59	28.50	6.62	13.22
2011	2.51	71.98	1.02	4.91	3.91	20.16	7.00	15.43
2012	2.45	68.99	0.99	4.91	3.88	19.55	6.85	15.05
2013	2.45	68.99	0.99	4.91	3.88	19.55	6.85	15.05

As per the hypothetical assumptions of our model, the Hicksian estimated demands are less than the Marshallian estimated demand. This is true in present study as well. This is because the income effect has been isolated from the total effect. The key purpose behind it is to estimate the amount required by a single household in each selected district to obtain the initial level of utility before floods.

Compensation Required in KGs and PKR per household

The difference between the Marshallian and the Hicksian estimated quantities is the quantities of the goods in kilograms that may be estimated as the compensation required by each household per month to obtain the same initial level of utility that they had before the flood damage. Following table 24 presents the compensation in quantities of goods in KGs per household per month.

Table 24. *Summary of Compensation Required in KGs per household per month*

Year	1	2	3	4	5	6	7	8
	Wheat	Milk	Rice	Moong	Chicken	Beef	Fish	Banana
2004	18.96	0.00	0.22	18.71	0.05	0.18	0.02	9.67
2005	11.93	0.00	0.49	31.74	0.05	0.21	0.03	10.60
2006	16.92	0.00	0.28	30.97	0.05	0.22	0.03	11.09
2007	16.13	0.00	0.31	31.34	0.05	0.20	0.03	10.51
2008	16.24	0.00	0.31	31.74	0.05	0.21	0.03	10.60
2009	13.57	0.00	0.43	47.46	0.05	0.20	0.02	10.02
2010	20.91	0.00	0.20	31.31	0.05	0.23	0.03	11.18
2011	16.42	0.00	0.31	32.41	0.05	0.22	0.03	10.76
2012	16.24	0.00	0.31	31.74	0.05	0.21	0.03	10.60
2013	16.24	0.00	0.31	31.74	0.05	0.21	0.03	10.60

	9	10	11	12	13	14	15	16
	Apple	Potato	Tomato	Onion	other veg	sugar	gram	Chilies
2004	0.21	39.13	0.07	0.03	0.17	7.80	0.87	3.49
2005	0.19	73.29	0.00	0.02	0.14	7.85	1.03	4.00
2006	0.18	64.59	-0.01	0.02	0.12	12.90	0.96	3.27
2007	0.18	70.78	-0.01	0.02	0.14	7.64	1.01	3.91
2008	0.19	73.29	0.00	0.02	0.14	7.85	1.03	4.00
2009	0.19	122.35	-0.03	0.02	0.14	4.27	1.12	5.43
2010	0.19	66.56	0.00	0.02	0.12	13.19	0.98	3.33
2011	0.20	77.54	0.00	0.02	0.14	8.20	1.07	4.14
2012	0.19	73.29	0.00	0.02	0.14	7.85	1.03	4.00
2013	0.19	73.29	0.00	0.02	0.14	7.85	1.03	4.00

The information on the quantities presented in table 25 is multiplied by the prices of the goods in the selected districts to estimate the monetary value of the compensation required per month per household. Following table 25 presents the summary of the compensation required by each household per month in PKR.

Table 25. *Summary of Compensation Required in PKR per household per month*

	Wheat	Milk	Rice	Moong	Chicken	Beef	Fish	Banana
2004	266.80	0.06	7.54	855.01	1.09	0.32	1.05	445.57
2005	247.48	0.02	9.92	2041.76	1.46	0.30	1.95	813.80
2006	320.40	0.04	9.86	1745.47	1.17	0.28	1.74	754.21
2007	334.77	0.04	10.64	2015.67	1.44	0.29	1.95	806.36
2008	337.04	0.04	10.67	2041.76	1.46	0.30	1.95	813.80
2009	421.20	0.05	15.03	4690.99	2.36	0.31	3.17	1250.98
2010	395.95	0.05	10.25	1764.82	1.18	0.28	1.74	760.16
2011	340.75	0.04	10.71	2084.69	1.48	0.31	1.97	825.99
2012	337.04	0.04	10.67	2041.76	1.46	0.30	1.95	813.80
2013	337.04	0.04	10.67	2041.76	1.46	0.30	1.95	813.80

	Apple	Potato	Tomato	Onion	other veg	sugar	gram	Chilies	Total
2004	9.67	2327.33	4.74	2.73	19.45	687.49	1.28	112.92	4743.05
2005	15.05	7696.75	-0.23	3.60	22.12	934.35	1.92	184.70	11974.95
2006	11.44	6999.31	-0.62	3.41	16.72	1345.31	1.68	144.38	11354.79
2007	14.57	7432.82	-0.61	3.60	21.91	909.57	1.88	180.70	11735.60
2008	15.05	7696.75	-0.23	3.60	22.12	934.35	1.92	184.70	12065.27
2009	27.58	17605.09	-4.08	4.79	34.14	765.63	2.79	347.53	25167.55
2010	11.77	7212.43	-0.29	3.41	16.86	1375.81	1.71	147.15	**11703.27**
2011	15.85	8143.44	0.42	3.61	22.45	975.82	1.98	191.34	12620.86
2012	15.05	7696.75	-0.23	3.60	22.12	934.35	1.92	184.70	12065.27
2013	15.05	7696.75	-0.23	3.60	22.12	934.35	1.92	184.70	12065.27

According to the above table 25, the total compensation in PKR per month required to bring each household at the same pre flood level of utility in the year 2010 is PKR 11703.27/month and in subsequent three years is around 12065.27 in 2011, 2012 and 2013. The district wise estimated need of the monetary compensation per household per month is presented in the following table 26.

Table 26. *Summary of District-wise Flood Affected Population and Compensation Required in PKR*

Flood affected Population[13]	Qambar Shahdadkot	Kandhkot-Kashmore	Jacobabad	Shikarpur	
	980,500	615,000	892,500	778,000	
Average Family Size 7.5 (PDMA, 2010)					
Flood affected families	130733.33	82000	119000	103733.33	
Total PKR Required (2010) per Month	11530007528.43	959668159.1	1392689158	1214019232	
Total Million PKR per Month	1530.01	959.67	1392.69	1214.02	
Total Million PKR per Year	18360.09	11516.02	16712.27	14568.23	Total
Total Billion PKR per Year	18.36	11.52	16.71	14.57	61.16

Source: Self-Calculated; Summary of Various Analyzed Tables

According to table 26, the compensation required per year in all four districts in total is PKR 61.16 billion per year. The compensation required in district Qamber-Shahdadkot is the highest (PKR 18.36 billion), followed by Jacobabad (PKR 16.71 billion), Shikarpur (PKR 14.57 Billion) and Kashmore-Kandhkot (PKR11.52 Billion).

Intervention

The intervention in the flood affected areas took place by the nongovernmental organizations, international NGOs and the government sector with the support from Pakistan army and the paramilitary forces. The type and duration of the intervention done is presented in the following table 28.

Table 27. *Summary of Rescue, Relief, Rehabilitation, Early Recovery Operations*

Phase I: Rescue	
Intervention	Stakeholders
Shifting affected population to safer places	Government (Federal, Provincial and District) Pakistan Army NGOs and INGOs Affected population by themselves
Timeline: First two weeks after accruing floods in respective areas	
Phase II: Relief	
Intervention	Stakeholders
Flood affected population residing in open air	Affected population by themselves
Establishing camps in public buildings and tents	Governments,

[13] NDMA (NDMA, 2012)

	INGOs/NGOs
Providing cooked food, health, Water & sanitation facilities to flood affected population at temporary shelter places	Governments, INGOs/NGOs
Providing Food, Non-Food and Hygiene items (Basket) to flood affected population	Governments, INGOs/NGOs
Providing education facilities to children in Temporary Learning Centers (TLCs)	INGOs/NGOs
Time Line: August to November, 2010	
Phase III: Rehabilitation	
Intervention	Stakeholders
Facilitating flood affected population in shifting from camps to their home (base) place	Government, INGOs/NGOs
Providing monthly Food items (Basket) to flood affected HHs at their doorsteps for six months	INGOs/NGOs
Providing once non-food and Hygiene items (baskets) to flood affected population at their door steps	INGOs/NGOs
Nutrition support to children and pregnant & lactating women	INGOs/NGOs
Providing education facilities to children in Temporary Learning Centers (TLCs)	INGOs/NGOs
Health & Hygiene sessions with flood affected communities at village level	INGOs/NGOs
Food for Work (FFW) and Cash for Work (CFW) for debris removal from villages, Agricultural fields and house re-construction	INGOs/NGOs
Provision of material kits required for Debris removal from villages, agricultural fields and house re-construction	INGOs/NGOS
Provision of Agricultural inputs to flood affected farmers	INGOs/NGOs
Provision of One Room Shelter (ORS) to flood affected families	INGOs/NGOs
Watan Crad (Cash) support to flood affected Population	Government
Phase IV: Early Recovery	
Intervention	Stakeholders
Watan Crad (Cash) support to flood affected population	Government
Provision of Agricultural inputs to flood affected farmers	INGOs/NGOs
Livestock support to flood affected population	INGOs/NGOs
Livelihood restoration support to non-farmer flood affected families	INGOs/NGOs
Provision of One Room Shelter (ORS) to flood affected families	INGOs/NGOs
Restoration of community infrastructure the CFW schemes	INGOs/NGOs
Capacity Building of flood affected HHs in "Community Based Disaster Response Management - CBDRM"	INGOs/NGOs
Time Line: April – December, 2011	
Phase V: Reconstruction	
Intervention	Stakeholders
Construction and repair of agricultural channels, culverts, roads and bridges	Government
Construction and repair of public buildings (educational and health facilities, administrative etc.)	Government
Time Line: July 2012 to June 2015	

Source: Self-Calculated: Various Flood Response Reports

The district wise distribution of the amount that was spent on all of the phases of interventions is presented in the following table 29.

Table 28. *Rescue & Relief and Rehabilitation Expenditure in PKR (Billions): Total & District-wise*

Intervention	Qambar Shahdadkot	Kashmore-Kandhkot	Jacobabad	Shikarpur	Total	%age of funding
Rescue, Relief and Rehabilitation	7.03	4.41	6.40	5.58	23.42	49.65
Early Recovery	3.53	2.22	3.22	2.80	10.77	24.93
Reconstruction	3.60	2.26	3.28	2.86	12.00	25.42

Source: Self-Calculated: Summary of various Analyzed Tables

According to table 28, 50% of the funds allocated were spent on the Rescue, Relief and Rehabilitation. The total amount allocated for the flood affected areas was as high as PKR 47.20 Billion (Federal Flood Commission of Pakistan, 2014) and (Associated Press of Pakistan, 1955). The amount spent on Rescue, Relief and Rehabilitation is equal to PKR 23.42 billion. The amount spent in Qamber-Shahdadkot is PKR 14.16 billion that is highest spending among the selected four districts followed by Jacobabad (12.9) and Shikarpur (11.24) and Kashmore-Kandhkot (8.89).

The required amount for compensation is PKR 61.16 billion however the amount spent is around PKR 47 billion. Therefore it can be said that the intervention was short by approximately PKR 15 billion. The detailed discussion on the gaps is presented in the summary of findings and conclusion.

6. Qualitative Analysis Throught Focus Group Discussions

Focus Group Discussions (FGDs) were conducted to record the perceptions of the flood affected population. The format of FGDs were adopted from the USAIDs report entitled "SUKKUR DISTRICT: Socio-Economic Profile" and OMVs report entitled "Social Audit of Community Development Interventions". Both the report are widely accepted. The format was modified according to the situation.

In all 8 FGDs were conducted i.e. 2 in each of the selected districts. In each FGD 6-8 participants from flood affected areas were invited to express their views about flood occurrence, damages, displacement, returning and support interventions.

Flood Occurrence

Flood occurred due to breach in Thori band, district Kashmore-Kandhkot. Following is the flood water inundation in different districts.

Table 29. *Occurrence of flood 2010 in the selected villages*

Kashmore-Kandhkot	August 07-08, 2010
Jacobabad	August 09-18, 2010
Shikarpur	August 10-13, 2010
Qambar-Shahdadkot August	August 18-25,201

Displacement

The displacement took place immediately in the near-by areas due to high velocity of flood water. The participants of FGDs expressed that was the most difficult part of flood 2010 in term of

mental, physical and financial hardships. The support provided at this stage was minimal.

Community Perceptions

Losses / Damages

The nearby villages to Thori Bund have lost everything; they were only able to save human beings only with some injuries as well. However the other areas flood affected population, apart from human beings were able the save some of the animals in nearby districts. Household items, stored grains and bedding were destroyed completely. All the katcha and Pacca houses were either severely damaged or destroyed completely. Their standing crops of Kharif 2010 were completely destroyed in all the four selected districts and only 20%-25% area was able for cultivation of Rabi 2010-2011 crops. The ground water quantity and quality was also badly affected. The irrigation system was badly affected due to flood 2010.Infrastructure was badly affected and mobility was not possible for months.

Support during displacement

During the displacement facility of camps initially in schools was provided for 6-8 weeks till the establishment of tent cities by the INGOs/NGOs or tents were provided to the flood affected population to install by themselves in safer places. Initially for two weeks the cooked food was provided followed by the food items pack for at-least two weeks for one family. Non-Food items were provided once per family. Hygiene kits were also provided to each family. Drinking water was supplied and sanitation facility provided by the INGOs/NGOs. Health facility was provided at camps either by mobile team or fixed set-up.

Returning to home

The flood affected population started returning to their home place after 6 weeks of evacuation where water has receded. Initially one male member of the family returned to look after the destroyed belongings and preparing the agricultural fields. All the family members returned when pathways, roads and other communication channels were restored at minimum level of communication.

Support after Return

Initially returnees were provided temporary shelter followed by the two weeks food item packs which continued for 4-6 months. They were once provided the Non-Food Item (NFIs) pack. Hygiene kits were provided to each family and health & hygiene sessions were conducted at village level. For livelihood restoration initially FFW and CFW schemes were implemented. Seed and fertilizers

were provided for Rabi2010-11 crops to the farmers. Government waved the agricultural taxes in the flood affected areas. The non-farmers households were provided support for the restoration of their old business / economic activity and the laborers were engaged for FFW and CFW schemes for 4-6 months.

The flood affected population was provided cash support through Watan Card scheme of PKR.20,000 each installment for each head of the household for 3 installments in 8 months. Majority of the recipients got all the three installments but few of them got 1 or 2 installments as well. One Room Shelter (ORS) was provided to flood affected households, at-least 25% households benefitted from this scheme. The FGDs participants expressed that they were supported by the Government, INGOs/NGOs to the extent of 75%-100% in different areas. Very few participants expressed that their area was ignored by the support providing agencies.

7. Conclusion and Recommendations

Conclusion

The study's main objective was to estimate the household welfare loss during floods 2010. To measure the welfare losses, Hicksian Compensating Variation is estimated. Literature has suggested welfare losses in the rural settings in developing countries. However intervention has been identified as the directly depending on the government and nongovernmental organizations and departments' degree of functionality.

For Hicksian Compensating Variation required by the households, Income and Substitution Effects have been separated from the total effect of the flood 2010 on households. Following table presents the summary of compensation provided, required and the subsequent gap between the intervention and the estimated compensation.

Table 30. *Summary of comparison of Estimated Compensation and the disbursed Compensation in selected districts and the estimated gap in PKR (Billions): Total & District-wise*

District	Compensation (Billion PKR) Required	Compensation (Billion PKR) Provided	Gap in Compensation (Billion PKR)	Gap in Compensation (Percentage)
Qambar Shahdadkot	18.36	14.17	4.19	22.82
Kashmore-Kandhkot	11.52	8.89	2.63	22.83
Jacobabad	16.71	12.9	3.81	22.80
Shikarpur	14.57	11.24	3.32	22.79
Total Compensation in PKR Billion	61.16	47.2	13.95	22.81

Recommendations

Keeping in view the detailed analysis of the damages and the estimated compensation required and the intervention done, following recommendations for new researchers, policy makers and the fellows from NGO sectors can be presented.

- The major problem in intervention was delay in response due to administrative issue within the government system and international donor cannot intervene without the invitation of the government, then after international donors conducted the assessment to start the interventions. Therefore it is recommended that bureaucratic bottlenecks should be removed.
- Although the National Disaster Management Authority (NDMA) and Provincial Disaster Management Authorities (PDMAs) were in place but being at infancy stage and the magnitude of the flood 2010 was beyond their capabilities and capacities. However over the period of time the NDMA & PDMAs have significantly improved in terms of emergency response and development of mechanism to tackle the natural disasters at colossal level. For the sake of meeting the rural household needs and welfare effects it is recommended that efforts may be taken at all levels of government to enhance the technical capacity and capability to international standards defined by UN(UNOCHA)
- In case of the disaster, it was observed that schools in safer/unaffected places/urban settings were given status of temporary relief camps. Though this arrangement provided cheap and immediate rescue and shelter to the flood affected and displaced families yet it had a heavy toll on the ongoing education process in the settled areas. This way, the settled areas were also affected badly in terms of lost school hours from the school going children. To minimize the flood losses from reaching the settled areas, it is strongly recommended that independent relief centres and camps should be arranged for rescue of the flood affected families.
- The role of Community Based Disaster Response Management (CBDRM) was neglected during the whole process of rehabilitation and rescue in the flood affected area. Though their role was undermined at initial stage, its role was integrated at a later stage at community level. It is further recommended that the relief teams and rescue operations should be started in coordination at lower/grass root level institutions and organizations.
- The assessment of the situation and the sanctioning of funds at all levels of governments also proved to be a factor holding back the rescue operations. Therefore it is highly recommended that

government at all tiers should earmark the Emergency Response Fund (ERF) through NDMA and PDMAs in future like the international organizations do to respond the affected population at earliest.

- Bigger groups of bureaucracies at district, provincial and national levels are formed and structured. Due to lack of proper training and skills and absence of the Disaster Management Plans, complex hierarchical discrepancies arise. To avoid such situations, it is recommended that these plans should be developed in advance to cope with the grave situations in case of natural disasters. Further, these plans should be designed and modeled in such a way that they take into consideration the ground realities with clear division of roles for participants and defined responsibilities of each stakeholder.

Appendices

A1. Focus group Discussions Format

Activity: Village level
Deliverable: **Focus Group Discussion Report**
Submission deadline: Next day of the activity
District / Taluka:____Total No. of participants: _____(Male: _____ Female: ____)
Date of FGD: _____ Venue of FGD:_____
Submitted by: _____ Date of submission: _____

Key areas discussed:

Thematic area 1 (History of floods 2010)

Thematic area 2 (Evacuation)

Thematic area 3 (Losses)

Thematic area 4 (Support provided during evacuation / displacement)

Thematic area 5 (Return to village)

Thematic area 6 (Support provided at village after return)

Thematic area 7 (Any Other (Specify):

A2. List of Participants Focus group Discussions (FGDs)

FGD #	District	Taluka	UC	Village	Participant	Cell #
1	Shikarpur	Khanpur	Ghari Dhako	Ghuhram Kaladi	Muhammad Pariyal Kaladi	0333-7262257
					Kandero Kaladi	
					Mehar Kaladi	0308-3466182
					Naimatullah Kaladi	0302-9455752
					Mumtaz Ali	0306-2342120
2		Shikarpur	Sultan Kot	Daya Muhallah	Illahi Bux Dayo	0307-3412346
					Ghulam Rasool Shaikh	0302-3627828
					Manthar Ali Shaikh	
					Zulfiqar Ali Dayo	
3	Kashmore@Kandhkot	Kandhkot	Haibat / Dadar	Rajoo Bhayo	Zulfiqar Ali Bhayo	0300-2662372 0313-2882372
					Abdul Karim Bhayo	
					Allah Dino Bhayo	0302-3361536
					Sarfraz Ahmed Bhayo	0300-3284978
					Muhammad Younas Bhayo	0345-8769990
4		Tangwani	Naseer	Wahid Bux Bhayo	Noor Hassan Bhayo	0313-8562503
					Rabnawaz Bhayo	0300-8995595
					Muhammad Ali	0313-8867470
					Rasool Bux	
					Munawar Ali	0302-3682613
5	Jacobabad	Thul	Mirpur Buriro	Muhammad Rabban Buriro	Imamuddin Buriro	0301-2935548
					Ghulam Qadir Buriro	0310-3472793
					Sadoro Khan	0302-3182107
					Abdul Karim Buriro	0313-8809325
					Taungal Khan	0312-1036437
6		Ghari Khero	Ghari Khero	Wali Muhammad Brohi	Ghulam Muhammad Brohi	0346-1318616
					Abdul Malik Brohi	0301-3293314
					Ahsan Ali Brohi	0347-1543714
					Ali Dost Brohi	0306-2486942
					Deedar Ali Brohi	0305-3607228
					Asadullah Brohi	0307-0020240
7	Qambar - Shahdadkot	Shahdadkot	Jamali	Kamal Khokhar (Ummani)	Abdul Qadir Jamali	0332-2019054
					Sanaullah Jamali	0334-2007120
					Ahmed Ali Jamali	
					Rajib Ali Jamali	0336-3897576
					Muhammad Qasim Jamali	0343-3431914
8		Qubo Saeed	Hazarwah	Gul Hassan Khan Brohi	Muhammad Saifal Brohi	0333-7501258
					Abdul Jabbar Brohi	0336-0397548
					Javed Ali Brohi	0313-2088828
					Amir Ali Brohi	0331-2118070

A3 Selected Village Profile Format

Date: _____

Name of Village: _____ Union Council _____
Taluka _____ District _____
Respondents: 1. _____ 2. _____ 3. _____ 4. _____
Total Households in the village: _____

Total Population:

Male	Female	Children (<5 Yr)	Total

Educational Profile:

Illiterates		Primary		Secondary		Graduate & Others	
M	F	M	F	M	F	M	F

Facilities & infrastructure:

Facility	Before Flood			After Flood		
	Within Village	If Not, Distance from village	Status	Within Village	If Not, Distance from village	Status
Road to Village						
Road within Village						
Electricity						
Primary School						
Middle School						
Health Center						
Others						

Major Occupations of Villagers:

Occupations	Employment	Land	Peasantry (Cropping)	Livestock / byproducts	Handicraft	Other (_____)	Total
Persons involved							

Major Problems faced by the villagers during flood 2010:

1. _____
2. _____
3. _____
4. _____
5. _____

Additional Information

VILLAGE PROFILE

A3-1. Direction of selected Villages

S.NO	Village	Location		
		From	Direction	Distance
1	Ghuhram Kaladi, UC Ghari Dhakho, Taluka Khanpur, SHIKARPUR	Sukkur	North	40-45 kms
2	Daya Muhallah, UC Sultan Kot, Taluka Shikarpur, SHIKARPUR	Sukkur	North	35-40 kms
3	Rajo Bhayo, UC Haibat / Dadar, Taluka Kandhkot, KASHMORE@KANDHKOT	Sukkur	North-East	60-65 kms
4	Wahid Bux Bhayo, UC Naseer, Taluka Tangwani, KASHMORE@KANDHKOT	Sukkur	North-East	55-60 kms
5	Muhammad Rabban Buriro, UC Mirpur Buriro, Taluka Thul, JACOBABAD	Sukkur	North	60-65 kms
6	Wali Muhammad Brohi, UC Ghari Khero, Taluka Ghari Khero, JACOBABAD	Sukkur	North-West	125-135 kms
7	Kamal Khokhar (Ummani), UC Jamali, Taluka Shahdadkot, QAMBAR-SHAHDADKOT	Sukkur	North-West	100-110 kms
8	Gul Hassan Khan Brohi, UC Hazarwah, Taluka Qubo Saeed Khan, QAMBAR-SHAHDADKOT	Sukkur	West	100-110 s

A3-2. Population of selected villages

S.NO	Village	Population	Male	Female	Children
1	Ghuhram Kaladi, UC Ghari Dhakho, Taluka Khanpur, SHIKARPUR	680	198	245	237
2	Daya Muhallah, UC Sultan Kot, Taluka Shikarpur, SHIKARPUR	300	80	80	140
3	Rajoo Bhayo, UC Haibat / Dadar, Taluka Kandhkot, KASHMORE@KANDHKOT	250	85	90	75
4	Wahid Bux Bhayo, UC Naseer, Taluka Tangwani, KASHMORE@KANDHKOT	810	215	235	360
5	Muhammad Rabban Buriro, UC Mirpur Buriro, Taluka Thul, JACOBABAD	230	65	65	100
6	Wali Muhammad Brohi, UC Ghari Khero, Taluka Ghari Khero, JACOBABAD	400	130	140	130
7	Kamal Khokhar (Ummani), UC Jamali, Taluka Shahdadkot, QAMBAR-SHSDADKOT	350	95	95	160
8	Gul Hassan Khan Brohi, UC Hazarwah, Taluka Qubo Saeed Khan, QAMBAR-SHAHDADKOT	400	110	110	180

A3-3. Housing structure in the selected villages

S.NO	Village	Total	Katcha	Pacca
1	Ghuhram Kaladi, UC Ghari Dhakho, Taluka Khanpur, SHIKARPUR	100	70	30
2	Daya Muhallah, UC Sultan Kot, Taluka Shikarpur, SHIKARPUR	30	22	8
3	Rajoo Bhayo, UC Haibat / Dadar, Taluka Kandhkot, KASHMORE@KANDHKOT	50	10	40
4	Wahid Bux Bhayo, UC Naseer, Taluka Tangwani, KASHMORE@KANDHKOT	180	130	45
5	Muhammad Rabban Buriro, UC Mirpur Buriro, Taluka Thul, JACOBABAD	14	12	2
6	Wali Muhammad Brohi, UC Ghari Khero, Taluka Ghari Khero, JACOBABAD	50	25	25
7	Kamal Khokhar (Ummani), UC Jamali, Taluka Shahdadkot, QAMBAR-SHSDADKOT	45	25	20
8	Gul Hassan Khan Brohi, UC Hazarwah, Taluka Qubo Saeed Khan, QAMBAR-SHAHDADKOT	150	100	50

A3-4. Literacy in the selected villages

S. NO.	Village	Ill –Literate		Primary		Secondary		Others	
		M	F	M	F	M	F	M	F
1	Ghuhram Kaladi, UC Ghari Dhakho, Taluka Khanpur, SHIKARPUR	40	270	240	94	24	8	4	0
2	Daya Muhallah, UC Sultan Kot, Taluka Shikarpur, SHIKARPUR	75	150	40	17	15	1	2	0
3	Rajoo Bhayo, UC Haibat / Dadar, Taluka Kandhkot, KASHMORE@KANDHKOT	0	80	80	25	30	15	18	2
4	Wahid Bux Bhayo, UC Naseer, Taluka Tangwani, KASHMORE@KANDHKOT	150	410	135	0	90	0	25	0
5	Muhammad Rabban Buriro, UC Mirpur Buriro, Taluka Thul, JACOBABAD	40	120	48	0	18	0	4	0
6	Wali Muhammad Brohi, UC Ghari Khero, Taluka Ghari Khero, JACOBABAD	155	190	40	15	0	0	0	0
7	Kamal Khokhar (Ummani), UC Jamali, Taluka Shahdadkot, QAMBAR-SHSDADKOT	80	134	90	40	5	0	1	0
8	Gul Hassan Khan Brohi, UC Hazarwah, Taluka Qubo Saeed Khan, QAMBAR-SHAHDADKOT	68	150	70	30	40	12	25	5

A3-5. Facilities in the selected villages

S.NO	Village	Primary School		Middle School		Health Center	
		If not in village, distance in Kms					
		Before Floods	After Floods	Before Floods	After Floods	Before Floods	After Floods
1	Ghuhram Kaladi, UC Ghari Dhakho, Taluka Khanpur, SHIKARPUR	YES	YES	NO (8)	NO (8)	NO (8)	NO (8)
2	Daya Muhallah, UC Sultan Kot, Taluka Shikarpur, SHIKARPUR	YES	YES	YES	YES	NO (3)	NO (3)
3	Rajoo Bhayo, UC Haibat / Dadar, Taluka Kandhkot, KASHMORE@KANDHKOT	YES	YES	NO (2)	NO (2)	NO (15)	NO (15)
4	Wahid Bux Bhayo, UC Naseer, Taluka Tangwani, KASHMORE@KANDHKOT	YES	YES	NO (2)	NO (2)	NO (2)	NO (2)
5	Muhammad Rabban Buriro, UC Mirpur Buriro, Taluka Thul, JACOBABAD	NO (1)	NO (1)	NO (3)	NO (3)	NO (6)	NO (6)
6	Wali Muhammad Brohi, UC Ghari Khero, Taluka Ghari Khero, JACOBABAD	YES	YES	NO (3)	NO (3)	NO (3)	NO (3)
7	Kamal Khokhar (Ummani), UC Jamali, Taluka Shahdadkot, QAMBAR-SHSDADKOT	YES	YES	NO (3)	NO (3)	NO (18)	NO (18)
8	Gul Hassan Khan Brohi, UC Hazarwah, Taluka Qubo Saeed Khan, QAMBAR-SHAHDADKOT	YES	YES	YES	NO (6)	NO (20)	NO (20)

A3-6. Infrastructure in the selected villages

	Village	Road to Village		Road within village		Electricity	
		Before floods	After Floods	Before floods	After Floods	Before floods	After Floods
1	Ghuhram Kaladi, UC Ghari Dhakho, Taluka Khanpur, SHIKARPUR	Katcha	Pacca	Katcha	Katcha	Yes	Yes
2	Daya Muhallah, UC Sultan Kot, Taluka Shikarpur, SHIKARPUR	Pacca	Pacca	CC Block	CC Block	YES	YES
3	Rajoo Bhayo, UC Haibat / Dadar, Taluka Kandhkot, KASHMORE@KANDHKOT	Pacca	Pacca (damaged)	Katcha	Bricks	Yes	Yes
4	Wahid Bux Bhayo, UC Naseer, Taluka Tangwani, KASHMORE@KANDHKOT	Pacca	Pacca	Katcha	Katcha	Yes	Yes
5	Muhammad Rabban Buriro, UC Mirpur Buriro, Taluka Thul, JACOBABAD	Pacca (damaged)	Pacca (damaged)	Mud (Pathway)	Mud (Pathway)	YES	YES
6	Wali Muhammad Brohi, UC Ghari Khero, Taluka Ghari Khero, JACOBABAD	Pacca	Pacca (damaged)	CC Block	CC Block (Damaged	YES	YES
7	Kamal Khokhar (Ummani), UC Jamali, Taluka Shahdadkot, QAMBAR-SHSDADKOT	Pacca	Pacca (damaged)	Mud	Mud (damaged)	YES	YES
8	Gul Hassan Khan Brohi, UC Hazarwah, Taluka Qubo Saeed Khan, QAMBAR-SHAHDADKOT	Pacca	Pacca (damaged)	Mud partial CC Block	Mud Partial CC Block	YES	YES

A3-7. Employment in the selected villages

	Village	Occupations					
		Employ ment	Land	Peasantry/ Cropping	Livestock / by-products	Handi craft	Other daily wages
1	Ghuhram Kaladi, UC Ghari Dhakho, Taluka Khanpur, SHIKARPUR	12	15	40	2	5	0
2	Daya Muhallah, UC Sultan Kot, Taluka Shikarpur, SHIKARPUR	5	0	0	0	3	8
3	Rajoo Bhayo, UC Haibat / Dadar, Taluka Kandhkot, KASHMORE@KANDHKOT	8	50	0	3	12	0
4	Wahid Bux Bhayo, UC Naseer, Taluka Tangwani, KASHMORE@KANDHKOT	12	12	140	0	0	0
5	Muhammad Rabban Buriro, UC Mirpur Buriro, Taluka Thul, JACOBABAD	4	10	5	0	15	0
6	Wali Muhammad Brohi, UC Ghari Khero, Taluka Ghari Khero, JACOBABAD	0	10	40	10	0	30
7	Kamal Khokhar (Ummani), UC Jamali, Taluka Shahdadkot, QAMBAR-SHSDADKOT	3	25	25	1	0	0
8	Gul Hassan Khan Brohi, UC Hazarwah, Taluka Qubo Saeed Khan, QAMBAR-SHAHDADKOT	13	40	90	8	0	0

A4. Details of Watan Card

The Pakistan's Citizen's Damage Compensation Program (CDCP) a rapid response cash grant to the 2010 flood victims named WATAN CARD, through biometric verification and integration with financial institutions. It was initially created by the Government of Pakistan to provide much-needed relief to the flood-affected population, later continued and expanded to support their early recovery with the support of international community.

Watan Cards were launched in 2010 to help the victims of floods in Pakistan. NADRA played a vital role in supporting the Government of Pakistan to provide the financial assistance to the flood affected population of Pakistan on a short notice of 72 hours. The National Disaster Management Authority (NDMA) in collaboration of PDMAs of respective governments started the issuance and distribution of Watan Cards to help the food victims to cover basic consumption and to recapitalize assets, repay loans, recover their livelihoods and repair housing.

Watan card provides the beneficiaries to manage their life style with the grant provided and support family members. This project ensured rehabilitation after natural calamities. It has also developed a web based case management system to facilitate appeals and complains of the applicants.

Following were the major steps of Watan card:

01 Preliminary Geographical Targeting (Affected Areas) by Revenue Department of respective provincial governments

02 Cross Verification from National Citizen Database by NADRA

03 Unique Beneficiary Selection from the Family (Head of Family) jointly by NADRA and DCO office of the respective district

04 Biometric Verification of each Beneficiary (Fingerprint, Photograph) by NADRA

05 Debit Card Delivery to the Verified Beneficiary by DCO of respective district

06 Cash Withdrawal through various banks (POS, ATM)

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Present study has applied Hicksian Compensating Variation approach for empirical estimation of the welfare loss in the households of the four selected districts of North Sindh (Qamber Shahdadkot, Kashmore-Kandhkot, Jacobabad and Shikarpur) that were severely affected during flood 2010. The income and substitution effects were estimated from Marshallian demand curves. Slutsky equation is applied to isolate the income effect from the total effect to estimate the Hicksian demand equations. The total intervention estimated to be required was approximately PKR 61.16 billion in the four selected districts however the total intervention provided in the form of rescue, relief, rehabilitation, and reconstruction was equal to PKR 47.2 billion. A short fall of approximately PKR 15 billion was observed. The Hicksian Compensation required estimated per household per month is to the tune of PKR 11703 per month.

Imtiaz Ahmed Pirzada
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