

# Flood Causes, Consequences and Protection Measures in Pakistan

Muhammad Yaqub<sup>1</sup>, Beytullah Eren<sup>2</sup>, Emrah Doğan<sup>1</sup>

Received: 16.04.2015 Accepted: 05.05.2015

<sup>1</sup>Sakarya University, Civil Engineering, Sakarya, Turkey

<sup>2</sup> Sakarya University, Environmental Engineering, Sakarya, Turkey

**Abstract:** Flooding is the most overwhelming natural hazard in Pakistan due to diverse ecosystems and occurs mainly due to the heavy monsoon rains throughout the country, commonly late in the summer season and overflow the rivers and streams over dry land. In Pakistan floods are common problem and their continuity makes them more alarming for its economic growth. Although the impacts of flood vary from one place to another and in the consequences, there are significant losses such as human life loss their shelter, livelihood, damage to the public and private infrastructure such as roads and bridges. The aim of this work is to present a brief analysis of flooding behavior of the Indus basin, flood causes, their dreadful impacts and the flood administration at national level. This study also examines the aftermaths of severe floods in 67 years (1947-2014) history of the Pakistan by comprehensive and systematic review of suitable; Recommendations have been made through detailed analysis of flooding, to minimize the terrible impacts and to avoid floods continuity in the coming years.

**Index Terms**— Analysis, infrastructure, impacts, literature, Pakistan

## I. INTRODUCTION

PAKISTAN shares its borders with India in the southeast, Afghanistan in the northwest, Iran in the west and the north is China and it lies between Longitudes of 62°E and 75°E and Latitudes of 24°N and 37°N, having 796,095 km total land area. Pakistan is geographically divided into three zones as, Indus river plains, northern highlands and the Baluchistan plateau. The diversity of natural and physical environment is a challenge and threat to a variety of natural disasters like Floods, Earthquakes and Landslides etc. The natural disasters including floods, earthquakes, landslides and human induces disasters such as road accidents, Industrial accidents, fire, terrorism, internally displaced people [1] and war also affect the livelihood of people.

In Pakistan there are more than 60 small and large rivers but Indus River is the largest having its origin in the hills of Kailas Mountains and flows from north to south through the whole length of the country (3200KM) and 207 billion cubic meters water flow per annum. The other major tributaries of Indus River are Jhelum River, Chenab River, Ravi River, Sutlej River and Kabul River etc. as major ones are shown in the map given below. It collects water from all other rivers and finally unloads into the Arabian Sea near Karachi, a highly populated city of Pakistan located in the province of Sindh.

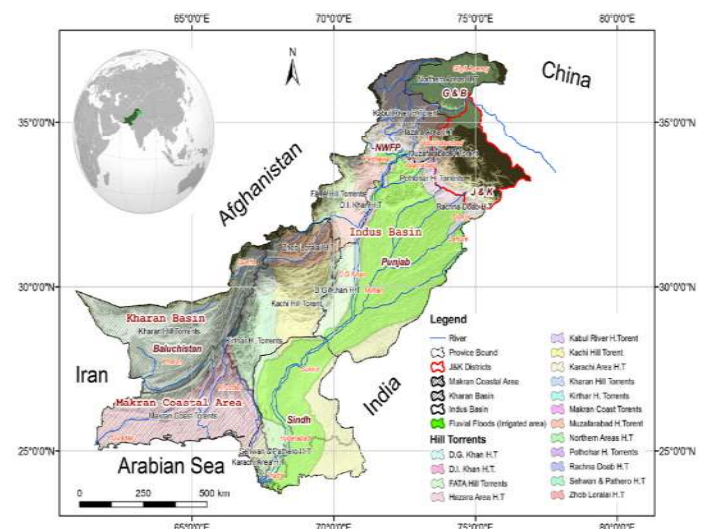


Fig: 1 Map of Pakistan showing geopolitical and hydrological features [2].

It can be judged by the World Disaster Report 2003 Geneva, stated that 6037 people lost their lives and 8,989,631 were affected in the era of 1993 to 2002. Flood is an overflow of water on the dry land adjacent to a river or lake that is not covered by water normally and causes to material loss, human health affect or cause to fatality.

Worldwide statistics shows that floods are widespread natural hazardous risk to lives as well as their properties in the recent decades [3].

According to global disaster analysis studies in the last ten years, after earthquake and tsunami the floods are third most frequent occurring natural disaster, cause of 5202 deaths, and millions of people were affected in 2011 as reported by the Centre for Research on the Epidemiology of Disasters [4].

The intensity, frequency and damages by floods and other natural disaster have been repeating and increasing in the recent decades [5]. The study of history shows that Pakistan is one of the most vulnerable countries to natural disasters in the world. The numerous disasters happened such as floods, earthquake, landslides and droughts, but floods are the most common and cause to immense damage to human lives and their properties [6].



Fig.1 Map of Pakistan's River system [7]

In history it has been observed that there are up and down in following civilizations, which grow rapidly along the banks of Indus River and are known as Indus valley civilizations, having history dates back to 3300BC. Indus River and its tributaries provided a perfect situation for establishment of people and growth of arts, culture and politics. It is a useful water resource for irrigation of agriculture lands to fertile the plains and plays a vital role in the economy of Pakistan. The geography of Pakistan differs from Northern alpine together through glaciers and Southern plains alongside Arabian Sea as shown in figure 1.

The river system of Pakistan consists of five major rivers named as Indus basin with its streams, Ravi, Jhelum, Sutlej and Chenab are flowing through the country from north to south and finally falls in Arabian Sea [8].



Fig.2 Village under heavy flood (2010) [9]

Due to the growth of urban areas in flood plains, the frequency and intensity of damages increases as flash floods in natural streams occur due to heavy rains in hilly and semi hilly areas [10]. As it is studied that flood are continuously occurring in Pakistan due to heavy monsoon rains in the river catchment areas and sometime flow increases when snow melt and add a large quantity of water to the rivers. These factors cause harsh flooding in most of the Indus basin areas and its tributaries as Ravi, Jhelum, Sutlej and Chenab in Pakistan. [11].

It was realized in 1947 when Pakistan came to existence, that it is important to develop new flood forecasting and warning systems to avoid the continuity of floods by keeping the long history of floods in this area but no concrete step was taken until a devastating flood occurred in 1976 and then Flood Forecasting System (FFS) was established. The study done by [12] showed that after severe floods in 1990, explored the weaknesses in the existing flood warning and monitoring systems. It encompasses the improvements that can make in the systems and other requirements for further concrete efforts to make them more efficient.



Fig.3 Agricultural Economy Loss in floods [13]

Floods either coastal, river or flash floods cause irreversible damage to human lives, destroy properties, failure of economy, make fertile land unsuitable for agricultural purpose by taking fertile soil to river systems due to erosion and also hurt our environment. The new



techniques, measurements and assessment, help the decision makers to understand the flood risk and in reducing fatalities and property loss. In this study we mainly focus on quantitative and qualitative analysis of flood causes, their deadly impacts and suggestions to minimize the losses in future, identify the flood affected areas, impacts on people, agriculture, livestock, infrastructure and economy of Pakistan.

## II. TYPES, HISTORY AND CAUSES OF FLOODS IN PAKISTAN

### A. Types of floods in Pakistan:

Generally there are five types of floods that occur commonly in the world such as flash floods, river floods, urban floods, coastal floods and pluvial floods. Pluvial flooding happen in canals or lakes due to the heavy rain falls in their catchment areas and water flow out to dry land and damage the community of region.

Different types of floods occurred in the history of Pakistan approximately every year; however floods most commonly occurred due to heavy monsoon rains in Pakistan. The heavy monsoon rains in the Indus basin catchment areas cause to fill it and a large quantity of water comes from snow melting on the glaciers in the hilly areas. In the northern areas of Pakistan flash floods also occur due to which there is a loss of human lives and their properties at large scale. It mostly happened in all the districts of Pakistan flooding are caused by breach of banks and embankments of water streams. Urban floods occurred commonly in the main cities of Pakistan due to the heavy monsoon rains because there is no alternative to drainage systems so water more than their capacity causes of flooding. The coastal floods happened in those areas near coast like south eastern Sindh and Makran bear the coastal floods due to tropical storms.

#### 1) Floods history in Pakistan:

In the history, Pakistan has faced various disastrous floods due to heavy monsoon rains caused by climate change in this region. The extreme monsoon rains causes of flooding by adding more water to the catchment areas of different rivers and finally comes to the Indus basin, as annual peak flows of Indus basin at different sites in the history of Pakistan are shown in the figure below.

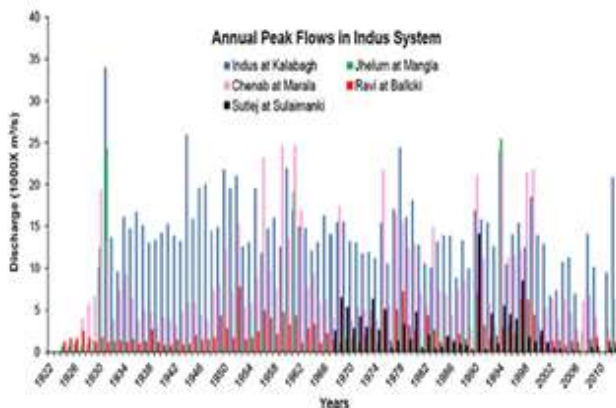


Fig.4 Annual peak flows (1921-2010) in Indus Basin River System [14]

The floods happened in 1990-2000, but there were two major floods of 1992 and 1998 in the months of August and March respectively. The flood in 1992 was a hazardous one which flooded the whole country excluding Baluchistan. In the decade of 2000-2009 almost every year other than 2002 and 2004, flood occurred with different intensities and in 2005 flood happened two times in the month of February and June. Flood happened two times in the 2005, in the months of February and June. The report of Asian Development Bank shows that during 1950-2011 Floods frequency in the history of Pakistan from 1950-2011 is shown in the figure below.

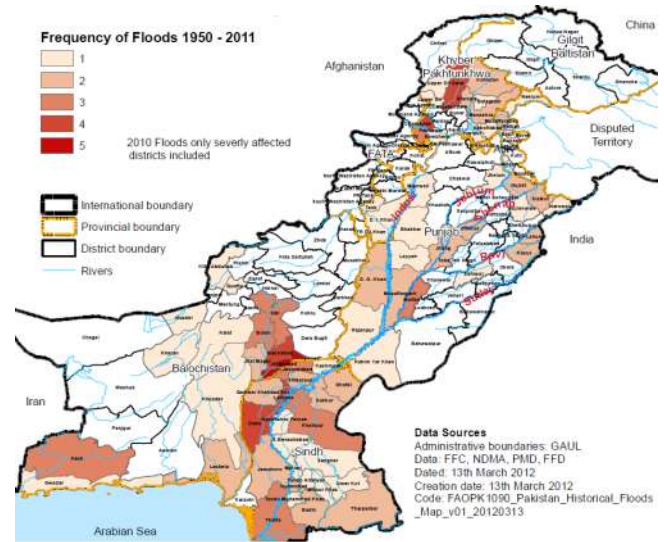


Fig.5 Frequency & flood affected areas (1950-2011) [15]

Pakistan has experienced 21 major floods claiming human lives, damage to villages, loss of livestock, agricultural and economy as Table.1 shows in detail.

Table.1 Major Floods and their impacts in the history of Pakistan [16]

Year	US\$ million	Lives Lost	Affected villages	Area (km <sup>2</sup> )
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	683.7	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
2011	3730	516	38700	27581
2012	2640	571	14,159	7145
2013	1500	287	8297	4080
2014	2000	367	2235	4046
<b>Total</b>	<b>37554.45</b>	<b>11893</b>	<b>190766</b>	<b>609984</b>

## 2) Latest floods in Pakistan:

There are more than 20 dreadful floods in the history of Pakistan but their intensity and frequency has been increased in last decade as described below.

In flood 2003 province of Sindh province was dreadfully affected due to the flood caused by above normal monsoon rainfall. The urban flooding caused due to continuous rainfall 284.5 millimeters created destructed situation in Karachi city, while flash flood hit the Thatta district was the most horrible where rainfall goes up to 404 millimeters. In this disaster at least 484 people lost their lives and a number of 4,476 villages in this region were affected.

The flooding in 2007 caused by heavy monsoon rainfall, badly affected the areas of Khyber-Pakhtunkhwa, Sindh and coastal Baluchistan. Flooding occurred in Khyber-Pakhtunkhwa due to snow melting on glaciers and additionally heavy rain fall in July and August 2007. Cyclone and torrential rains in July and August affected the Sindh and coastal areas of Baluchistan.

In this disastrous flood nearly 130 people lost their lives and 2,000 were displaced from their homes to shelter rooms in Khyber-Pakhtunkhwa in July and in the month of August 22 people died on the other side 815 people died in flash floods happened in the different areas of Baluchistan and Sindh.

In 2010 massive flooding started in July 2010, approximately whole country was affected when flooding was caused by heavy monsoon rain more than normal and affected the most areas of Khyber-Pakhtunkhwa and Punjab. This was the most devastating flood in the history of Pakistan in which around one-fifth of total area of the country flooded. In this disaster number of affected people was more than the total of people those were affected in Indian Ocean tsunami 2004, the Kashmir earthquake in 2005 and the 2010 Haiti earthquake.

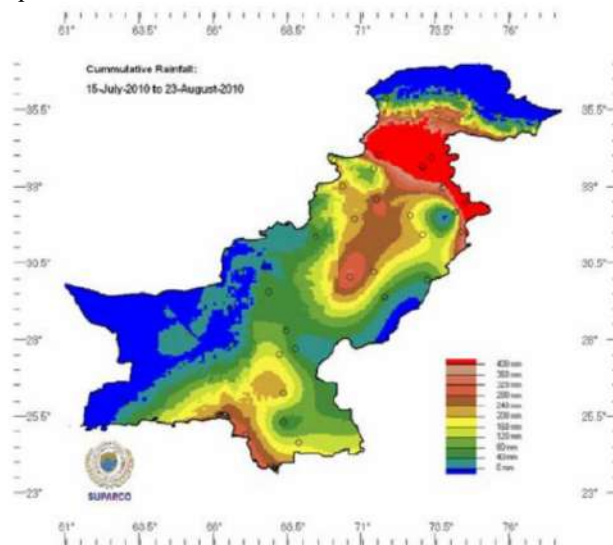


Fig.6 Cumulative rainfall during flood season 2010 [17]

It was the second most horrible flood in terms of destruction in the history and it caused the death of 1985 people, flooded 17,553 villages, affected more than 160,000 square kilometers area and around 21 million people suffered this flood disaster.

The flood happened in the province of Sindh due to the above normal and continuous rainfall during the months of August and September 2011 and it affected badly the southern districts in the Sindh. The most affected districts were Badin, Tando Mohammad Khan, Mirpurkhas due to recorded rainfall up to 400mm but Tharparkar (Mithi) and Tando Allah Yar were somewhat affected. Agricultural loss was the big one in this flood because Sindh has fertile soil and produces large amount of crops but in that season the whole standing crops were fully damaged in those districts. The deaths reported in this flood were 434, around 5.3 million people were displaced and at least 1,524,773 homes were affected.

The forecasted monsoon rainfall was 5-15% above normal in 2012, and in the early weeks of monsoon season it appeared that predictions were right as forecasted but in the last week of August and at the start of September there was a big turnaround and rain started pouring heavily. Sudden and extreme torrential rains were happened for a short period of one week and flooded areas of Jacobabad, Kashmore, Shikarpur, Jafferabad and Nasirabad where three provinces share their boundaries and caused a large destruction of life and property. In floods 2012 at least 571 people lost their lives and properties that ultimately hurt the economy of Pakistan.

In 2013 river and flash floods happened due to heavy monsoon rains and affected different parts of the country including North West of Khyber Pakhtunkhwa, FATA, Central Punjab, Baluchistan, Karachi and the Katcha areas of Sindh. In different districts of Punjab like Sialkot, Narowal, Sheikhpura and Jhang were affected due to the flooding of Chenab River and its channels, Kasur and Okara districts were flooded by Sutlej River. In the Northern area of Sindh flood was caused by Indus River and Karachi, Hyderabad and Gujranwala divisions were affected by urban flooding. In Chitral there were suspected Glacial Lake Outburst Flooding (GLOF) and land sliding in the region of Kashmir. The people died in floods 2013, were reported 287 with heavy damage to the economy of country.

Heavy monsoon rains in September 2014 in the catchment areas of Indus basin like Chenab, Ravi, Sutlej, and Jhelum, caused flash flooding in Punjab, Gilgit Baltistan and Azad Jammu and Kashmir. In this flash flood 367 people were died, affected a large number of people approximately more than 2.5 million and 129,880 houses were damaged. More than one million acre agriculture land and 250,000 farmers were affected too. The living sources other than farming also affected including many industrial production and processing units and loss of earning sources were also caused due to disturbance of economy.

It is observed that recorded events in Asia proved that this region is under the influence of climate change and causes of catastrophic natural disasters because these extreme weather conditions have increased the frequency as well as intensity of such disastrous events and millions of people are suffering in the region.

RANK	DISASTER	DATE	COST	DEATHS
1	Flooding, India and Pakistan	9/2 - 9/15	\$18 billion	648
2	Cyclone Hudhud, India	10/12 - 10/14	\$11 billion	68
3	Typhoon Rammasun, China	7/15 - 7/20	\$7.2 billion	206
4	Winter Weather, Japan	2/8 - 2/16	\$5 billion	95
5	Drought, China	Summer	\$5.2 billion	0
6	Flooding, Serbia and Bosnia	5/13 - 5/21	\$4.5 billion	86
7	Drought, Brazil	Yearlong	\$4.3 billion	0
8	Severe Weather, Midwest, Rockies, NE U.S.	5/18 - 5/23	\$4 billion	0
9	Drought, Western U.S.	Yearlong	\$4 billion	0
10	Severe Weather, France, Germany, Belgium	6/8 - 6/10	\$4 billion	6
11	Typhoon Kalmaegi, Philippines, China, Vietnam	9/10 - 9/1	\$3 billion	31
12	Winter Weather, Eastern U.S.	1/5 - 1/8	\$3 billion	21
13	Hurricane Odile, Mexico	9/10 - 9/17	\$2.5 billion	5
14	Flooding, Midwest, Northeast, Mid-Atlantic U.S.	8/11 - 8/13	\$2 billion	1
15	Severe Weather, Midwest, Plains, Rockies U.S.	6/3 - 6/9	\$1.7 billion	3
16	Severe Weather, Central/Eastern U.S.	4/27 - 5/1	\$1.6 billion	39
17	Severe Weather, Plains, Midwest and SE U.S.	4/2 - 4/4	\$1.5 billion	0
18	Flooding, UK	12/23 - 3/1	\$1.5 billion	0
19	Flooding, China	9/10 - 9/17	\$1.4 billion	50
20	Flooding, China	7/13 - 7/18	\$1.25 billion	66
21	Severe Weather, Southwest, Rockies U.S.	9/27 - 9/30	\$1.25 billion	0
22	Severe Weather, Australia	11/27	\$1.25 billion	0
23	Flooding, China	5/24 - 5/28	\$1.2 billion	37
24	Cyclone Ita, Australia	4/10 - 4/14	\$1 billion	0
25	Severe Weather, Plains, Midwest, Southeast U.S.	4/12 - 4/14	\$1 billion	0

Source: Aon Benfield

Fig.7 Worldwide Billion Dollar Weather Disaster 2014 [18]

## B. Causes of Flooding in Pakistan

### 1) Natural Causes of floods

The main natural reason of floods is heavy rainfall that causes to raise the water level in the reservoirs and when this level goes up than the river bank or dam capacity, the water overflows out from banks and cause of flooding. The global warming is a hot issue these days as it causes to raise the temperature of environment and is going to higher side with each passing year. Due to this temperature change the ice on glaciers melt rapidly and add more water to the rivers and seas and finally cause of flooding. The coastal areas of sea come under floods due to the high tide storms and in result sea level is higher than coastal lowland that causes flooding.

### 2) Human causes of floods

Pakistan has forests over 2.5% of its land area and according to WWF, 2010 report Pakistan has the highest deforestation rate in Asia. Due to this environmental degradation Pakistan has faced extreme natural disasters in recent years such as consecutive floods observed in 2010 and 2011, and it is projected that such natural disasters will be more frequent in coming years.

Forests near the rivers have been cleared for settlements, roads and farmlands, so soil binding is not strict due to which erosion take place and more soil goes to rivers and seas quickly. This erosion increases the river bed and decrease holding capacity of rivers that causes flooding. Due to the silting, riverbed shallower and water volume increases in the river more than their holding capacity causes to overflow from its bank. The vegetation cover is damaged due to the deprived farming methods and caused washing of soil easily to the river systems. Being a populated country it is important to produce more food and income sources to fulfill

the basic human needs for which they grow many animals and to meet their feed requirements, the meadow is eaten away quickly and decreases the vegetation cover, and it reduces the binding of soil particles and erosion take place easily in such regions. As the living requirements of people increases, they need more, like wood, land and food that is a big cause of deforestation due to which soil erosion happen more frequently and it maximize the risk of flooding.

The nonstop use of land for agriculture crops cultivation purpose for a long era due to which the soil fertility decreases in contrast to the past and soil goes to the river systems; decrease their holding capacity and cause of flooding. Flooding is also caused by the breaches of dams and streams embankments because improper design and low quality material are used in construction phase and can easily collapse to flood the surrounded region.

The rapid and unplanned urbanization and industrialization causes to increase imperviousness of land and climate change respectively. The infiltrate of rains decreases due to the imperviousness of land and increases the runoff, the climate change, causes heavy rains and melting of glaciers due to these factors the water quantity load increases to the rivers and finally it causes flooding.

Immature politics is also another important human factor causes reoccurrence of floods which badly hurt the economy of a country. With respect to this topic there is a big dispute at Kalabagh Dam construction and politicians have no interest at this national issue to minimize the flood impacts as well as to overcome the energy crises in the country but their approach is just to keep their vote bank by holding a territory. It is a common opinion that in the best interest of Pakistan the construction of Kalabagh dam should have been complete 20 years ago but opponents has made it political issue with hidden motives.

There is a clear picture of some political statement in favor and opposition of Kalabagh dam like in 2004 General Pervaiz Musharraf announced that he would build the Kalabagh dam on priority basis in attention of Pakistan but in 2008 Raja Pervez Ashraf said that "Kalabagh Dam would not be constructed" because this project was opposed by Khyber Pakhtunkhwa, Sindh and some other stakeholder and finally construction of this dam was cancelled. But due to the catastrophic flood in 2010 the Prime Minister of Pakistan, Yousaf Raza Gilani said that the heavy damage in this flood can be minimized if the Kalabagh Dam were built. So we have to come out from such conflicts as soon as possible to avoid such dreadful floods in the future.

## III. GENERAL FLOOD MANAGEMENT AND RECOMMENDATIONS

By taking the important factors into consideration it clears, that floods are continuously occurring in Pakistan and deadly hurting its economy. The economy loss caused by disasters requires large amount of funds in the relief and rehabilitation process after disaster and rate of return in these disaster mitigation projects is higher than any other development project. The post disaster development projects must be incorporated with disaster evaluation and their vulnerability



reduction, are important components to assure the sustainability of such development projects.

There are two routes to mitigate the floods known as structural and non-structural, in structural mitigation route we try by keeping water away from people i.e “modifying the floods”, while in non-structural route we try to keep the people away from water i.e “modifying the losses due to floods”. Therefore, a model shift has now taken place from reactive to proactive i.e. preventive actions are better than corrective actions. Hence to avoid the flooding, steps were taken by the Government of Pakistan those can be briefly stated as:

After earthquake in 2005 Government of Pakistan established an authority for disaster management named as National Disaster Management Authority (NDMA). This authority fails to perform effectively and efficiently due to lack of expertise and technical knowledge regarding flood control. There is a vital need of hour to increase the capability of this authority by hiring expert and technically sound manpower along with the use of newer technologies.



Fig.8 Pakistani army helicopter hovers to rescue people from a flooded area on the outskirts of Islamabad [19],

In the history of Pakistan disaster management is mostly done by army, they can manage war and law and order well; they can be helpful in rescue, relief and recovery works. This misuse of army in disaster management working is a way to kept themselves away from their basic objectives and also put them under extra burden. The NDMA think that their responsibility is just to regulate the disasters and this concept is totally wrong, because any National disaster management authority is responsible to regulate, coordinate, train the manpower and develop the systems with latest technologies to avoid the disasters.

The disaster management is a multidimensional field and it requires sound scientific knowledge to do the job properly. Although army played an efficient and excellent role in all the nationwide disasters but on the other hand it shows flaws in NDMA, which has the responsibility to provide technological support and coordination with other administration agencies to control and avoid flood disasters.

NDMA fails to develop such a system by which this authority can handle the disasters at national level. The training of officials to deal with emergencies is an important factor to minimize the disaster losses. As floods are most frequently occurring disasters in Pakistan, it is more than important to do something extraordinary on urgent basis to avoid reoccurrence and to minimize its impacts. Natural

hazards cannot be fully controlled but their vulnerability can be reduced by proper planning and measures.

There is a need of hour to take concert and continuous steps to reduce the vulnerability of the public to flood disasters. After dreadful flood in 2010 NDMA is subdivided into small units at provincial and district level named as Provincial Disaster Management Authority (PDMA), District Disaster Management Authority (DDMA) to make it more efficient to control the disasters specially floods. The investment in Disaster Risk Reduction in Pakistan for flood forecasting after devastating flood in 2010, improved the forecasting and warning system and it helped a lot in flood 2014 as shown in below chart. The forecasted and actual discharges are nearly same at different sites as shown below in the figure so by using latest technology and models we can avoid the flood as well as minimize their dreadful impacts.

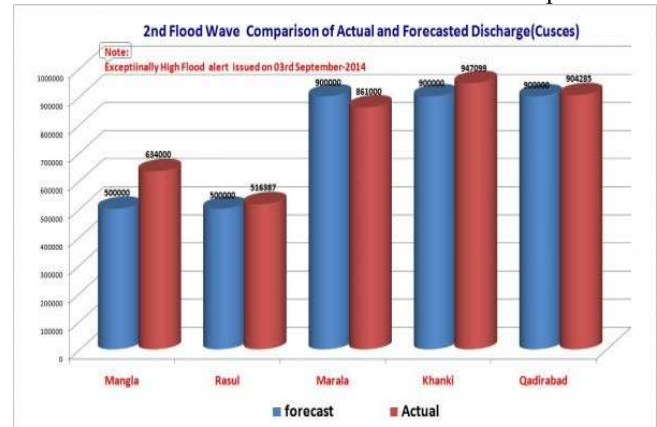


Fig. 10 Flood forecasting and comparison [21]

It is a good sign that all the concerned authorities are now taking keen steps towards flood control and management but these efforts must be continue to upgrade the existing systems as well to install new ones to avoid flood damages in the future. Other flood management organizations working in Pakistan include Department of Health (DoH), Pakistan Red Crescent Society (PRCS), World Health Organization (WHO) and United Nations Office for the Coordination of Humanitarian Affairs (OCHA).

The rehabilitation is an important step after flooding to settle the affected people in such a way to avoid flood damages in the coming years. Those people who have lost their belongings, livestock and crops, due to damage of school buildings and other infrastructures their children are unable to continue their education. There is a need of hour to construct homes on urgent basis by using resilience materials away from high flood plain zones alongside the steps must be taken to avoid the diseases that may spread after floods.



Fig.11 Bridge collapsed during flood 2010 [22]

It has become very important to construct houses with low cost alternative approach to fulfill the shelter requirements and household items for flood affected people. To come out from flood crises it is important to provide the above said requirements on priority basis to revive their lives straightaway after the water move away with minimum displacement, least live lost and livestock.

The floods heavily damage the infrastructure as in flood 2010 an estimation has been made that floods damaged the 2,433 miles (3,916 km) of highway and 3,508 miles (5,646 km) of railway track and it required 289 million USD for their repair and maintenance work. It is important responsibility of disaster management authorities to prepare a plan in advance for appropriate arrangements to minimize the flood impacts. Most commonly identified flood preparedness activities are as follows,

- To raise the community awareness on floods attentiveness, preparation, planning, scheduling, response and improvement measures.
- The basic need materials like food, fodder for livestock, emergency medicines, materials for temporary shelter etc. must be in stock for emergency relief work.
- For advance and effective flood warning system we should install newer systems to forecast and communicate with people.
- The management authorities are responsible to arrange the safe areas for temporary shelter in case of flood emergency and also to communicate with the community about those areas, to evacuate from the threatened places.

In future flood proofing, especially in medium and high flood plain zones the construction of buildings must be as per standard measures, use resilient fixtures and minimum freeboard above ground or predicted flood level to resist the flood impact to minimize the losses. It is relatively economical at design and construction stage by applying the precautionary principle and provision of freeboard and flood resistance and resilience in buildings. In development planning we should also keep management of surface run-on as part of the development drainage strategy and also improvements of watercourses, drains and sewerage networks to reduce the flood risks.

In flood preparedness there should be a clear agreement between all stakeholders such as government authorities, disaster management organizations, voluntary groups as well

as community members, on their roles and responsibilities. It is only possible by arranging meetings between all the teams at various levels to agree on set of standard operating procedures (SOPs) by defining what actions should be taken before, during and after floods.

There must be an effective coordination among disaster management authorities to ensure efficient and quick response during flooding and also urgent restoration of critical infrastructures to make things normal after floods. It is strongly recommended that Government of Pakistan should construct new dams as well as complete the ongoing projects as soon as possible.

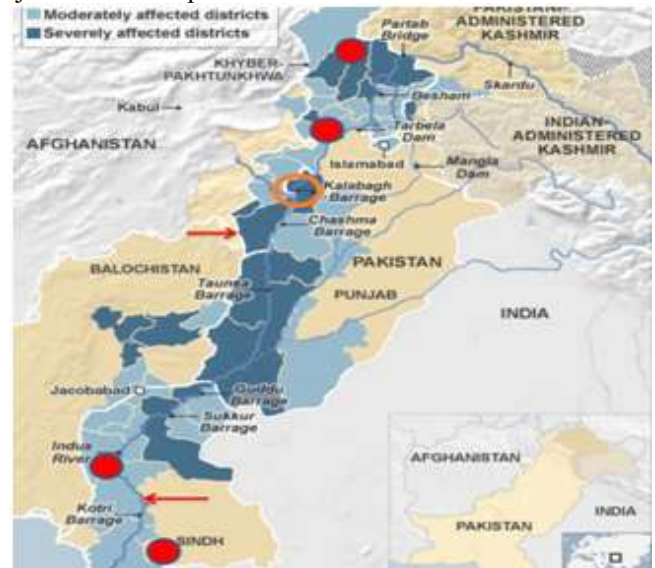


Fig.12 Indus River with major Barrages and Kala Bagh dam site encircled [23]

They must make a solid decision by taking all the political parties in confidence on Kalabagh Dam construction issue on priorities basis. Now a day's Pakistan is also suffering energy crises so it becomes more important to construct Kalabagh dam that can generate 3600 MW electricity.

The construction of this dam and other new dams will augment irrigation supplies, hydropower and alleviate floods and indirect benefits like more industrial and food production, employment and agricultural boost will accrue.

It is more important for economic growth of Pakistan to utilize the water available in Indus river form by constructing new dams and also by increasing the capacity of existing dams and barrages. It would be beneficial in two ways, as for irrigation purpose in the production of crops as well as to minimize the flood hazards happening almost every year and being an agriculture based country these steps are the only option to survive the economy of Pakistan.

## V. CONCLUSIONS

It is advised to focus on technical knowledge and practical expertise of the flood management authorities to avoid and also to minimize the dreadful impacts of flood by providing alternative solution to the current issues. This will reduce the money spent on governments and foreign experts and spend it in protecting vulnerable regions which were found abundant. Pakistan require the latest technologies in weather

forecasting, satellite imaging, Remote Sensing (RS), Geographical Information System (GIS) and should use the Markov Decision-making process, a mathematical structure for modeling decision-making processes and that is an alternative approach to measure point of departure by using historical data, current data and on the basis of data calculate short-term expectations. The flood damages assessment and their extent during the events and used as the main input to assess the damages with the help of GIS analysis tools. The information derived was very essential and valuable for immediate response and rehabilitation. [24].

Pakistan is an agriculture based country so water is a basic need to grow crops and it's important to store the water in dams and barrages in rainy season and used to produce electricity, irrigation purposes as well as it will also minimize the frequency and intensity of floods that are continuously happening almost every year in the country. Construction of new dams is the need of hour so keeping all political conflicts aside the Government should have to unite the all concerned parties on this issue.

Pakistan is 6th populated country in the world and it is a driver to land pressure which most consequently results in the environmental disasters and also encroachment on the fragile ecosystems. Therefore, population control should be taken seriously and controlled as a critical intervention if the proposed restoration activities have to make successful in Pakistan. The settling of people in the floodplain results in a serious damage during the flood season. People living in floodplains are poor and they do not have enough sources to shift their homes to any other alternative place away from floodplains. They came and settled here in search of economic benefits as their source of income depends upon the agriculture and fishing in the river. It is responsibility of the government to provide them alternative places to resettle and also give them maps of floodplains so the people can keep themselves away from those areas by taking legal measures or alertness program. [25].

The plants and vegetation helps to bind the soil structure as well as to minimize the impact of flood by taking water for their growth and retaining the rain water for a while to avoid the sudden flow of water from river basin catchment areas. Forests are a key source of biodiversity, and controlling the negative impacts of climate change helps protect their livelihood and reduce flood damage [26].

The rapid and unplanned urbanization causes to increase imperviousness of land due to construction of buildings, roads and other infrastructures. So the imperviousness of soil increases as compare to the natural groundcover so the runoff increases because rain infiltrates quantity decreases and finally it causes to add more quantity of water to rivers and other streams. In the extremely urbanized areas approximately more than one half of rain directly goes as surface runoff so this increment in runoff needs additional infrastructures to reduce the flooding. It came to observations that the frequency and intensity of flooding, waterway erosion, and devastation of aquatic habitat normally caused due to the unplanned urbanization. The industrialization is another big cause in climate change that disturbs the water cycle due to which large numbers of disasters are happening in recent years.

The unplanned urbanization and industrialization is a big concern and it is the responsibility of related authorities to plan, monitor and control the urbanization as per standards to minimize the impacts of flooding for economic growth of the country.

## REFERENCES

- [1] World Disaster Report by the International Federation of Red Cross and Red Crescent Societies, ISBN 92-9139-092-5.
- [2] Muhammad Atiq Ur Rehman Tariq, Nick van de Giesen "Floods and flood management in Pakistan" *Physics and Chemistry of the Earth* 47-48 (2012) 11-20
- [3] S. N. Jonkman "Methods for the estimation of loss of life due to floods: a literature review and a proposal for a new method" *Nat Hazards* (2008) 46:353-389.
- [4] Report of Centre for Research on the Epidemiology of Disasters [http://www.cred.be/sites/default/files/ADSR\\_2012.pdf](http://www.cred.be/sites/default/files/ADSR_2012.pdf).
- [5] Bernhofer, C., J. Franke, V. Goldberg, J. Seegert and W. Kuchler, 2006 "Regional climate change: To be included in future flood risk analysis" *Earth Environ. Sci.*, 67(2): 91-100.
- [6] Atta-ur-Rahman and A.N. Khan, 2011a. "Analysis of flood causes and associated socio-economic damages in the Hindukush region" *Nat. Hazards.*, 59(3): 1239-1260.
- [7] Figure: 1 source <http://pakistangeographic.com/rivers.html>.
- [8] Hashmi, H.N., Q.T.M. Siddiqui, A.R. Ghumman, M.A. Kamal and H.R. Mughal, 2012a. "A critical analysis of 2010 floods in Pakistan" *Afr. J. Agric. Res.*, 7(7): 1054-1067.
- [9] Figure: 2 source <http://geographyheroes.com.tr/2010/09/Pakistan-flood-crisis.html>.
- [10] Hashmi, H.N., Q.T.M. Siddiqui, M.A. Kamal, H.R. Mughal and A.R. Ghumman, 2012b. "Assessment of inundation extent for flash flood management" *Afr. J. Agric. Res.*, 7(8): 1346-1357.
- [11] Report by Government of Pakistan Ministry of Water and Power Federal Flood Commission (FFC) "Annual Flood Report 2010".
- [12] Dorosh, P., S. Malik and M. Krausova, 2010. IFPRI, Rehabilitating Agriculture and Promoting Food Security following the 2010 Pakistan Floods Insights from South Asian Experience. IFPRI Discussion Paper, World Bank/International Food Policy Research Institute, Washington, DC, pp: 26.
- [13] Figure: 3 source <http://zaraimedia.com/2014/09/25/floods-inflct-rs-240-billion-loss-on-frail-agriculture-economy/>.
- [14] Figure: 4 source "Tariq and Van de Giesen, 2011"
- [15] Figure: 5 source "Federal Flood Commission and National Disaster Management Authority".
- [16] Table: 1 sources <http://www.ndma.gov.pk>, [www.emdat.be](http://www.emdat.be).
- [17] Figure: 6 Hashim Nisar Hashmi, Qazi Tallat Mahmood Siddiqui, Abdul Razzaq Ghumman, Mumtaz Ahmed Kamal and Habib ur Rehman Mughal "A critical analysis of 2010 floods in Pakistan" *African Journal of Agricultural Research* Vol. 7(7), pp. 1054-1067, 19 February, 2012.
- [18] Figure: 7 source "Weather Underground Billion Dollar Weather Disasters 2014".
- [19] Figure: 8 source "Report of WHO Flood Emergency Pakistan".
- [20] Figure: 10 source "Flood Forecasting Division of Pakistan Meteorological Department"
- [21] Figure: 11 source [http://en.wikipedia.org/wiki/2010\\_Pakistan\\_floods](http://en.wikipedia.org/wiki/2010_Pakistan_floods)
- [22] Figure: 12 source [http://www.idrc.ca/EN/Programs/Agriculture\\_and\\_the\\_Environment/Climate\\_Change\\_and\\_Water/Pages/ArticleDetails.aspx?PublicationID=1078](http://www.idrc.ca/EN/Programs/Agriculture_and_the_Environment/Climate_Change_and_Water/Pages/ArticleDetails.aspx?PublicationID=1078).
- [23] Mateeul Haq., 2012. Techniques of Remote Sensing and GIS for flood monitoring and damage assessment: A case study of Sindh province, Pakistan, *The Egyptian Journal of Remote Sensing and Space Sciences* (2012) 15, 135-141.
- [24] Zubair Ahmed., 2013. Disaster risks and disaster management policies and practices in Pakistan: A critical analysis of Disaster Management Act 2010 of Pakistan, *International Journal of Disaster Risk Reduction* 4(2013)15-20.
- [25] Khalid Ahmed., 2014. The linkages between deforestation, energy and growth for environmental degradation in Pakistan, *Ecological Indicators* 49 (2015) 95-10.



**First Author:** Muhammad Yaqub is a student at Sakarya University in Environmental engineering department as a master's degree student; He was born on 10 March 1983 in Toba Tek Singh, Punjab, Pakistan. He studied chemical engineering at the Institute of Chemical Engineering and Technology University of the Punjab, Lahore, Pakistan. He joined Sakarya University since 2013.

**Second Author:** Dr. Beytullah EREN is an Assistant Professor in the Department of Environmental Engineering at Sakarya University where he has been a faculty member since 2005. He received a B.S. degree in Environmental Engineering at 2004 and Industrial Engineering at 2005. He has graduate with PhD from the University of Sakarya at 2012. His research interest are wastewater engineering, mathematical and computer modeling of environmental system, artificial neural network modeling. He has published many works in different fields of environmental engineering.

**Third Author:** Dr. Emrah Dogan is an Associate Professor in the Department of Civil Engineering at Sakarya University. He received a B.S. degree in Civil Engineering at 2001. He has graduate with PhD from the University of Sakarya at 2008. He has published many works in different fields of civil engineering.