

## **Catastrophic Effects of Floods on Environment and Health: Evidence from Pakistan**

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### **ABSTRACT**

Torrential rains and floods have been causing irreplaceable losses to both human lives and environment in Pakistan. This loss has reached to an extent of massively aggrieved situation to reinstate life at operationally viable position. This paper unfolds the notion that only constructive paradigm shift to overcome this phenomenon is vital as a strategy. Multiple levels of observations and on-site assessment of various calamity-prone venues were considered to probe into this scenario. Some of the grave site in Sindh and Punjab were observed and necessarily practicable measures were recommended to avoid loss to human health and environment. The paper finds that a consistent drastic management authority on national level with appropriate caliber and forecasting expertise can reduce the damage to human life and environment to great extent. Weather forecasting system need to be installed at many appropriately observed cities and towns in the country with adequate man power, funds and technical recourses. By implementing the proper frame work of prevention and mitigation of floods country can save the major costs cleanup and recovery. These measures are expected to reduce operational cost of state in terms of GDP and GNP to restore life and environment.

**Keywords:** Floods, Causes, Impacts, Health, Environment, Disaster

### **1. INTRODUCTION**

Due to environmental change, floods are perceived as the most successive and destroying sort of common calamity in the world. The quantity of worldwide floods occasions multiplied from 2001 to 2010. Pakistan regularly encounters characteristic catastrophes, of which flooding is the most serious. Indus River Basin, the most expansive stream in Pakistan stretches around 2682 km from northern to southern part of country (Ali, 2013). Environmental change brought plenty of rainfall resulting storms floods to both Northern (Punjab) and southern (Sindh) Pakistan.

Floods are known to cause overwhelming physical harms initially, yet as floodwaters retreat there are more dangers to individual wellbeing and health. Pakistan's Flood emergency is having a tremendous effect on the wellbeing of a great many individuals and the capacity to convey crisis and routine social health care to numerous population (Jongman, 2015).Floods are connected with an expanded danger for diarrheal diseases. Some studies have demonstrated this impact that diarrheal infections can increase in weeks or months after floods both in Developed and Developing countries.

Three key elements would evaluate the strength and intensity of future floods in the Indus River region are intrusion in river's regime and environmental change and deforestation in watershed regions and flood fields. The Indus River basin will stay under the enduring hazard of calamities, if these major issues are not addressed on urgent basis (Akhtar, 2011). The eccentricities of climate are a trait of environmental change. Considering that the issue has no confined arrangements, adjustment is the main alternative. Changes in flood plains through climatically under designing works have presented an irreversible contortion in the river administration.

Pakistan is one of the five South Asian nations with the most astounding number of people exposed to floods, which happen ordinarily because of storm frameworks that begin from Bay of Bengal amid the rainstorm from July to September (Shrestha, 2008). The mountain extends in the compelling north of Pakistan give a lasting wellspring of inflow into the streams. Pakistan has 79 meteorological stations located in different areas but still every year reoccurring floods indicate the lack of integration of forecast and implementation.

## **2. LITERATURE REVIEW**

### **Pakistan Flood History**

Amid the most recent 66 years, the floods have influenced 599,459 square kilometers of land, asserted 11,239 lives, brought about misfortunes worth over PKR 39 billion to the national economy and left 180,234 towns immersed. According to Asian Development bank, during the year 1950 to 2011 Pakistan has experienced 21 floods that have an estimated economic damage of \$19 billion and since last three consecutive year (2011-13) Pakistan witness two more floods summing up to this loss more (Ali, 2013).

In recent years floods have imposed significant loss to the nation. The areas influenced by floods were reliably lingering behind socially and economically then the other areas. Flood standout amongst the most dramatic, dangerous and immoderate danger in the physical environment that compasses away the work of numerous years. Since 2010 floods has become one of the most occurring catastrophe that is keep on re-occurring every year in most of the areas in Sindh and Punjab. The floodwater vanquished at many places and brought on overpowering damages to agricultural land irrigation system, infrastructure drains, environment and above all human lives.

**Table I.***History of floods in Pakistan*

<i>Year</i>	<i>Cause</i>	<i>Area Affected</i>	<i>Life affected</i>	<i>Economic Damages</i>
1955	Rainfall	Punjab		
1973	Rainfall	Punjab	474 Perished	\$2.39 Billion
1976	Rainfall	Punjab / Sindh	425 Died/1.7 million affected	\$1.62 Billion
1988	Rainfall	Punjab	500 Died	\$400 Million
1992	Rainfall	Punjab/ Sindh	1000 Died, 4.8 million affected	\$14 Billion
1994	Rainfall	Punjab/Sindh	386 Died	
2005-2006	Rainfall	Punjab	591 Died	
2010	Rainfall	Punjab/Sindh/ KPK	1985 Died, affected 21 million	\$10 Billion
2011	Rainfall	Punjab/Sindh	516 Died	\$3 Dillion
2012	Rainfall	Punjab/Sindh	571 Died	

Source: National Disaster management Authority

### **Causes of floods**

In Pakistan floods are frequently activated by Indus River. The Indus River is a major trans-limit waterway in Asia with nine tributaries. Its five tributaries on the left bank are the Beas, Chenab, Jhelum, Ravi, and Sutlej streams. The primary right bank tributaries are the Gomal, Kabul, Swat and Kurram streams. The Indus River is around 2,800 kilometers (km) long, with 2,682 km of it extended in the middle of northern and southern restrictions Pakistan. Its alluvial plain zone is around 207,200 km, while its deltaic region is about 20,000 km. It begins in the Tibetan tableland at Singi Kahad spring, on Kailas Parbat (mountain) close Mansarwar Lake. It then passes through the Himalayan range, and gathers spillover from the Hindu Kush and Suleiman ranges (Memon, 2012).

According to the Intergovernmental Panel on Climate Change (IPCC) with the increase in global temperature the rainfall pattern will also change and increase. The increment in precipitation level and changes in precipitation pattern may further expand the recurrence of force of floods in the Himalayan–Hindu Kush region, of which the Indus Basin is a part. Avalanche and debris stream have brought about eight Floods in the Indus Basin, and all the more downstream flooding is anticipated because of the undeniably variable precipitation and overflow. The Himalayan and downstream waterway bowls are liable to face more floods.

If we look into the history of floods the cause of floods in Pakistan is always been extraordinary torrential rain. Flash floods are the result of precipitations that lead to flood wave development. The overwhelming precipitation in the Hindu-Kush and Karakoram Mountain goes additionally quickened the glacier melt and their consolidated impact brought about uncommon floodwater in the Indus River. Pakistan's once incredibly generally overseen watershed instrument is presently in vestiges. Uncontrolled deforestation in the fields of Sindh and Punjab has denied the rivers of its wave-engrossing shield. Pakistan is among those nations that have the least levels of forest spread. As indicated by a few gauges,

the nation loses about 66,718 sections of land of forest cover every year. Pretty nearly 5,683 acres of land of riverside forest is lost consistently (Memon, 2012).

In a study conducted by Jonkman (2005) it was identified that in Asia during the period of 1975 to 2001, 21 out of 30 disasters that affected the human life in general were floods, Although it was concluded that the average mortality rate due to floods is relatively lower than other catastrophes but epidemic outrage after that is much worsen against any other disaster.

Memon (2012) indicated the cautious survey of the impacts floods uncovers that this debacle was not only a regular cataclysm, additionally the consequence of terrible administrative engineering, poor flood administration procedures and disintegrating institutional frameworks. There is probably the Irrigation Division tried to deal with the surge however the methodology was reactionary, instead of being preventive.

Shreshta (2008) examined the flood history of south Asia and found that during the period of 30 years (1976–2005) Pakistan is the third most flood affected country after India and Bangladesh with 12.3% events reported from Pakistan with the dead toll of 7505 people and economic loss of \$ 1843230. Rasool (2012) after studying the data of 56 metrological stations concluded that these massive floods are caused mainly due to the heavy precipitation in limited time period, this thus trigger the gigantic water flow from northern region accelerated by gravity towards the southern region which is further strengthen by the rainfall in southern region.

### **3. IMPACT OF FLOODS ON HEALTH AND ENVIRONMENT**

According to Pakistan disaster knowledge network, flood occasions of 1950, 1992, 1998, 2010 and 2011 brought about numerous deaths and tremendous misfortunes to the national economy. As per authority sources, floods in Pakistan amid the decade 1991 to 2001 created an expected harm of over Pak Rs 78,000 million to property.

Akhtar (2011) established the relationship between flood damages and south Asia monsoon in Indus river basin. Floods appeared to be influencing approximately around 75 million people with mortality rate 20,000 people/year. Many flood dangers were confronted by Pakistan occasionally. The floods for 2010 might have been the most exceedingly bad flood catastrophe in the history of Pakistan.

#### ***Health Impacts***

According to the report published by United Nations Development Program Bureau for Crisis Prevention and Recovery (UNDP-BCPR) Pakistan is the fourth vulnerable to the floods related disaster in South Asia. The ranking is done on the basis of disaster risk index (DRI) which is based of mortality based index and exposure of people to the hazardous situation in particular country. Flood also caused sever infrastructure damage. During 2010-2011 floods 515 health facilities were damaged. And around 35000 health worker were displaced. Around \$50 million worth of damages were calculated.

In the areas affected by floods many epidemic disease out break is common, According to Annual report of UNICEF( 2014) after 2012 floods around 200,000 measles vaccines have been provided to the affected area and still according to report of WHO (2013) , 8046 cases of measles were reported from

Pakistan in 2012. Furthermore report summarizes around 480,000 children were treated for severe diarrhea, pneumonia and acute respiratory infections. Also 77000 children were diagnosed with malnutrition in affected area.

Shabir (2013) discussed in his paper that the most pervasive transferrable diseases in Pakistan are intense respiratory contamination, diarrhea, polio, tuberculosis, hepatitis B and C, measles and vector-borne malady including malaria, Leishmaniasis and hemorrhagic fever (CCHF). The pervasiveness of intestinal sickness is more prominent in the ruler part of country. Only in flood affected area in 2010 to 2011 the total medical consultancies were about 37.36 millions. The most widely recognized ailments included: intense respiratory contamination (23%), skin illnesses (11%), diarrhea (9%) and malaria (6%) Pakistan has an endemic issue with tuberculosis (297,000 cases reported in 2008) and polio.

Nishtar (2007) discussed that the Burden of diseases carried by Communicable Diseases is the most prominent of all the other type of disease are more than any other type. Communicable diseases contribute 38.4% of total death daily in Pakistan. And communicable diseases are most likely to affect the flood stricken areas. Diarrheal deaths represented 43.3% of all post-neonatal deaths among children of years and under. An expected 10-11% of the aggregate populace of children under five are influenced by the floods (i.e., roughly 2.4-2.8 million youngsters under five years "influenced" and 1.2-1.4 million "extremely influenced"). The floods could possibly have a critical effect on waste and so on children health in both the short- and long haul. Evaluation reports of Health Cluster bulletin propose an increment in squandering among some flood influenced populaces of kids.

The predominance of Malaria is measured through the Annual Parasite Incidence (API)/1000 individuals/year. In 1990 the API was 1/1,000 and the target set for the MDG target was to decrease this by 75%, i.e., 0.25/1,000. The Floods have a profound effect on Malaria hazard and require fitting preventive and therapeutic measures to be set up. Taking into account the yearly affirmed cases in 2010, it is assessed that the Annual Parasite Incidence (API) rate was as high as 1 million cases (UNICEF, 2014).

UNICEF (2013) annual report conclude that in Pakistan 100-150 kids pass on consistently as a consequence of diarrheal-related illnesses. Many of these deaths can be anticipated by sufficient sanitation, safe drinking water and enhanced cleanliness. Somewhere around 60 and 75 million individuals are influenced by diarrheal-related sicknesses yearly and 60% of children deaths are because of water- and sanitation-related sicknesses. Therefore, the floods gravely focused on food security also expanded under-sustenance, a condition that additionally increases vulnerability to diseases. UNICEF reported that six months after the flood 2010, 22% of children in Sindh were all the while experiencing intense malnutrition.

### ***Environment Impacts***

In light of information accumulated from a forest loss in a chose number of areas, the net change in forest cover because of floods is evaluated as 11.2% of the aggregate forest cover in the entire geological region of Pakistan. This is 0.56% of the area range as contrasted with the pre-flood forest spread of 5.02%.

Floods also have adverse impact on wildlife. Damages caused to forest have impact on inhabitant living there. According to Punjab wildlife department floods of 2010 have affected 25% of Hog deer population. Also, the floods have potential genuine dangers for the Indus dolphin endangered specie). Indus River and their tributaries give essential arranging and encouraging grounds to a huge number of transient waterfowl and other water birds (Khan, 2010). These essential natural surroundings have been severely harmed by filling floods likewise washing out of indigenous fish fauna from Indus River would likewise cause negative impact on the number of inhabitants in transitory waterfowl and water birds.

The prime river damage caused by river flooding along the banks are outpouring and damaging the irrigation and agricultural facilities. It also erodes the land along the river banks and displaces the communities along them. The insufficient drainage capacity of some of critical structure like Barrage and rail or road bridges on rivers are another significant reason of flooding. Vulnerabilities of extensive urban communities to flooding have expanded because of insufficient drainage framework to adapt to heavy downpour ( Balaji, 2015). Especially in recent past urban communities like Karachi, Lahore and Rawalpindi have encountered flooding due to storm water drainage issue.

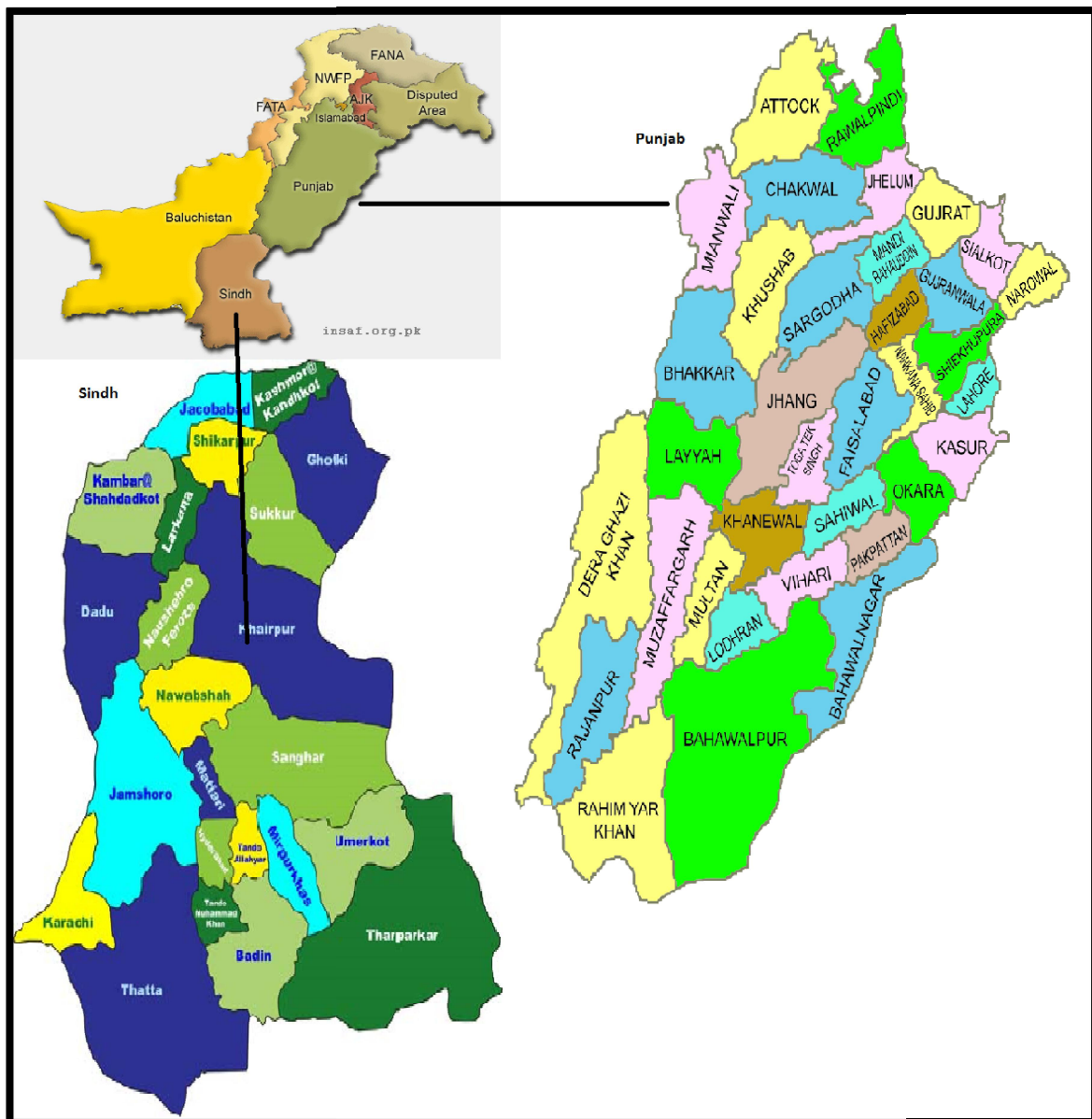
Another important environmental damage that flood caused is exposed soil and slitting up of agricultural land. The floods has washed tremendous territory, and has brought with it gigantic amount of sand and sediment. The soil exposed will be inclined to disintegration later on and will increase siltation of streams and waterways with heavy rains. The floods, in a few regions, influenced petrol pumps. Floods not only damage the infrastructure but also the spills of petroleum product are very common in flood affected areas. In a study conducted by Khan (2010) it was concluded that average petroleum product spill is around 8800 liters/pump in flood impacted area.

Pakistan Economic Survey (2011-2012) summarizes that the 2011 Floods have not only effectively affected a huge number of individuals but also harm forest, physical infrastructure, nurseries and social legacy destinations. Only for floods of 2011 these harms have been assessed to be Rs. 2,762.66 million (Us\$ 31.75 million). Also approximately 10-15% of population who were based on fishing industries was also affected. Also in major part of Sindh has been generally influenced in the Shaheed Benazirabad, Badin, Sanghar and Mirpurkhas areas likewise were worst hit in terms of water supply and sanitation sector.

## 4. METHODOLOGY

### Study areas

Fig. 1 shows the geographic location of two under study provinces Sindh and Punjab. The similarity of both the provinces is that they are sharing the Indus river basin. Sindh is located between 23° -35° and 28°-30°, north latitude and 66°-42' and 71°-1' degrees east longitude. It covers 140,915 square kms with an average temperature of 33.2°C in summers and 17.5°C in winter and an average annual rain fall of 160 mm. Punjab is located between 32° -0', north latitude and 72°-30' degrees east longitude. It covers 205,344 square kms with an average temperature of 43°C in summers and 4°C in winter and an average annual rain fall of 460-960 mm.



Source: www.pakvisit.com

Figure 1: Study Areas

### Data collection and Management:

The initial stage was a study of adult inhabitants of Sindh and Punjab confronted floods in their general vicinity in 2010, 2011 and 2013.

The second phase of the exploration included directing an open meeting. An exploratory study utilizing qualitative methodology was likewise directed where respondents were questioned. Amid the meeting session the people were asked to impart their encounters regarding the floods and review everything that they had experienced and they had seen befalling them.

Yearly disease data for decade (2002-2012) is obtained from World health organization data base. Also the data of mega floods of 2010 and 2011 is taken from National disaster management authority reports. Data of floods and rainfall is obtained by reports of Pakistan Meteorological department and Pakistan disaster management authority data base.

### Data Analysis

Descriptive Statistical analysis was performed on Yearly Diseases Data, total affected and death data by using Statistical Package for Social Sciences (SPSS) version 16 in order to interpret key findings and results. Also Microsoft Excel 2007 was used to compile and evaluate the comparative analysis of damages of floods 2010 and 2011.

## 5. RESULTS

**Table 1:** *Yearly Reported data of incident of Disease in Pakistan*

Year	Cholera	Malaria	Measles	TB
2012	144	290781	2.6	273097
2011	11489	334589	4386	270394
2010	164	240591	4321	269290
2009	0	167579	441	267451
2008	0	104454	53	248115
2007	0	128570	2801	234100
2006	0	124910	7641	170334
2005	0	127826	2981	131939
2004	0	126719	4248	25876
2003	0	125152	4740	53531
2002	0	107666	3903	30217
2001	0	125292	3849	9204
2000	1293	82526	2064	19918
1999	1293	91774	2940	58424

Source: World Health Organization (WHO) Data Base



**Table 2:** *Frequency table for all four communicable diseases*

Statistics		Reported Cases of Cholera	Reported Cases of Malaria	Reported Cases of Measles	Reported Cases of Tuberculosis
N	Valid	14	14	14	14
	Missing	0	0	0	0
Mean		1027.3571	155602.0714	3169.3286	147277.8571
Std. Deviation		3045.95537	77025.84011	2076.64997	1.10662E5
Minimum		.00	82526.00	2.60	9204.00
Maximum		11489.00	334589.00	7641.00	273097.00

**Table 3:** *Table of losses due to catastrophic disasters in Pakistan*

Comparison of losses and damages caused by floods and all other disaster in Pakistan								
Year	Frequency		Deaths		People Affected		Damage	
	Flood	Other Disaster	Flood	Other Disaster	Flood	Other Disaster	Flood	Other Disaster
2010-11	4.00	8.00	2,113.00	2,118.00	20.35 million	20.36mil lion	\$9.5 billion	\$9.58 billion
2000-09	33.00	68.00	2,265.00	77,282.00	9.56milli on	14.57 million	\$0.7 billion	\$7.78 billion
1990-99	14.00	44.00	4,180.00	6,654.00	15.18 million	17.9 million	\$1.09 billion	\$1.36 billion
1980-89	7.00	20.00	519.00	1,074.00	302,900.0 0	0.31 million	-	\$5 million
1970-79	5.00	8.00	2,066.00	6,850.00	13.38 million	13.4 million	\$1.17 billion	\$1.17 billion
1960-69	2.00	5.00	32.00	10,519.00	224,427.0 0	0.62 million	\$3.3billio n	\$7.4 million

**Table 4:** Comparison of Mean and Standard Deviation of casualties due to flood and other disasters

Descriptive Statistics			
	Mean	Std. Deviation	N
Death due to other Disasters	15478.1429	27440.25831	7
Death due to Flood	3720.1429	5094.56984	7

**Table 5:** Damages detail of 2010-2011 floods

Sector- wise Details of Damage of Floods in 2010/2011		
Sector	Cost (US\$) Millions	
	2010	2011
Housing	1588	982
Education	311	138
Health	50	14
communication	1382	304
Water & sanitation	109	14
Energy	309	14
Irrigation	278	55
Agriculture & livestock	5100	1840
Private sector & Financial Sector	783	313
Government & environment	62	51.53

Source: Pakistan economic survey (2010-2011)

## 6. DISCUSSION

The results and data show significant evidences of floods affecting the health and environment of country. Table 1 summaries the last 14 years data obtained by world health organization (WHO) record book, which shows the during the flooded years especially 2005,2006,2010,2011 and 2012 epidemic disease like Cholera , Malaria , Measles and tuberculoses incident rate increased. Also reports from government agencies from influenced areas demonstrate an expanding number of instances of water-borne ailments contracted through immediate contact with dirtied waters and vectors and expanded quantities of intense respiratory diseases. Another main issue of flood effected area is the stagnant water after flood waves passes which provides the perfect breeding ground for parasites of malaria, whereas The non-accessibility of safe drinking water and harm to sanitation framework is creating skin issues and

contaminations, particularly among ladies and kids, too as intense loose bowels and other water-borne ailment. Stagnant water where individuals live stays in all territories, bringing on a potential general wellbeing risk.

Table 2 shows the clearer picture of on average in last 14 years malaria incident per year is about to be 155,602 people which is way too high. Pakistan is off-track to meet the anticipated Millennium development Goal (MDG), which targets 67% people should have enhanced sanitation. Access changes generally the nation over urban and rural areas. Only 48% of the populace has entry to enhanced sanitation (UNICEF, 2013). And if situation persist than future floods will again have same mega effects on population health. This re-enforce the significance of a successful and appropriate development in flood warning framework to permit residents enough time to evacuate. The NDMA surrenders that the current early cautioning framework in Pakistan is of constrained nature and can give an estimate upto 3-4 days;. Further venture is required in upgrading early warning frameworks through the utilization of cutting edge innovation for building up a more extensive framework for checking and documenting information. More, infrastructural speculation is required in growing more effective channels for scattering notices to powerless groups (Rashid, 2011).

Table 3 and 4 provides the comparative analysis of causalities and people affected since 1960 till 2011 due to floods against all other natural disasters. It can be interpreted from the data that flood is most reoccurring disaster in Pakistan and almost in all separate decade we have faced couple of floods, death toll of floods is itself around 13% as compare to any other disaster. In terms of people affected flood is the most prominent than all, whereas in raising death toll flood comes after earthquakes. In economic reference again floods are the most damaging to our economy. Asian development bank assessed the disaster cost of 2010 floods only to be around 5.8% of GDP. Pakistan endures a loss of 8.84 percent of its GDP every year from environment-related ailment. Just about 50% of this expense is created by mortality while the rest stems from the lack of healthy sustenance brought about by environment-related ailment (Pakistan Economic Survey, 2010-2011). Almost 90% of typhoid and diarrheal disease in Pakistan is attributable to insufficient drinking water, sanitation and cleanliness.

Table 4 indicates the comparison of two consecutive flood hit year damages. Pakistan when still in phase of recovery of previous floods again stuck with the catastrophe. At first the elected and common governments reacted to the catastrophe through own assets, in spite of giving support amid the uncommon surges of 2010, the worldwide group instantly reacted to the claim by the Government of Pakistan for worldwide backing for salvage and relive campaigns emulating 2011 floods. Incomparable damage was caused to housing, livestock, health facilities, communication and electrical networks, power plants and grids, irrigation channels and land.

## **7. RECOMMENDATION**

There are many steps that are to be taken in order to lessen the effects of global temperature rise, climate change and precipitation changes on both governmental and community level. In Pakistan there are so many national and international institutions and organization that are involved in flood relive programs once it hit but none of them have clear national policy with them so what is recommended most is:

1. A Nationwide flood risk adaptation and mitigation policy should be devised and implemented.
2. Flood resilient infrastructure should be built on flood prone regions.
3. Poor drainage system which is one of the main reasons behind many diseases should be redesigned and proper investment should be done on this sector.
4. An appropriate flood policy focusing on all aspects of health and environment should be practiced.
5. Early disease response and early flood warning system should be re-enforced for proper effectiveness and results.
6. Institutional and technological reforms are prime need of time, reoccurrence of floods from time to time also explain the weakness of our warning and precipitation forecast system therefore the prediction facility should be expanded along the Indus river basin.

## **8. CONCLUSION**

The flood had a serious effect on individuals' homes, lives and resources. The vast majority don't yet know when they will have the capacity to return home and resume their employments after the consecutive years of flooding in their areas. The flood circumstance is as of now developing and there is the prospect that more regions will be influenced in coming years due to same catastrophe. Therefore early recovery exercises must be devised and executed. Pakistan should likewise enhance responsiveness towards already affected population and strategy for future. It should first develop national limits and create particular alternate arrangements for regions at danger. Since for floods, the NDMA has created a Strategic Arranging Unit (SPU). Building the large reservoirs is now unavoidable and policy makers should take some serious measures in this direction. Similarly setting a long term goal and involvement of all stake holders is inevitable.

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