

Research Article

Historical Analysis of Flood Information and Impacts Assessment and Associated Response in Pakistan (1947-2011)

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Abstract: The present research is an attempt to present a brief historical analysis of dreadful impacts of floods caused by enormous floods frequently occurring in Pakistan most of which resulted in serious monetary damage and fatalities. The study also examines the extent of previous work done in this field. The aftermaths of severe floods in all over the Pakistan on different aspects were assessed quantitatively of last 65 years (1947-2011) by extensive and thorough review of valid literature. Since its creation, Pakistan has faced about 38 floods of various magnitudes among of which about 50% were considered major floods including 1950, 1955, 1956, 1957, 1958, 1973, 1975, 1976, 1977, 1978, 1982, 1988, 1992, 1994, 1995, 1997, 2001, 2003, 2005, 2006, 2007, 2010 and now 2011. This is first time that an attempt has been made to determine comprehensive details of impacts of floods in Pakistan throughout of its history. Recommendations have been made to ensure adequate and detailed availability of flooding event and to prevent huge damages in the future.

Keywords: Historical analysis, impacts, literature, Pakistan, work

INTRODUCTION

Floods defined as "inundation of an area adjacent to a river or lake, which causes material loss, adversely affects human health, or results in people dead. Inundation of an area, which does not cause serious damage, is associated with the water level rise in a river or lake" (Dobrovolskii and Istomina, 2009) are among the most damaging natural hazards in the world, affecting more lives and resulting in more property damage than any other disaster (Brasdil *et al.*, 2006; Ghoneim and Foody, 2011) and one of the most threatening natural hazards for the human societies (Schanze, 2006). Floods and other climate related natural disasters have been increasing not only by repeated damage but also by the intensity and frequency (Bernhofer *et al.*, 2006).

Pakistan is one of the most vulnerable countries to natural hazards worldwide (Ahmad *et al.*, 2011) and is exposed to several hazards such as floods, earthquake, landslides and droughts, but floods has been most common issue causing immense damages to lives and properties (Atta-ur-Rahman and Khan, 2011a; Atta-ur-Rahman *et al.*, 2011b).

Pakistan has varying geography with Northern alpine enclosed with glaciers and Southern plains along with the Arabian Sea. The five major rivers Indus and its tributaries, Jhelum, Chenab, Sutlej and Ravi are flowing through in Pakistan from south to north parts (Hashmi *et al.*, 2012a).

The frequency of damages of urban flood is increasing with the investment and growth in urban areas. Flash floods that happen in natural stream as a consequence of localized extreme rains in hills and semi hilly areas have really shown their potential of damage in the few previous years in the Pakistan (Hashmi *et al.*, 2012b).

The chief cause of continuity of floods in Pakistan is heavy intense rainfall in the river catchments that is occasionally increased by the snowmelt flows that final result into floods particularly in the season of monsoon. Sporadically monsoon currents initiating in the Bay of Bengal result in destructive and harsh floods in some or mostly all the river of Indus system (FFC, 2010; Hashmi *et al.*, 2012a).

Soon after its creation in the 1947, Pakistan realized the need for having an early flood warning and forecasting systems due to continuous floods in the country. An entirely fledged Flood Forecasting System (FFS) was established after the Pakistan suffered a catastrophic flood in 1976. The system was further developed after exploring weaknesses and learning experience from the severe floods in 1990s. The system got improvements with the passage of time and now it has turned into adequately inclusive; but still, it requires further concrete efforts to build it more efficient and self-contained (Dorosh *et al.*, 2010).

This study mainly aims to primarily focus on quantitative and qualitative assessment of floods impacts on various factors in Pakistan, covering the

period of (1947-2011). This study is also directed towards identifying the areas affected by floods and determining the impacts of floods on people, agriculture, livestock, houses, economy, villages in Pakistan. This attempt has been made also to evaluate the extent of previous researches carried out on floods impact in Pakistan.

METHODOLOGY

The research conducted reviews the wide and extensive literatures in order to explain and demonstrate the impacts of floods in all over the Pakistan. The thorough study of valid existing information also involved the evaluation of numerous methods used to mitigate the flood impacts, warning of floods and forecasting. About 200 published studies have been reviewed since creation of Pakistan till recent (1947-2011) for determination of impact on human mortality, livestock, crops, houses, villages, property while the numbers of people affected by the floods and areas influenced by the particular flood are also considered. Brief literature review that provided descriptions of the country's geography and its relation to flood characteristics, causes and consequences of floods in Pakistan were generally reviewed in order to help clarify. References from other countries have also been incorporated which supported more specific findings on the effects of floods on human population that resulted in large scale of causalities (Boughton and Droop, 2003).

LITERATURE REVIEW

Zakaullah *et al.* (2012) highlighted the analysis of flood frequencies of homogeneous regions of the Jhelum River basin. The study had covered the Northeast area of Pakistan up to the Mangla Dam. Maximum annual flow data for fifteen gauging stations was gathered. For flood frequency analysis, Design Flood for Window (DFW) software was used while MINITAB-11 was used for multiple linear regression analysis. Application of Chi-square was considered best for Gumbel distribution.

Zainudini *et al.* (2011) deliberated the use of Intensity-Duration-Frequency (IDF) curves of rainfall that provide the rainfall intensity of various lengths and reappearance intervals. Curves were reported to be used by the engineers for the creation of risk assessment design of systems flood plain management, dams, bridges, storage structures, storm sewers and runoff canals etc. These curves were also used as a tool of prediction which identified the likelihood. Several durations were presented and developed by IDF curves via rainfall data from Balochistan and Sistan. Results were compared with the data examined by countries and were possible and could potentially be beneficial for the purpose of design.

Mustafa (2002) determined the outcomes based on the survey that was conducted in four villages situated

in central Punjab concerning public's perception and thought about issues regarding flood and irrigation. In this research, methodology of perception studies was used. It was shown by log-linear evaluation of survey data that well informed vis-à-vis social power differences and relation between diverse social issues and susceptible to flooding.

Khan *et al.* (2011) estimated the flood risks of the Indus river basin using historical data of annual flood peak discharges for the purpose of risk assessment. River Jhelum, River Kabul, River Chenab and lower and upper parts of the Indus River were reported chief sources of floods in Pakistan. River Indus system, which is considered Pakistan's largest and the world's most important system encompassing a number of barrages and seven gauge stations was stated to have greater role in country's power production and irrigation system. The results found need estimation for construction of more dams and barrages and necessity to update them.

Baig *et al.* (2012) elaborated influence of 2010 floods on environmental sanitation and drinking water quality in about 82 regions of Pakistan. As a result, various water relief and rehabilitation programs were launched by numerous humanitarian organizations in the areas severely affected. One hundred samples of drinking water were collected randomly and their quality was examined by the field standard method. Microbiological analysis of water indicated the presence of *E. coli* bacteria abundantly. Chemical and physical parameters (such as PH, turbidity) of water were within WHO standards. Results found the considerable change in people's demands and perception about emergency management and relief activities.

Bhatti *et al.* (2011) appraised the impacts of floods in rural Sindh. The simple random technique was used and data were gathered from 5000 households of six districts named as Jacobabad, Larkana, Dadu, Shahdaktot, Shikarpur and kashmore. Structural questionnaire was designed as an instrumental tool to measure and determine the poverty. Among all six districts, the worst poverty situation was found in the Shikarpur and Jacobabad districts. Other elements like tribal conflicts and poor law and order situation in Jacobabad and Shikarpur enforced people to shift out their business. Literacy rate and Health facilities were also found in bad condition in Jacobabad, while other districts had petite differed. It was noticed that poverty level was increased as recent flood caused destruction of several livestock and crops and directly affected the common man.

Gaurav *et al.* (2011) analyzed the efficiency of using remote sensing data to weigh the extent of Indus flood of 2010 in Pakistan. The reason of 2010 flood was heavy rainfall between July and September that led to intensify this disaster. Human intervention was also

considered as another causative factor for exaggerating this disaster. Accumulation of flow was analyzed by using Shuttle Radar Topography Mission STRM data which highlighted the reaches, exceedingly vulnerable to breaches. It was recommended to establish mitigation strategies and identify vulnerable areas.

Akhtar (2011) pondered the nature and relationship of South Asiatic monsoon and manifestation of flood hazards in Indus River Basin of Pakistan. Floods were reported to affect about 75 million people while killing 20,000 individuals annually due to human encroachment in flood vulnerable areas. Several flood hazards are faced by Pakistan periodically. The flood of 2010 was the worst flood disaster Pakistan has ever faced in its history which subjected all over Pakistan to distressing impacts.

Habib-ur-Rehman *et al.* (2012) conducted a research on the analysis of flood estimation by using Geographic Information System (GIS). The research reported that there is lack of flow data of hydraulic structures. It was determined that connection for the site could be developed for the site by constructing assessing stations at downstream and upstream of the certain dam site. Empirical equations were launched in the upper locations of Chenab River. Watershed arrays and average flow of river was measured by digital evaluation model, using GIS software. The equations showed peak floods in considerable order of accuracy. These equations were applicable for specific regions, therefore their use for other parts required Preferences.

RESULTS AND DISCUSSION

Islamic Republic of Pakistan has been remained a highly prone country to natural disasters particularly floods throughout of its history. Pakistan has faced approximately 38 floods of varying intensities almost in every decade (including 19 major floods). Maximum floods came in the decades of 1990's and 2000's eight times each decade. The hugest flood of the 1990's decade was flood of 1992 and the decade of 2000's encompasses one extreme flood of 2010 taking all provinces into its effects.

First flood of Pakistan after independence was the flood of 1947 that had occurred in the province of Punjab in the month of September. Seven floods including major and minor were faced by the country in the decade of 1950's which consisted 1950 flood that was most disastrous flood of this decade.

In the next decade of 1960's, two floods came in the years of 1960 and 1966 in the months of July and September respectively.

The decade of 1970's incorporates five floods including two major floods of 1976 and 1977 which had taken place in the months of August and June predominantly in the provinces of respectively Punjab and Sindh respectively.

Afterward decade of 1980's comprises total six floods from 1981-1985 and 1988 while the flood of

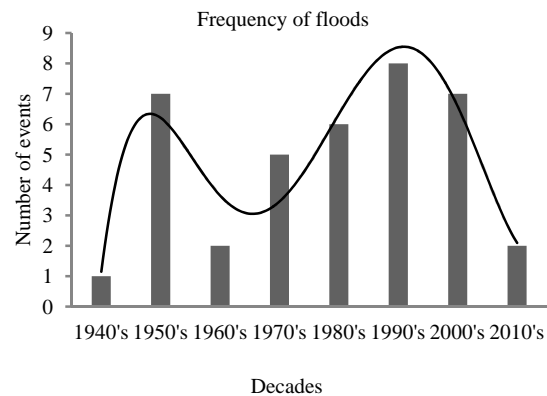


Fig. 1: Frequencies of floods (decade wise)

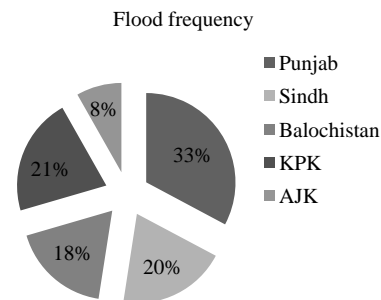


Fig. 2: Flood frequencies according to province

1988 was the most catastrophic flooding event in this decade that happened late September mainly in the province of Punjab and had subsequent impacts on the victims.

Eight floods came continuously in the decade of 1990's from 1991-1998 including two significant floods of 1992 and 1998 in the months of August and March Respectively. The flood of 1992 caused severe aftermaths in all over the country except Balochistan. Finally, Pakistan faced eight floods of fluctuating strengths and intensities approximately every year from 2000-2009, except in 2002 and 2004. Flood happened two times in the 2005, in the months of February and June. The most calamitous flood of 2010 was the major flooding event of the next decade "2010s". The flood of 2010 began on 22 July and all over the Pakistan severely. Following the sequence, one more devastating flood of 2011 was added in the history of Pakistan hitting Particularly Sindh and Balochistan in the month of August. The floods have been continuously increasing since 1970's till recent (Fig. 1) with their serious and long term effects on living beings and infrastructure (Table 1 and 2).

Figure 2 illustrates the number of flood events occurring in each province of Pakistan. Maximum numbers of floods have been occurring in the province of Punjab (19 floods) since 1947 till recent. The second most affected province is KPK where floods have

Table 1: Historical floods damages in Pakistan (1947-2011)

Floods	Date	Affected areas	People died	People affected (million)
1947	20 September	Punjab	N/A	N/A
1950	22 August	N/A	2,900	N/A
1954	26 September	Punjab, Balochistan	N/A	N/A
1955	8 October	Punjab, NWFP	679	N/A
1956	N/A	N/A	160	N/A
1957	27 August	N/A	83	N/A
1958	N/A	Punjab	90	N/A
1959	5 July	Punjab	88	N/A
1960	12 July	Punjab	N/A	N/A
1966	9 September	Punjab	N/A	N/A
1973	12 August	N/A	160	4.8
1975	N/A	N/A	126	N/A
1976	2 August	Punjab	425	5.566
1977	June	Sindh	848	1.200
1978	July	N/A	393	2.246
1981	N/A	N/A	82	N/A
1982	N/A	N/A	350	N/A
1983	N/A	N/A	39	N/A
1984	N/A	N/A	42	N/A
1985	N/A	N/A	30	N/A
1988	27 September	Punjab	508	N/A
1991	February	Balochistan (districts Chagai and Pishin)	N/A	N/A
1992	9 Aug	Azad Kashmir, KPK, Punjab, Sindh	1334	12.324024
1993	7 July	Punjab, Kashmir, KPK	15	0.261295
1994	3 July	Sindh, Baluchistan	386	0.840
1995	22 July	All provinces, AJK	451	1.255
1996	24 August	Punjab province (central and southern)	80	1.186131
1997	N/A	N/A	848	N/A
1998	3 March	Balochistan, (Makran, Turbat)	1000	0.200
2001	23 July	KPK, Punjab	210	0.400
2003	July	Sindh, Balochistan, Punjab, KPK	230	1.266223
2005	June	KPK, Punjb, Sindh	200	0.010
2005	Feb	KPK and Balochistan	800	7.000,45
2006	July-September	All provinces of Pakistan, AJK	230	N/A
2007	12 August	Sindh and Balochistan, KPK	420	2.500
2008	August	Punjb, Balochistan, KPK, Sindh	27	0.241
2009	17 August	Sindh (Karachi), KPK	26	
2010	22 July	KPK, Balochstan, Pnjab, Sindh	1,985	20.185
2011	August	Sindh, Balochistan	443	9

Table 2: Historical flood damages: impacts on different parameters (1947-2011)

Floods	Agriculture (acre)	Villages affected	Livestock	Houses damaged	Loss in amount (million \$US)
1947	N/A	N/A	N/A	N/A	N/A
1950	N/A	10000	N/A	N/A	488.05
1954	N/A	N/A	N/A	N/A	N/A
1955	N/A	6945	N/A	N/A	378.40
1956	N/A	11609	N/A	N/A	318.20
1957	N/A	4498	N/A	N/A	301
1958	N/A	24,59	N/A	N/A	35
1959	N/A	3902	N/A	N/A	234.35
1960	N/A	N/A	N/A	N/A	N/A
1966	N/A	N/A	N/A	N/A	N/A
1973	N/A	9719	N/A	3000000	5134
1975	N/A	8628	N/A	N/A	683.70
1976	N/A	18390	N/A	1000000	3485.15
1977	N/A	2185	N/A	N/A	337.55
1978	N/A	9199	N/A	N/A	2227.40
1981	N/A	2071	N/A	N/A	298.85
1982	N/A	7,545	N/A	N/A	N/A
1983	N/A	643	N/A	N/A	135.45
1984	N/A	251	N/A	N/A	75.25
1985	N/A	171	N/A	N/A	5

Table 2: Continues

Floods	Agriculture (acre)	Villages affected	Livestock	Houses damaged	Loss in amount (million \$US)
1988	N/A	1000	N/A	N/A	857.85
1991	N/A	N/A	N/A	100	N/A
1992	N/A	13208	6,200	875,000	3010
1993	164,340	N/A	N/A	1080	N/A
1994	1,807,233	4,078	14,306	557,017	842.80
1995	1126000	6852	15,375	55,473	376.25
1996	4500000	2024	N/A	N/A	N/A
1997	N/A	N/A	N/A	N/A	N/A
1998	43,000	100	20,000	12000	N/A
2001	N/A	50	1000	N/A	246
2003	343,188	7573	20236	141,060	N/A
2005	952,788	1286	403	25624	N/A
2005	40,000	1931	N/A	24,000	11
2006	N/A	1000	N/A	16872	N/A
2007	N/A	6500	N/A	88,000	327
2008	N/A	800	N/A	3200	103
2009	N/A	89	N/A	400-450	N/A
2010	5170927.213	17,553	1523380	1,608,184	10000
2011	1600000	60	115,500	924,777	3730

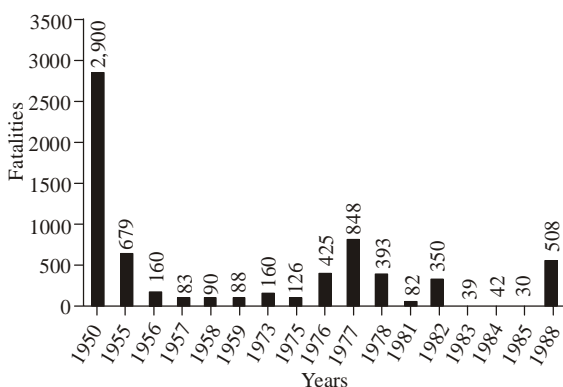


Fig. 3: Lives loss caused by floods (1947-1988)

influenced 13 approximately, followed by the Sindh where 12 flooding events have been taken place till now. Punjab and KPK have been remained most vulnerable to floods and their resulting impacts as compared to the other regions of the country.

Fatalities: In the history of Pakistan, floods caused deaths on gigantic levels (Fig. 3 and 4). Maximum

fatalities by the severe effects of the floods were occurred during the decade of 2000s that influenced mainly Sindh province, followed by the decades of 1950's and 1990's. The most disastrous flood in term of fatalities was flood of 1950 (first major flood in Pakistan). Second most devastating flood in terms of deaths was flood of 2010 and third flood causing considerable casualties was flood of 1992 that considerably impacted all over Pakistan except Baluchistan.

People affected: Several people have been affected by the heavy floods in Pakistan till recent (Fig. 5). People were most affected by the consequences of floods in the decade of 1990's, Second most significant decade in terms of affecting people was decade of 2000s affecting huge population including missing persons, injured persons and displaced persons etc. Largest number of people were affected in the by the flood of July 2010 which stimulated all over Pakistan. Second largest floods in terms of affected people were flood of 1992 and thirdly, flood of 1976 that happened in Punjab.



Fig. 4: Lives loss caused by floods (1991-2011)

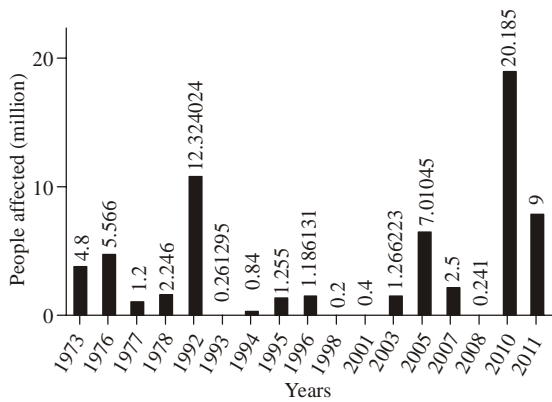


Fig. 5: People affected by floods (1947-2011)

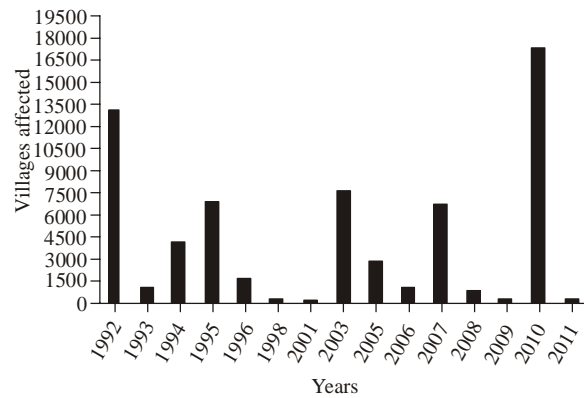


Fig. 8: Villages affected by floods (1991-2011)

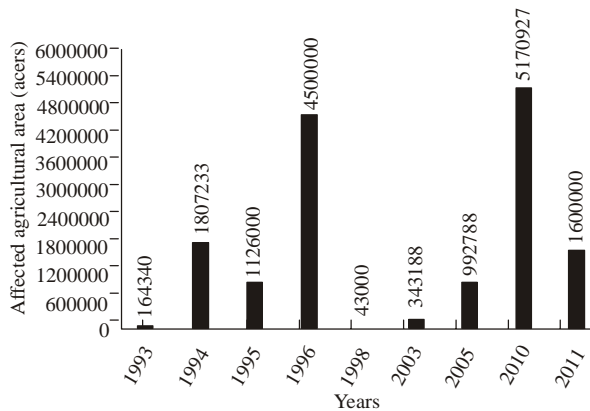


Fig. 6: Agricultural area (in acre) affected by floods

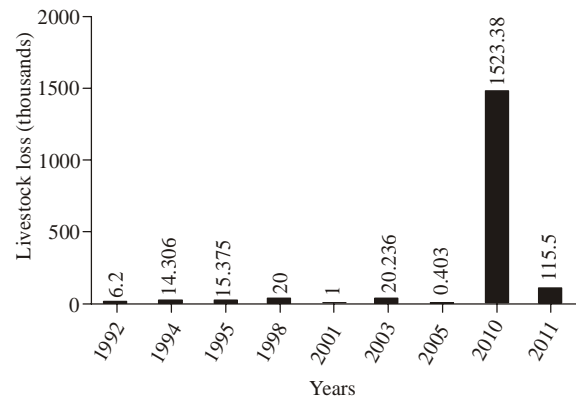


Fig. 9: Affected livestock (1947-2011)

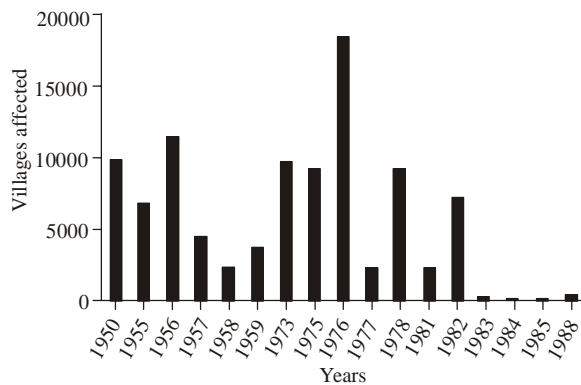


Fig. 7: Villages affected by floods (1947-1988)

Agriculture: Agriculture sector is severely affected by floods in Pakistan that further lead to interrelated damages (Fig. 6). Data found of initial decades was insufficient. Largest damage in agriculture sector occurred in the decade of 1990's followed by 2000s. Maximum loss of crops was resulted from 2010 floods. Second most damaging flood causing large level of destruction in the agriculture sector was the flood of 1996. After that the flood of 1994 caused huge level of loss in terms of agricultural damage.

Villages: In the history of Pakistan, floods inundated and destroyed numerous villages (Fig. 7 and 8). Maximum villages were destroyed severely during the decade of 1970's overall in province of Punjab, followed by the decades of 1950's and 2000s. Maximum villages were affected by the floods of 1976; second most destructive flood in term of villages' destruction was flood of 2010 followed by floods of 1992 that had taken place in the entire country.

Livestock: Millions of livestock have been killed by floods that have occurred frequently in Pakistan since its creation and affected vast area of country (Fig. 9). Maximum numbers of livestock were lost in the decade of 2000s while second number of destruction in term of livestock was happened in the decade of 1990's. Similarly, highest loss of livestock was caused by the flood of 2010, followed by the floods flood of 2003 and 2011.

Houses damaged: Several disastrous floods have been affecting and damaging infrastructure including houses since Pakistan came into being (Fig. 10). Maximum numbers of houses were damage in the decade of 1970's. Second most dreadful decade of flood which

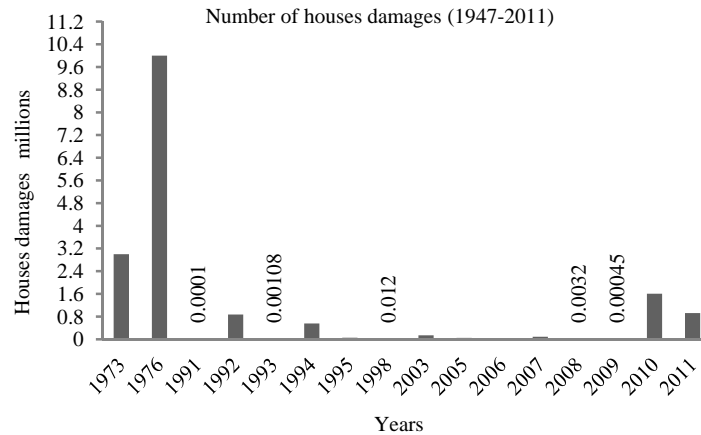


Fig. 10: Houses damaged by floods (1947-2011)

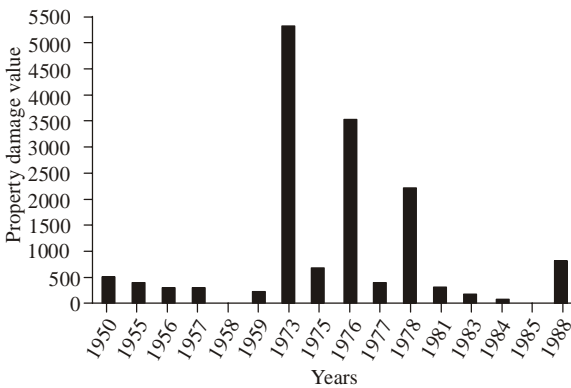


Fig. 11: Monetary loss caused by floods (1947-1988)

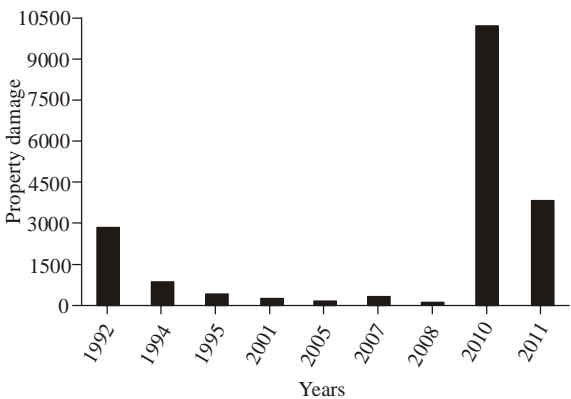


Fig. 12: Monetary loss caused by floods (1991-2011)

caused destruction of numerous houses, was 2000s and third was decade of 1990's. Maximum houses were damaged by the flood of 1976, followed by the floods of 1973 and 2010.

Property damage: Pakistan has been suffering from serious losses by the serious aftermaths of floods that occur frequently in the country (Fig. 11 and 12).

Comparatively, the decade of 2000s had brought biggest property damage while second and third most dreadful decades in terms of property damage were 1970's and 1990's respectively. The flood of 2010 had caused maximum damage of property of country. Second and third hugest floods causing large monetary losses were 1973 and 1976 floods.

CONCLUSION

Since its creation, Pakistan (having an area of 796,095 km²) has been suffering from number of shattering flooding events leaving long term consequences on its victims most of whom loss their lives, property, livestock, shelter and agricultural lands etc. To obtain first objective, data was collected from the power resources in the form of published literature. It was found that North east areas of Pakistan remained most affected which include mainly Punjab and KPK. Least flood affected province is Balochistan. Reviewing the literature to obtain second objective found that flood impacts in all parts of the Pakistan have not been recorded adequately due to lack of accessibility. Previous works on this field rely mostly on the latest floods while leaving initial floods unrecovered since Pakistan's independence. Data about the impacts of floods of 21st century on people, livestock and country's economy is comparatively more than the 20th century. Thorough study to obtain 3rd objective found that maximum people were died in the flood of 1950, maximum people were affected by the floods of 2010, maximum agricultural area was severely affected in the flood of 2010, maximum villages were affected in 1976 flood, maximum livestock damage was seen in the flood of 2010, maximum houses were destroyed in the flood of 1976 and maximum economic loss was noticed in the flood of 2010. The factors that lead to these devastating floods require to be tackled by the establishments of Pakistan.

REFERENCES

- Ahmad, F., S.F. Kazmi and T. Pervez, 2011. Human response to hydro-meteorological disasters: A case study of the Pakistan 2010 flash floods in Pakistan. *J. Geogr. Reg. Plannin.*, 4(9): 518-524.
- Akhtar, S., 2011. The South Asiatic monsoon and flood hazards in the Indus river Basin, Pakistan. *J. Basic Appl. Sci.*, 7(2): 101-115.
- 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.
- Atta-ur-Rahman, A.N. Khan, A.E. Collins and F. Qazi, 2011b. Causes and extent of environmental impacts of landslide hazard in the Himalayan region: A case study of Murree, Pakistan. *Nat. Hazards*, 57(2): 413-434.
- Baig, S.A., X. Xu, Naveedullah, N. Muhammad, Z.U. Khan, B. Nawab, Q. Mahmood and R. Khan, 2012. Pakistan's drinking water and environmental sanitation status in post 2010 flood scenario: Humanitarian response and community needs. *J. Appl. Sci. Environ. Sanitation*, 7(1): 49-54.
- 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.
- Bhatti, D.M., D.M.B. Jamali, I.A. Ghumro and F.M. Shaikh, 2011. Supreme floods and its impact on poverty in rural Sindh. *Aust. J. Bus. Manage. Res.*, 1(5): 50-60.
- Boughton, W. and O. Droop, 2003. Continuous simulation for design flood estimation: A review. *Environ. Modell. Softw.*, 18(4): 309-318.
- Brasdil, R., P. Dobrovolny, V. Kakos and O. Kotyza, 2006. Historical and recent floods in the Czech Republic: Causes, seasonality, trends, impacts. *Flood Risk Manage. Hazards Vulnerability Mitigation Meas.*, 67(6): 247-259.
- Dobrovolskii, S.G. and M.N. Istomina, 2009. Characteristics of floods on the territory of Russia with regard to their natural and socioeconomic parameters. *Water Resour.*, 36(5): 491-506.
- 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.
- FFC, 2010. Ministry of water and power of Pakistan. Annual Flood Report, Pakistan.
- Gaurav, K., R. Sinha and P.K. Panda, 2011. The Indus flood of 2010 in Pakistan: A perspective analysis using remote sensing data. *Nat. Hazards*, 59: 1815-1826.
- Ghoneim, E. and G.M. Foody, 2011. Assessing flash flood hazard in an arid mountainous region. *Arab J. Geosci.*, 2011: 1-12.
- Habib-ur-Rehman, U.A. Naeem, H. Nisar and N. Ejaz, 2012. Development of empirical equations for the peak flood of the Chenab River using GIS. *Arab J. Sci. Eng.*, 37(4): 945-954.
- 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.
- 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.
- Khan, B., M.J. Iqbal and M.A.K. Yousufzai, 2011. Flood risk assessment of river Indus of Pakistan. *Arab J. Geosci.*, 4: 115-122.
- Mustafa, D., 2002. Linking access and vulnerability: Perceptions of irrigation and flood management in Pakistan. *Prof. Geogr.*, 54(1): 94-105.
- Schanze, J., 2006. Flood risk management: A basic framework. *Earth Environ. Sci.*, 67(1): 1-20.
- Zainudini, M.A., M.J. Marriott, M.S. Mirjat and A.S. Chandio, 2011. Establishing intensity duration frequency curves for Sistan and Balochistan provinces of Iran. *Pak. J. Agr. Agric. Eng. Vet. Sci.*, 27(2): 115-125.
- Zakaullah, M.M. Saeed, I. Ahmad and G. Nabi, 2012. Flood frequency analysis of homogeneous regions of Jhelum River basin. *Int. J. Water Resour. Environ. Eng.*, 4(5): 144-149.