

Community Based Flood Catastrophe Preparedness, Vulnerability, Management and Response of Layyah District, Punjab, Pakistan (1990-2015)

Misbah Gull,¹ Saifullah Khan,^{1*} Muhammad Nawaz,² Mahmood Ul Hasan³

¹Department of Geography, Bahauddin Zakariya University, Multan, Pakistan

²Department of Environmental Sciences, Bahauddin Zakariya University, Multan, Pakistan

³Department of Geography, Peshawar University, Peshawar, Khyber Pakhtunkhwa, Pakistan

*Email: Saifullahkhan33@gmail.com

Received: 17 March, 2020

Accepted: 12 May, 2020

Abstract: The study articulates the society supported flood disaster preparedness, vulnerability, management, and response in the Layyah district, southern Punjab, Pakistan. The area has recorded high summer temperature, low rainfall and an arid climate with an optimistic departure of one centimeter. At Taunsa barrage, the Indus river, as well as the Thal canal, show a decline in the annual flow, while it remains high at Chashma barrage having a heavy flow from July to October. Historically, the foremost disasters experienced in Layyah district are floods, earthquakes, droughts, epidemics, and fires. About 81 Potwar areas have been affected every year by flood disaster consisting of 36 medium and 45 high risks units. Obviously, the locals are the primary instrument to fight any catastrophe for their safety at the initial stage as they are admirable arbitrators of risk assessment, vulnerability, rehabilitation, excavation, and can acquire consistent estimations for their safety. The joint endeavors of the locals and government during pre-disaster and a post-disaster stage will make certain that how to provide crucial support as well as services to the distressed community throughout the Layyah district. The social or anthropogenic level arrangements for flood catastrophes are appreciated mutually at national and international levels.

Keywords: Disaster preparedness, management, vulnerability, emergency response, community participation.

Introduction

The study deals with the people's perception of a flood disaster in Layyah district and Thal desert, Punjab. Generally, every year, the flood in the Indus river during monsoon season has affected the inhabitants residing on both sides of the Indus river. The government of Pakistan is trying to overcome the problem of the seasonal flood disasters, both in the urban and rural areas. Though, the authorities and stakeholders are not prevailing with regards to defeating the issue everlastingly. Obviously, the flood is the inundation of the river, when it ascends above its sides and influenced the residents and their surrounding areas (Uddin et al 2013). Floods are resulting due to heavy rainfall, glaciers retreat, melting of ice, clouds burst, and broken dams. Moreover, a flood is an ordinary natural disaster that brings significant damages to people's lives, assets, and infrastructure. Generally, the Asian continent covers almost 50% of the World's population and experiences a large number of different common hazards and disasters. The sixty percent of Pakistan is vulnerable to flood disaster and the government is required to invest in this sector massively (Iqbal, 2011). The developing nations have been affected by floods roughly twenty times more than the developed nations. Pakistan is an agricultural country, depending upon a river drainage system for its irrigation network. The heavy flow of these rivers has caused disasters since the time of independence and badly damaged the agricultural land and population resulting in social, economic, and health issues. The flood in 2010 was the worst in

Pakistan history, affecting a million individuals in different parts of Sindh, Punjab, and Khyber Pukhtunkhwa provinces of Pakistan.

The Layyah district located between 31°.24' and 30°.45' north latitudes and 71°.50' and 70°.44' east longitudes. The study area covered by the Bhakkar district in the north, Jhang district in the east and the Muzaffargarh district in the south. The western border is demarcated by the Indus river and separated from Dera Ismail Khan and Dera Ghazi Khan districts with an area of 6,291 km² (GoP, 1998). The total population of the district was one million in 1998 in contrast to 0.7 million people in 1981. The higher growth rate in the study area seems visible by the variation between the population density of 178 persons/km² (1998) and 106 persons during 1981. Commonly, the total population of the district was 0.2 million in 1951, 0.3 million in 1961, and 0.5 million in 1971 respectively. The urban population was 12.9% that increased in the ratio of 5% from 1981 to 1998. The study area comprises of 3 urbans, a single town committee, and 720 revenue villages. The community-based planning for disaster preparedness is not a new phenomenon, and numbers of workers have carried out their studies regarding flood disaster both in Pakistan as well as abroad. The utmost scholars among them are; Khwaja, Jawad, Khan (2009), Kronstadt, et al (2010), Shabaz et al (2012), Khan (2013), Sayed and Gonzalez (2014), Afaq (2016), Bukhari and Rizvi (2017), Sudmeier et al (2006), Rahman (2014), Shrestha (2008), Jaquet et al (2016), etc.

Materials and Methods

Every scientific research follows specific methodologies to achieve the goals of the study. Several methods and techniques have been used by the previous scholars for disaster management and preparedness, but for the current study, a unique technique has been used to observe the community opinion as well as secondary data and to plan how to prevail over the concern of the flood disaster in Layyah district. Apparently, the main objectives of the work are to evaluate the existing condition of the flood disaster, appraisal of the level of people's participation and discussing the possible steps on how to mitigate with flood disaster effects. The work has been focused on the rainfall as an independent variable, while the temperature, water flow, agriculture, housing, power supply, communication, population, health, education, and migration as dependent variables. Both secondary and primary data have been used to reach the aims of the study. The field data regarding people's perceptions have been collected using field questionnaires, discussions, interviews, and visits. In contrast, the secondary data regarding the remaining variables have been gathered as of their particular non-government and government institutions at the federal and provincial levels. The different research tools used during the course of research are; questionnaires, field surveys, field visits, discussions, mapping, observations, charts, graphs, statistics as well as numerical tests. A questionnaire covering different variables and 100 questions were prepared and distributed among the people using a random sampling method. The Karor Pakka and Layyah tehsil have been considered for the field surveys, which have been divided into union councils and revenue villages. Almost, 12 questionnaires have been filled from each union council randomly. The 100 persons sampling has been considered for achieving the targets of the study. A master sheet was prepared for the collected field as well as secondary information and analyzed critically to understand the trend in the public opinion using the SPSS and MS Excel.

Results and Discussion

Weather and Climate

The study area falls in a Thal desert of Pakistan, having hot long summers and short moderate winters. In summers, the temperature rises beyond 45°C in June and July, whereas it remains below 20°C (minimum) in January having an average rainfall of 18.7 centimeters. The heavy rainfall and glaciers retreat at the place of

origin of the Indus river and its tributaries have caused flood disasters in the upper and lower Indus plains. These floods have resulted in considerable damages in Sindh, Punjab and Khyber Pakhtunkhwa province.

Temperature Distribution and Fluctuation

Subsequent to rainfall, the temperature has been considered as an intervening parameter of the climate that plays a vital role in the flood disaster during the summer season. The melting of snow in the catchment area of the rivers ascend in temperature, atmospheric circulation, humidity as well as evaporation are responsible for the weather change in Layyah district. The area has recorded a mean temperature of 27.2°C Celsius having the highest temperature of 38.6°C Celsius (June) and the lowest temperature of 13.3°C Celsius (January). Generally, the annual pattern of the temperature condition indicates a rise from January to June and afterward slackens up to December with a regression estimation of 0.9°C that is above the normal value. Annually, the highest mean temperature of 29.4°C Celsius traced during 2002 with a low of 24.4°C Celsius in 2010 and considered as the most blazing and chilly periods of the series. During 1999 as well as 2007, the lowest annual temperatures of 24.7°C and 25.3°C Celsius have been noted. The data further show that there is a positive and negative trend in the temperature condition after every 5 years (1992-2010) and increasing continuously till date with a cyclic trend having a regression value of 0.00°C. The temperature condition of the district rises to above 48°C Celsius during summers and remains less than 20°C Celsius in the winter season, particularly in January, November and December. Obviously, due to high-temperature conditions, May, June, and July have been considered as the hottest and driest months in Layyah district (Table 1). The highest positive deviation of 2.2°C Celsius has been observed during 2002 in contrast to the lowest of the negative trend of -2.8°C Celsius during 2010. The total departure from the average temperature indicates a lowering of -0.7°C Celsius all through the time period with the rise and fall after every three years. The pattern of temperature after every five years reveals that it diminished from 1992 to 2000 ascends onward up to 2005 and further increased in 2011-2015. The trend shows a rise and fall after every 5 years, having a regression value of 0.001°C that is a cyclical trend (Table 1).

Precipitation Distribution and Fluctuation

The highest average rainfall of the study area is 2.9 cm in July, while the low (0.07cm) was recorded in

Table 1 Layyah district, five years average temperature °C (1992-2015).

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean	Dev.
1992-95	13.1	17.5	24.0	30.3	38.5	39.8	37.7	36.7	32.1	26.4	20.2	14.5	27.6	0.4
1996-00	13.3	16.6	24.6	30.9	38.1	37.9	34.4	32.9	31.3	25.5	17.9	13.4	26.4	-0.8
2000-05	12.5	18.3	26.0	31.4	38.0	40.5	37.7	36.4	33.7	28.2	21.4	13.4	28.1	0.9
2006-10	13.4	17.8	25.8	32.5	38.4	36.2	33.8	32.2	29.8	24.8	17.4	13.4	26.3	-0.9
2011-15	14.2	18.2	26.7	33.3	37.5	38.7	36.8	35.0	32.8	26.4	17.3	13.8	27.5	0.3
Average	13.3	17.7	25.5	31.7	38.1	38.6	36.0	34.5	31.9	26.3	18.8	13.7	27.2	-0.7

Source: PMDC, Karachi

Table3 Layyah district, five years mean flow of Indus river at taunsa barrage, cubic feet (1992-2015).

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Aver	Dev
1992	5664.8	18.0	6852.3	6415.0	7382.1	7439.4	7610.8	7359.7	5348.5	7156.3	7154.4	6757.4	6263.2	145.1
1995	5073.3	6414.3	6414.3	7258.1	7403.2	7500.0	7419.4	7451.6	7500.0	7508.8	7516.0	7500.0	7079.9	961.8
2000	4416.7	3978.4	3437.1	3041.7	6408.9	5743.0	7550.3	7435.5	7500.0	5691.9	5483.3	4335.5	5418.5	-699.6
2005	2813.2	2500.0	3577.5	7623.3	7680.6	7935.0	7424.2	7771.0	8000.0	5146.8	5590.0	5582.3	5970.3	-147.8
2010	1150.0	2816.7	4919.4	3566.7	5709.7	6323.3	6909.7	4109.5	5650.0	7219.4	6863.3	5903.2	5095.1	-1023.0
2015	3658.3	5157.9	5345.2	5716.7	7629.0	8196.7	8145.2	4435.3	7963.3	7116.1	6833.3	7258.1	6454.6	336.5
Mean	3420.0	4205.6	5149.0	5791.5	6892.2	7366.2	7694.4	7235.3	7083.4	5872.2	6559.3	6148.2	6118.1	-0.1
Dev	-2698.1	-1912.5	-969.1	-326.6	774.1	1248.1	1576.3	1117.2	965.2	-245.9	441.2	30.1	-0.1	

Source: WAPDA, Lahore

February, respectively. Generally, the district receives the intense rainfall in the monsoon season, when contrasted with the winter season. The annual pattern of average rainfall reveals that it has increased from February to July and afterward decreases up to January having a deterioration of 0.94 cm of the mean condition that is over the sensible state and demonstrates a slow rise throughout the study period (Table 2). The lowest mean rainfall of 0.2 cm has been noted in 1994 and considered a dehydrated year of the series. It shows a rise after each year and accomplished to its peak of 22.4 cm during 2007 and declared a year of heavy showers.

The deviation of the average rainfall indicates a rise of 1cm all through the series. The outcomes delineate that the minimal deviation of average rainfall is -11.5 cm observed during 1994 and -6.5 cm in 2015, respectively. The positive deviation of 10.7 cm has been noted in 2007, with a deterioration estimation of 0.45 cm that is over the ordinary level and indicates a rising pattern in the rainfall condition. The annual pattern of departure from the average state of rainfall reveals a rise or fall at regular intervals of three years (2007 till 2015). The average rainfall of five years of Layyah district illustrates a positive fluctuation of 23.3 cm during 2005-2010 and a declining trend of -20 cm in 1992-1995. The general outcomes show that the deviation of the average rainfall of the district rose after every 5 years with a regression value of 0.37 cm (Table 2).

Surface Water Discharge

Taunsa Barrage

The barrage has been built on the Indus river for the purpose to manage the water resources for cultivation as well as to overcome the issue of the flood disaster in the southern Punjab and Sind province. The average

flow of the Indus river at Tansa barrage is 447 thousand cubic feet in September, while the minimal of 431 thousand cubic feet was recorded in January. The annual pattern of the water flow demonstrates that it increases from January to September through the increase in solar radiation and afterward decreases till December with a decrease in temperature. The water flow in the Indus river is directly proportional to the precipitation and temperature conditions in the catchment area. Obviously, the deviation of the flow of the Indus river is above the average state (+3) in the monsoon season and takes a negative turn during the winter season. This fluctuation in the flow of surface drainage is due to the rise and fall in the rate of precipitation, temperature, and the retreat of glaciers. During April and November, the Indus and its tributaries are passing through the increase or decreasing stages in the water and constitute transition month of the year (Table 3).

The heaviest annual flow of 445 thousand cubic feet having a positive deviation of 1.3 thousand cubic feet has been gauged during 2009, whereas the low of 444 thousand cubic feet with a negative deviation of -2.6 thousand cubic feet was noted in 2006. The maximum flow at Taunsa has been noted twice during 1992 to 2000 and 2004 to 2011 respectively, whereas it has been decreased during the excluding years of the series. The pattern of annual water flow illustrates a regression value of 0.34 thousand cubic feet which is close to the mean and shows a stable condition in the future. Due to climate change, the flow in the Indus river represents a diminishing state of -0.1 thousand cubic feet. The average of five years flow is 444 thousand cubic feet having a positive deviation of 0.1 thousand cubic feet from 1992 to 1995, which is decreasing during 2001 to 2015 with a deviation value of -0.4 in 2001. Consequently, the major disastrous floods in Layyah district have been noted between

Table 2 Layyah district, five years average precipitation cm (1992-2015).

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Sum	Devi.
1992-95	0.1	0.0	0.0	0.3	0.1	1.6	1.7	1.3	1.1	0.3	0.1	0.1	6.7	-20.0
1996-00	0.0	0.0	0.2	0.2	0.0	2.6	3.4	2.6	1.4	1.8	0.0	0.0	12.3	2.4
2000-05	0.2	0.0	0.6	0.7	0.1	1.0	1.8	2.5	2.1	1.0	0.4	0.1	10.5	-4.8
2005-10	0.4	0.1	0.0	0.0	1.5	3.7	4.7	4.0	2.3	0.5	0.1	0.0	17.5	23.3
2011-15	0.0	0.2	0.3	0.4	0.1	2.1	3.0	2.4	1.5	1.7	0.0	0.0	11.7	-0.1
Average	0.2	0.07	0.2	0.4	0.5	2.2	2.9	2.5	1.6	1.0	0.12	0.08	11.7	1.0

Source: PMDC, Karachi

1992 to 2000 as well as 2005-2015 and remained low from 2001 to 2005.

Thal Canal

The canal began from Chashma barrage and is one of the critical water assets in agriculture leading to the stability of the water table in the Thal desert. During the flood in the Indus river, the increase in the water flow in the Thal canal made serious issues of the closely cultivated lands as well as human infrastructure. The canal recorded an average annual flow of 6.1 thousand cubic feet throughout the study period (1992-2015). The heavy flow during July remains 7.7 thousand cubic feet, whereas in January, it is 3.42 thousand cubic feet (minimum). The flow ascends from January to July and diminishes up to December with a slight increase during November. The regression value of the Thal canal remains 0.9 cubic feet that are above the average state and reveals a stable state in the flow for the future. The information reveals a sufficient flow of the Thal canal for crop

to 1999 and diminishes ahead till 2015 having rise and fall in some years of the series. While, ordinarily, the data illustrate a visible decline in the flow of the Thal canal and indicates a disturbing situation for agriculture production in the area. The pattern additionally shows a regression of 0.34 cubic feet. The data indicate a maximum flow of 7.1 thousand cubic feet having a positive deviation of 0.9 thousand cubic feet from the mean during 1995, while it remains low (4.5 thousand cubic feet) with a negative deviation of -1.6 cubic feet in 2001. The decrease in the flow of the canal has been observed both in winter and summer seasons having a sum of the declined -0.1 cubic feet. The annual pattern reveals a long spell of maximum flow from 1992 to 1999 with a regression level of 0.523 cubic feet throughout the series. It illustrates that the flow in the canal declines with the passage of time and will initiate a disturbing condition in the future.

Chashma Barrage

The barrage built on the Indus river in the Mianwali

Table 4 Thal canal, mean monthly water flow, cubic feet (1992-2015).

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean	Dev
1992-95	430.1	444.6	445.0	445.0	445.7	446.6	446.2	446.7	446.4	445.5	444.0	443.7	444.1	0.1
1996-00	429.9	442.6	444.5	444.1	446.3	447.0	447.1	447.4	447.4	445.3	444.0	443.1	444.1	0.1
2001-05	428.5	442.0	442.3	443.0	445.9	447.2	447.5	447.7	447.1	444.3	444.2	443.3	443.6	-0.4
2006-10	434.7	441.5	443.6	443.2	445.3	447.0	447.6	447.0	447.5	443.9	444.0	442.3	444.0	0.0
2010-15	429.5	442.1	444.9	444.4	445.7	447.2	447.3	447.0	447.0	445.2	444.6	444.5	444.1	0.1

Source: WAPDA, Lahore

cultivation from April to September which affects and residence during flood season. Though it is insufficient during October to March with the decrease in the monsoon showers and surface temperature. The maximum departure from the average flow of the canal is observed during July having a minimum in January. The sum of the deviation of the Thal canal is -0.1 cubic feet, which indicates the decline in the flow during 1992 to 2015.

The annual trend reveals that the flow rises from 1992

district for the purpose to manage and log the overflow and to burrow canals for the irrigation system in Layyah district, particularly in the Thal desert. The other aim of the barrage is likewise to decrease the stress of flow in flood season over Sindh province and southern Punjab. The annual discharge of the river at Chashma barrage is 643 thousand cubic feet during 1992 to 2015. The data further elaborates that the minimum flow of 642 thousand cubic feet has been recorded during December (winter season) and the highest of 646 thousand cubic feet during September

Table 5 Chashma barrage, Indus river, five years average flow, cubic feet (1992-2015).

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Aver	Dev
1992-95	645	647	644	646	644	642	642	643	646	646	644	642	644	4.2
1996-00	638	642	643	643	644	637	642	644	646	648	645	641	643	-2.8
2001-05	644	641	640	641	641	643	644	645	643	644	642	642	642	-4.6
2006-10	643	642	640	642	645	643	646	646	645	643	642	643	643	0.3
2011-15	642	641	644	645	644	645	646	646	647	645	643	642	644	3.7
Deviation	-0.8	-1.1	-1.2	0.1	0.3	-1.2	0.7	1.3	2.3	1.8	-0.2	-1.5	643	0.8

Source: WAPDA, Lahore

Table 6 Punjab province, effects of different disasters on human, 1990-2015.

Hazard	Likelihood (Score 1-5)	Impact (Score 1-5)	Risk
Flood	4	5	20
Earthquake	2	2	4
Drought	3	3	9
Epidemic	3	4	12
Fire Incidents	3	3	9
Environmental	3	3	9

Source: GoP, 2010

(post-monsoon). The annual pattern shows twice heavy and low spells in the flow of the Indus river throughout the year. The primary heavy flow has been noted from July to October having substantial monsoon rainfall and severe temperature, whereas the subsequent is from March to April (pre-monsoon). The initial minimal water discharge of the Indus river has been noted from December to February with minimum temperature and low rainfall. Though, the subsequent least flow is seen in June when the WAPDA begins storage of floodwater at Tarbella and Mangla reservoirs. Consequently, the study area is vulnerable to overflow from July to October and stays harmless in the excluding months of the year. Obviously, the data show a regression value of 0.89 cubic feet, which is, a stable condition for the future. The average of five years and deviation from the mean of the water flow at Chashma location shows that the ever high-flow cycle is between 1992 to 1995 as well as 2011 to 2015 with an average discharge of 644 thousand cubic feet. During September, the flows remains high due to melting of glaciers, heavy monsoon rains, and discharge from Indian dams, and constitutes as a month of heavy flow throughout the year (Table 5).

The comparative study of the Taunsa and Chashma barrages reveals that the average annual flow is higher at Chashma locality as compared to the Taunsa barrage (Fig.1). The Chashma barrage assumes a prime position in the storage of floodwater through the rainy season and afterward to include the storage water into the normal flow in winter months (Fig.1).

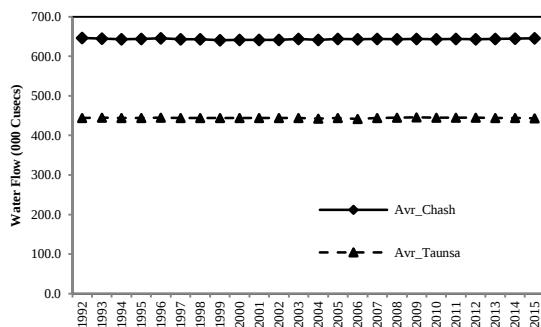


Fig.1 Chashma and Taunsa barrage comparison of mean monthly annual flow (1992-2015)

Potential Disasters in Punjab Province

The well-known disasters in the Punjab province having many human fatalities and its consequences for various sectors comprise of epidemic, droughts, floods, mists and fogs (visibility), hails, sound and lightning, thunderstorms, heat waves, infections, urban floods, and gusts (*Loo*). Generally, the human deaths brought by different disasters are 10146 people having affected population of 39.02 thousand from 1992 to 2015. Among these disasters, the most remarkable are floods, trailed by urban rains, epidemics, and heat waves. These disasters are the significant disasters affecting people throughout the Punjab province consistently. Nevertheless, the flood is the leading disaster having affected 2700 thousand people in Punjab, urban floods 711 thousand people and wind storms 233 thousand. The drought condition prevails over the southeastern Punjab province and caused 14 deaths and affected 3.1 thousand people (Table 6, 7).

Vulnerability to Flood Disaster

The Layyah district is located on the eastern bank of the Indus river in northwestern Punjab. The serious disasters that have been noted in Layyah district are; earthquakes, floods, droughts, forest fires, and epidemics, etc (Table 7). The Layyah district is one of the specific disaster areas, which flooded consistently and influenced severely in the flood disaster 2010 (Fig.2). There is about a 703 acre area, comprising of 81 Potwar circles (high risk) and 36 (medium risk), 289 revenue villages (141 high risks and 148 medium risks), and 1120 thousand risky population, which were affected by flood disaster almost every year (Table 8, Fig.2). The total affected houses by flood disaster are 118 thousand (49 thousand severely affected) comprising of 81 thousand mud made, 27 thousand cemented, 29 thousand non-cemented houses. Based on this, in 2010, the absolute population influenced by the flood disaster has 361 thousand, contain 249 thousand in Layyah and 111 thousand in Karror Lal Esan tehsil. There has no effect of flood disaster on Chubara tehsil, however, it is mostly affected by drought condition in summer season.

Table 7 Layyah district, potential hazards of the district.

Event	Deaths	Affected	Event	Deaths	Affected
Drought	16	4123	Lightning, Fog	8	0
Epidemic	985	53407	Rains	3705	7,11133
Flash Flood	43	54766	Sand Storm, Storm	106	1487
Flood	4612	27,00704	Thunderstorm	19	526
Hail Storms	0	39820	Windstorm	114	2,32678
Heat Wave	358	46208	Total	10146	3902670

Source: GoP, 2014

Table 8 Layyah district, affects of flood disaster on human livelihood.

Tehsil	Aff_Pop	Aff_Area	Dam_Hous	Dam_Sch	Health	Villages
Layyah	249410	704	10871	Partially	202	Affected 12
K L Esan	111237	335	7703	Completely	32	Deaths 8
Total	360647	1039	18574	Industry	21	Risk=71

Source: GoP, 2010

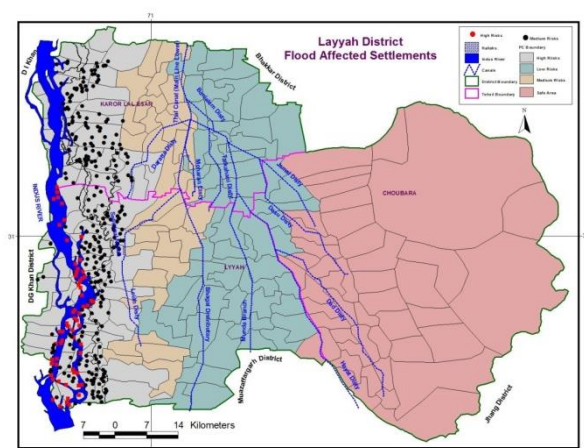


Fig.2 Flood Vulnerable Surveyed Settlements, Layyah District.

The sum of flood disaster-affected area during 2010 was 1039 square kilometers, comprising of 704 square kilometers in Layyah tehsil and 335 square kilometers in Karror Lal Esan. The total of 19 thousand houses were completed or partially damaged, wherein the maximum number of the demolished houses was eight thousand in Karror Lal Esan tehsil and 11 thousand in Layyah. Moreover, the sum of flood-influenced education institutes were 234, consisting of 202 partial and 32 completely damaged. Evidently, there has a total of 21 small scale industries, which were entirely or partially damaged. Moreover, the number of health care units vulnerable to flood disaster was 71, out of which about 12 units were partially destroyed. The sum of the revenue villages having severe damages were 122, where around 58 persons died in Karror Lal Esan and Layyah tehsil (Table 8). Consequently, the number of losses in different sectors caused by flood disaster has seen to be more severe in Layyah tehsil as compared to Karror Lal Esan tehsil.

Effects on Human Health

The flood disaster is not just influenced human infrastructure, yet it additionally caused various sorts of infection in human beings. In a flood disaster, the river water logged in various areas is suddenly soaked by the earth's surface. It approaches to the water table openly without natural filtration by the soil. As indicated by GoP (2010), the absolute number of individuals influenced by different flood disasters and injured were 209 thousand. The individuals contaminated by diarrhea are 5 thousand, influenza 40 thousand, and fever 15 thousand. During 2010 flood disaster, they affected were 6 thousand people, while 47 thousand were influenced by skin infections, 14 thousand by eye and ear sicknesses, and around 82 thousand occupants by different illnesses like typhoid and malaria, and so forth (Table 8).

Conclusion

In Pakistan, Layyah district is perhaps the hottest area, having a severe summer, moderate winter, and semi-arid climate. It is characterized by heavy rainfall in late

pre-monsoon and monsoon having moderate rainfall in the winter seasons. At Taunsa barrage, the flow of the Indus river remains high in September, July, and August and below the average in January (winter months). The information shows that there is sufficient flow in the Thal canal for agriculture from April to September and inadequate between Octobers to March. The sum of the deviation of the flow in the Thal canal is -0.1 thousand cubic feet that demonstrate an all-out decline during the study period. The annual flow of the Indus river at Chashma location is 643 thousand cubic feet with a regression estimation of 0.89 cubic feet and a deviation of 0.8 cubic feet. The water discharge has stayed high during pre-monsoon and monsoon season and declined to below normal levels in post-monsoon and winter months. Thus, the Layyah locale is at risk against overflow from July to October and stays secure in the barring months. Because of heavy discharge in the Indus river, the Layyah locale is rendering to the flood disaster because of which the poverty ratio of the area is higher than 3%. The significant disasters noted in the area incorporate earthquakes, floods, droughts, fires, epidemics, and other environmental dangers. Generally, out of 81 potwar circles, the 45 is at a high and 36 as medium risk. Among the 289 revenue villages, the 141 are at a high and 148 at a medium risk. The Karror Lal Esan and Layyah tehsils have been influenced by the flood disaster almost every year and required mitigation.

The suggestions expressed by the locals are; social planning for poverty reduction, distribution of funds, construction of dams, extension in the irrigation system, provision of first aid boxes, safety jackets, food, social trainings, drinking water, social based evaluation, and improvement in the flood disaster monitoring, preparedness, management, response, hazard appraisal overviews, excavation, awareness, and mitigation. Moreover, the people have requested for the enhancement in the flood disaster strategy, agriculture and asset insurance policy, health facilities, literacy centers, transportation, and foundation of teams for all activities at a neighborhood level.

References

- Afaq, A. (2016). Chitral Floods 2015: Recovery needs assessment and action framework. A report of PDMA, government of Khyber Pakhtunkhwa, 22 pages.
- Bukhari, S. I. A., Rizvi, S.H. (2017). Impact of 2010 Floods on Pakistan's Agriculture. *Journal of Environment and Toxicology*, 7 (1), 1-4.
- GoP., (1998). District census report of Layyah District, population census organization, Government of Pakistan, Islamabad. 331 pages.
- GoP., (2010). Report of the judicial flood inquiry tribunal, 2010, Chapter-7, Government of Pakistan, Islamabad, 267-273.

- GoP., (2014). Recovery needs assessment and action framework 2014-16. Pakistan Floods 2014. SUPARCO, IV (10), 53 pages.
- Iqbal, A. R., (2011). Flood management in Pakistan-A case study of flood 2010, ISSRA papers, 55-66.
- Jaquet, S., Shrestha, G., Kohler, T., Schwilch, G., (2016). Effects of migration on livelihoods, land management, and vulnerability to natural disasters in the Harpan watershed in western Nepal, *International Mountain Society*, 494-505.
- Khan, F. (2013). Pre and post disaster evaluation: A case study of 2010 floods in Pakistan. Master thesis in human geography, University of Umea, 54 pages.
- Khawaja, M. Z., Jawad, S., Khan, T. (2009). People's experiences and perspectives regarding disaster management (Disaster Response, Mitigation, Preparedness and Risk Reduction. A report of SDPI, Islamabad, project report series No. 14. 54 pages.
- Kronstadt, K. A., Sheikh, P. K., Vaughn, B. (2010). Flooding in Pakistan: Overview and issues for congress. Congressional Research Service 7-5700, 1-33.
- Rahman, S.U. (2014). Impacts of flood on the lives and livelihoods of people in Bangladesh: A case study of a village in Manikganj district. A dissertation for the degree of master in disaster management, Dhaka University Bangladesh, 1-48.
- Sayed, S. A., González, P. A. (2014). Flood disaster profile of Pakistan: A Review, *Science Journal of Public Health*, 2, 144-149.
- Shahbaz, B., Shah, Q. A., Suleri, A. Q., Commins, S., Malik, A. A. (2012). The Livelihoods, Basic Services and Social Protection in North-Western. Researching Livelihood and Services Affected by Conflicts, Working Paper-5, Report of SDPI, Islamabad, 70 pages.
- Shrestha, M. S. (2008). Impacts of flood in South Asia. International Centre for Integrated Mountain development. ResearchGate, 1. 1-23.
- Sudmeier, R. K., Masundire, H., Rizvi, A., Rietbergen, S. (2006). Ecosystems, livelihoods and disasters: An integrated approach to disaster risk management. ecosystem series No. 4, IUCN, Gland, Switzerland and Cambridge, UK. 58 pages.
- Uddin, K., Raj, D., Giriraj, A., Shrestha, B. (2013). Application of remote sensing and GIS for flood hazard management: A case study from Sindh Province, Pakistan. *American Journal of Geographic Information System*, 2 (1), 1-5.