

Flood Impact on Water Supply and Sanitation Services; A Case Study of Dera Ghazi Khan City



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THESIS ACCEPTANCE CERTIFICATE

Certified that final copy of the thesis titled “Flood Impact on Water Supply and Sanitation Services; a Case Study of D.G.Khan City” written by Ms. Hifsah Nawaz Qaisrani (Registration No. 00000206723), of Urban and Regional Planning (NIT-SCEE) has been vetted by the undersigned, found complete in all respects as per NUST Statutes/Regulations, is free of Plagiarism, errors and mistakes and is accepted as partial fulfilment for the award of MS degree. It is further certified that necessary amendments as pointed out by GEC members of the scholar have also been incorporated in the said thesis.

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DEDICATION

*This thesis is dedicated to my beloved parents, husband, sisters and brother for always being
an unending source of love and encouragement.*

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All praises to the Allah Almighty, the merciful and the most beneficent who showers his blessings upon us every day. He beholds all the knowledge of the universe and beyond.

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Hifsah Nawaz Qaisrani

Abstract

Floods cause damage to people, buildings, and infrastructure. Floods directly impact the poor structures of water supply and sanitation services, which indirectly cause service disruption and affect the population. Flood impacts have been studied in many different countries, including Pakistan. However, the hazard of flash floods in D. G. Khan district has distressed human activities due to disruption of water supply and sanitation during flooding. This exploratory research aims to assess the flood impacts on water supply and sanitation services, and identify the challenges being faced for disaster reduction. Furthermore, it will provide strategies to create resilient water supply and sanitation services in urban areas. Descriptive statistics, co-relation test, content analysis test and paired sample t-test were conducted in order to find out the impact of floods on water supply and sanitation services. Using Slovin's sampling method, a total of 400 samples were collected. Results indicate the impact of flooding on water supply and sanitation is high. Satisfaction level shows that people are not satisfied with the government's behavior regarding disaster management.

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Chapter 1: INTRODUCTION

Floods are a natural part of the hydrological cycle that causes casualties, economic losses, and devastation. However, there are many benefits associated with flooding such as renewing soil fertility. Flooding is the most frequent natural disaster. Amongst all the natural disasters, floods are the most common and habitual. Over the past two decades the numbers of flooding events have been increasing significantly (Lau et al., 2010). During this time, the flood disaster has become more intense despite vast efforts in flood management (Ranjan, 2017). The reasons behind severity of flood damages are climate change, population growth and unsustainable development (Bhattacharya, 2010).

The climatic changes are manifestation of an increasing likelihood of extreme weather conditions around the globe. Climate changes have impacts on city's future growth patterns and development (Ullah, 2016). However, mitigation and adaptation strategies are necessary to reduce the impacts of flooding on the city infrastructure and public services.

Floods cause major disruption to many life activities and businesses. Among these are the services, transportation, housing, water supply and sanitation provision are essential. Impact on these services creates wider impact on the health of population of the city. As a matter of fact, number of fatalities and economic losses are larger in the developing countries than developed countries because the developed world has better capacity to recover. The largest share of economy and population of South Asia is exposed to floods (Rasul, 2016). Significant number of people has started to live in the cities and flood prone areas along the rivers which ultimately increase their vulnerability towards natural hazards especially flooding. It has been estimated that 61 percent of population of

world will live in the cities by 2030 (Bhattacharya, 2010). It is evident that with persistent urban growth and improper urban planning, the vulnerability of cities for disasters will increase (Rana and Routary, 2017).

The understanding of flood impacts is very crucial to manage the effects of flooding, and make better and timely decisions for addressing the impacts. Flood risk management is described in terms of the risks, hazards, vulnerability, resistance, coping and adaptive capacity of the urban population. Flood risk management stands as a strategy which helps to stabilize the present needs of sustainability. Thus, integrated flood risk management allows combination of both measures that are structural and non-structural (Nawab, & Nyborg, 2009). The structural measures includes building infrastructure while non structural measures help to reduce the impact of floods and vulnerability of the people with help of early warning system, Disaster risk reduction, flood emergency response, and evacuation system. Thus, flood risk management strategies in flood prone areas consider the reduction of impacts of floods (Tank, 2014). Despite being protected with flood control infrastructure the challenge of flood hazard still exists. Flood control infrastructure is not a sustainable mitigation approach given the current climate change uncertainties. Thus, an alternative approach for mitigation is needed that can be achieved by focusing on the building resilient water supply and sanitation infrastructure (Choudhury, 2019).

Resilience is defined as “the ability to take over the change and shocks in the system while still manage to establish the same relationship between the community and state variables” (Vis et al., 2003). A resilient system is the one that can tolerate the disturbances thereby limiting the impact, by reducing the damage and disruption in the system, and

allows the system to recover and adapt quickly to such changes (Choudhury, 2019). In order to make the water supply and sanitation services resilient, planners need to figure out the ramifications of flooding. The strategies for building resilient structures include minimizing the negative impacts of flooding as well as working on risk management (Choudhury, 2019).

1.1 PROBLEM STATEMENT

Human settlements and urbanization patterns are unplanned due to which communities in the flood prone areas are more vulnerable to flooding impacts. The extent of damage to the communities is not only due to precipitation but influenced by many other factors such as poor quality and ill maintained infrastructure, low quality building material, poor drainage system and lower level of awareness among the community regarding flood preparedness. Nevertheless, the vulnerability can be reduced with the help of cooperative action by stakeholders, government and institution by addressing the challenges of flooding.

Living in flood prone areas, many communities develop their own adaptive measures. Many studies reveal that communities adapted to shocks and disturbances rather than resisting are more durable (Liao, 2012). In order to get back a normal life after shock, much effort, time and money is required due to which these areas are lagging behind. In short, disasters put pressure on individuals, communities, local and national economies. In order to seek understanding of the challenges caused by flooding impacts, there is a need for enhancing the policies, technical knowledge and strategies. It can only be achieved through coordinated effort of national and local institutions (Ahmed et al., 2014).

1.2 PURPOSE OF STUDY

This study will help to identify the challenges in DR for water supply and sanitation sector, and would recommend strategies to build resilient water supply and sanitation services in urban areas.

1.3 RESEARCH OBJECTIVES

The main objective of the research is to assess the flood impacts on water supply and sanitation services in urban areas to build strategies for resilient water supply and sanitation services in urban areas. The sub-objectives of the study are;

1. To study the basic characteristics of water supply and sanitation systems and services.
2. To assess the flood impacts on water supply and sanitation services.
3. To identify the challenges in DR for water supply and sanitation sector.
4. To give recommendations to enhance the flood risk management and build the resilience of water supply and sanitation system.

1.3 RESEARCH HYPOTHESIS

The study hypothesis is that existing water and sanitation services present in urban areas are vulnerable to floods and need immediate attentions.

1.4 RESEARCH OUTLINE

The research thesis includes five chapters with tables and figures as outlined below:

- Chapter 1 Introduction
- Chapter 2 Literature Review
- Chapter 3 Research Methodology
- Chapter 4 Results and Discussion
- Chapter 5 Conclusion and Recommendations
- References are attached at the end of the document.

1.5 RESEARCH SCOPE

The research is carried out in the urban area of D.G.Khan city. The research studies affects of flood on water supply and sanitation services in the vulnerable areas of D.G.Khan city.

1.6 SIGNIFICANCE OF STUDY

- This study will fill the research gap on the impact of floods on water supply and sanitation services of the case study area in the context of Pakistan.
- The results of this study will be useful for government and policy makers to understand how much important it is to plan resilient services in flood prone areas
- The findings of this research will help the planners to design better city services by considering all the impacts of floods.

Southern Punjab region is well known for its vulnerability to floods. In D.G.Khan District floods have the prolonged and damaging effects as it disrupts all the aspects of livelihood. D.G.Khan District suffers from flood on regular basis, and with the changing climate flooding is expected to increase in future. D.G.Khan District is mainly an agricultural area. During flooding the water supply and sanitation systems are affected severely which increases the risk of water borne diseases as well as danger to agricultural land.

This research will provide a comparative analysis of how water supply and sanitation sector is affected in rural and urban area during flooding. This research will also look into the adaptation mechanism used by the people. Additionally, this research will help to provide recommendations for effective management of these sectors. The expected outcome of this research is to highlight this issue for the concerned government authorities to deal with the problems of water supply and sanitation during flooding in an effective manner to reduce the vulnerability of people.

Chapter 2: LITERATURE REVIEW

KEYWORDS:

Water supply, Sanitation, Floods, Pakistan

2.1 NATURAL HAZARD

UNSIDR defines natural hazard as a natural process that can causes damage to property, social and economic life and disrupts the services.

“Natural processes or phenomena that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage.” (UNSIDR)

When a natural hazard causes loss of human life, livelihood and disrupts the social and ecological systems, then it becomes a disaster.

“A serious disruption of the functioning of a community or society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope with using its own resources.” (UNSIDR)

2.1.1 Floods: Devastating Natural Hazard

Floods are one of the most frequently occurring natural hazards around the world that cause serious damage to life, property and infrastructure. With the rise of extreme weather events as a result of global warming and climate change, the developing countries face the risk of more disasters in future. In South Asian countries, the lack of effective management of water for irrigation and sectoral policies affect drinking water supplies,

water and sanitation (Rasul, 2016). In India also various parts of the country are affected by floods, causing enormous damage to life, property and disruption of infrastructure. Due to neglect of urban planning and management, vulnerability to flood inundation increases (Singh, Saha, and Tyagi, 2019).

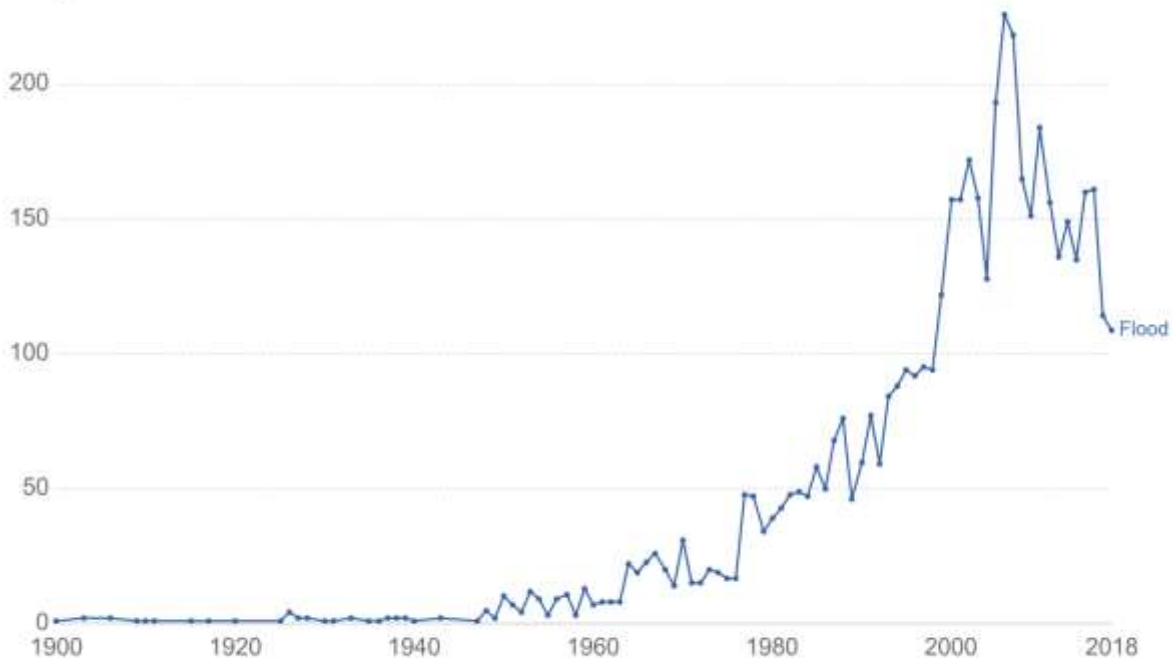
According to (Shimi et al., 2010) the disaster risk management activities rely on the role and participation of the local community and government. Furthermore, the participatory approaches used for risk management are based on the local knowledge about hazard intensity, vulnerability and resilience measures that are used to limit the level of risk. In the Sendai Framework for Disaster Risk Reduction 2015-2030, the need for community based disaster risk management has been underlined. In addition to it, many non-government organizations such as United Nations Development Program and Asian Disaster Preparedness Center have worked on this issue (Rahman and Shaw, 2014). One of the goals of 2030 Agenda for Sustainable development is the provision of access to clean water and sanitation.

Poor sanitation and inappropriate clean water supply, absence of national plans and cross-institutional collaboration is a major factor that is contributing to the increased number of health issues. Floods have short term as well as long term impacts particularly in the areas with poor hygiene and unsafe drinking water (Alderman, Turner, & Tong, 2012). In addition to it, climate change poses significant challenge for the water and sanitation services (Howard et al., 2016).

Number of recorded natural disaster events, Flood



The number of global reported natural disaster events in any given year. This includes those from drought, floods, extreme weather, extreme temperature, landslides, dry mass movements, wildfires, volcanic activity and earthquakes.



Source: EMDAT (2019): OFDA/CRED International Disaster Database, Université catholique de Louvain – Brussels – Belgium.
OurWorldInData.org/natural-disasters/ • CC BY

This graph shows that the number of flooding events have increased in its intensity and frequency in the past two three decades.

2. 2 INTEGRATED FLOOD RISK MANAGEMENT

Flood risk management requires the collaboration of various tasks that are incorporated into the development planning along with community participation to enhance the community resilience and lower the flood risk. The integrated flood management implies that resilience is the ability of institutions, communities and individuals to adapt and recover from the shock. Thus, adaptive capacity is the main concept for building the resilience of any community (Ullah, 2016).

2.2.1 Flood Resilience Practice for Managing Flood Risk:

Resilience is the ability to take over the change and shocks in the system while still manage to establish the same relationship between the community and state variables (Vis et al., 2003). Resilience is not just the capacity of the system to return back to its original state but the process of advancement in it that learns from past experiences (Cutter et al., 2008). In terms of flood risk management, resilience focuses on the minimization of impacts of floods by living with it (Vis et al., 2003). The management approaches for flood impacts recognizes that floods are unstoppable from occurring. However, it implies on reducing the vulnerability of the infrastructure and community at risk (Rafiq, & Blaschke, 2012).

2. 3 WAYS TO INCREASE FLOOD RESILIENCE

The ways to increase the flood resilience lies with the awareness of community and its preparedness for flooding. It leads to better preparation for example building the strong structures along with increased capacity, implementation of early warning and knowing the emergency procedures. The main aim of enhancing the resilience is to reduce the risk associated with flooding (Schelfaut et al., 2011). Institutions must be aware of the flood hazard and take necessary measures to protect their services and the community by anticipating against the floods. The government must acknowledge it and communities must know about the risk to take necessary measures. In addition to it, the risk analysis and policy making provide a basic understanding to flood hazard for improving the communication among local institutions, professionals and decision makers (Aslam, 2018). The communication must promote awareness and preparedness for flooding. The

utilization of the various flood management tools like plans for flood management and early warning systems can help increase the preparedness of the local authorities and the communities (Malik, Awan, & Khan, 2012).

2. 4 FLOODS IN PAKISTAN

Pakistan is one of the most vulnerable countries to climate related disasters. Among all the types of natural disasters, floods are the most disastrous in Pakistan (Ahmed et. al, 2014). Floods have posed key challenges to economic development in Pakistan. In the Indus River region, heavy monsoon results in severe precipitation that becomes the direct cause of floods. Floods are most terrible in the Indus plain.

In Pakistan floods happening along river Indus have caused catastrophic impacts in 2010. In addition to it, the flood events in various other countries in 2010 and 2011 ended in drastic damages (Jha et al., 2012). It has been observed that about 38 percent of the world population lives in the areas that are highly susceptible to flooding.

Since 1973, Pakistan has had major flood events which affected almost 40 million people. However, the 2010 flood is referred as one of the most devastating event. In 2010 the flood accompanied the annual monsoon season causing unusual level of water flow in the history of Indus River in Pakistan. In this event more than 78 districts were affected causing huge loss of life, property, crops and infrastructure (Baker, 2012).

In addition to it, (Ullah, 2016) has identified that the people living in the flood prone areas are most vulnerable group which is associated with minimal access to health services, safe water supply and sanitation services. In particular the infrastructure of

this vulnerable area is destroyed in every flood event. Thus, it will create negative impact on the Human Development Index of Pakistan, which is based on the access to education, health and public services (Rafiq, & Blaschke, 2012). According to Global climate risk index, Pakistan is the 7th on the list of top ten countries facing the serious effects of climate change. Pakistan has experienced heavy flood damage in 2010 and 2011. Proper management of sanitation system is one of the challenges that the local governments face (Baig et. al, 2019).

2.5 FLOOD MANAGEMENT IN PAKISTAN

In Pakistan, there are many departments that deal with flood risk management, working at national level as well as provincial level. At the National level, a focal body 'National Disaster Management Authority (NDMA) was established to deal with the mitigation, preparedness, adaptation, and response and recovery process. At present, the disasters are largely managed by the provincial Disaster Management Authorities. The district management institutions are not fully functional (Atta-ur-Rahman, 2014). It is mainly because the coordination mechanism of disaster management among various levels is weak.

The government of Pakistan has passed many acts and ordinances to form the flood policies. The national meteorological and hydrological departments provide data about weather events. However, the flood management in Pakistan falls under three aspects:

1. Flood management measures
2. Legislative framework

3. Institutional setup

2.5.1 Flood Management Measures

In Pakistan, the flood management measures consist of the protection structures build such as levees, spurs and the forecasting techniques. In addition to it, there are structural and non structural measures used by the government. However, Pakistan largely relies on the structural measures (Aslam, 2018). These consist of the construction of embankments, dikes and flood water channels.

2.5.2 Legislative Framework

According to (Aslam, 2018), the legal framework for water management in Pakistan is carried out by WAPDA Act (1958), Environmental Protection Act (1997) and Indus River System Authority Act (1992). Emergency services Ordinance (2002) and National Disaster Management Ordinance (2006) has provided strategies to deal with the emergency situations. In addition to it the Ministry of Water and Power has developed a draft of National Water Policy (2002) for floods in Pakistan. This policy helps to draw attention towards the enhancement of community awareness and stakeholder participation for flooding (Aslam, 2018).

2.5.3 Institutional Framework

Federal and provincial institutions are involved in the Flood risk management. The risk managing institutions deal with the structural and non-structural measures in order to cope with the floods while the crisis managing institutions are involved in the process of rehabilitation, relief, rescue and recovery operations (Nawab, & Nyborg, 2009).

2.5.4 Failure of Institutions

Flood is a natural phenomenon but some of human activities increase its potential adverse impacts. Even though there are institutions at federal and provincial level in Pakistan to manage various disasters however, the damage caused by flooding is increasing each year (Ahmed et. al, 2014). Lack of resources, poverty, unawareness, lack of political will worsen the flood disaster. In addition to it, there is no proper implementation of the schemes by which impacts of floods can be controlled. That is the reason people in hazard prone regions are severely affected by floods (Ahmed et. al, 2014). Therefore a better management system is needed to reduce the impacts and losses of flood.

Poor coordination among government institutions has led to unsustainable use of resources (Rasul, 2016). The impact of disasters can be enhanced through improvement and capacity building of local institutions (Atta-ur-Rahman, 2014). There is need for technical knowledge and government commitment to deal with such disasters in Pakistan.

2.6 Impacts of Flooding In Pakistan

The past flood events in D.G.Khan district have damaged properties in both rural and urban areas (Ahmed et. al, 2014). It was observed that the health condition during floods in urban area of D.G.Khan district were poor. This was mainly because the existing system was inadequate to fight against the water-borne and water-related diseases (Ahmed et. al, 2014). Furthermore, the mismanagement and defenseless infrastructure in the area causes inundation.

There is need for planning and innovation in the flood management sector. Much of the flood related work is based on the causes of floods but the research on effective management of the public services to build resilience structures is yet to be done. According to (Ahmed et. al, 2014) 50 percent of the urban area of D.G.Khan District was surged under water during 2012 floods. Due to this people are unable to fight against the water related diseases. It has been observed that the mismanagement and defenseless infrastructure bring about the inundations in this area.

Progress towards proper sanitation and hygiene can be achieved faster if a multi-sectoral and multi-disciplinary approach is developed and implemented (Ahmed et. al, 2018). In Gilgit Baltistan, after implementation of proper sanitation system services, an improvement in their living standards of the local community was observed (Baig et. al, 2019). In addition to it, the prevalence of diseases was observed to be tremendously decreasing after construction of the project.

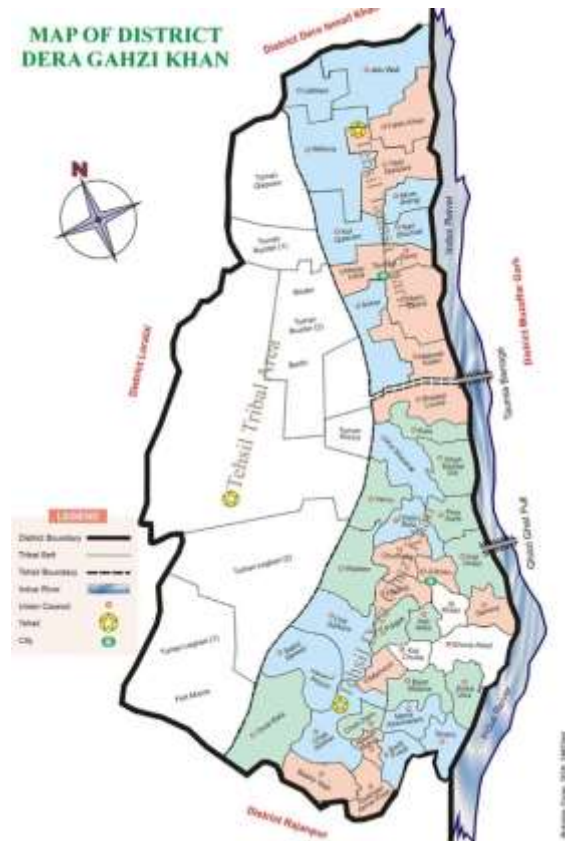
Chapter 3: RESEARCH METHODOLOGY

3.1 RESEARCH DESIGN

In this chapter the research approaches undertaken during this study are discussed. This study aims to examine the impacts of floods on water supply and sanitation services in urban area of D.G.Khan District. The study is based upon Mixed Research method involving both qualitative and quantitative means of data collection and analysis. Mixed research method is applied to gain information about the flood risk management system and how the adaptation strategies are mainstreamed at the local and community planning level. It helps to investigate the water supply and sanitation services and check if they are resilient against flooding event.

3.2 CASE STUDY AREA

Dera Ghazi Khan is located in Punjab province. The Indus River flows on its eastern side in the direction from north to south. D.G.Khan District is divided into two tehsils, and consists of total sixty Union Councils. Layyah and Muzaffargarh are located across the river. Rajanpur is located in the south of the District.



The case study area selected to conduct the research in District D.G.Khan is the main city of D.G.Khan. This research will contribute to the knowledge pertaining to flood risk management and flood impacts on the water supply and sanitation services in the flood prone area.

3.3 DATA COLLECTION

Data collection is the most important part of the study. This study derives information from two sources.

For this research data collection is divided into two types:

- Secondary data
- Primary data

3.3.1 Secondary Data

Information and data collected from secondary sources consists of information being essential to examine the flood impacts on urban environment of the D.G.Khan District. Secondary data was collected from various sources like articles, reports, academic literature, and National Disaster Management Authority reports. Secondary data were utilized to get descriptive data about flood affect communities and their coping mechanism.

Secondary information consists of the existing situation of water supply and sanitation, which is collected from the office of local government authority, and departments responsible for supply of water and sanitation services. This data helped to develop the statement on flood impacts on water supply and sanitation structures in the D.G.Khan district which ultimately depicts the situation of disaster risk management in Pakistan.

Available literature helped in developing the research questions and helped to assess the capacity building needs for making people and the infrastructure more resilient against flooding. Secondary information about the roles and responsibilities of the Government Institutions and other departments were collected from the reports of previous studies, peer reviewed research papers and reports published nationally and internationally.

3.3.2 Primary Data

The primary research involved key informants in the government and local institutional sector that are responsible for managing water supply, sanitation services and Disaster Risk Reduction of community against flooding. Primary data was collected through the field survey of the research area in the form of questionnaires, structured and unstructured interviews. Field survey at various locations in the study area was conducted so that the basic characteristics of the study area can be identified and analyzed. This **exploratory research** helped to get a perception of the local people about the water supply and sanitation services in the area, as well as their level of preparedness, role of government and their indigenous knowledge about flood risk management after previous flooding events.

3.4 INSTRUMENTS OF DATA COLLECTION

3.4.1 Field Survey

Site visits were conducted to observe the physical characteristics of the research area. In this field survey existing setup of the water supply and sanitation services were identified. The provision and accessibility of water supply and sanitation was examined in the selected areas. Through primary field observation, the existing form of services in the selected areas was perceived and it helped to gather initial information regarding the historic flooding events. It gave sufficient details to make generalization about the impact of flood in the case study area.

In addition to it, questionnaire survey was conducted to get the information from the community, and residents' opinion about the services being provided and their accessibility. Also, the residents were asked about impact of flood on the accessibility and quality of these services in the area. Residents were asked to give their valued view regarding the improvement of water supply and sanitation facilities to enhance their quality of life.

3.4.2 Structured/Un-structured Interview

Interviews were conducted to evaluate the existing situation of the water supply and sanitation services in the given study area. The performance indicators were defined to gather the right information from the respondents. The interview was designed to explore the attitude, perception and beliefs of the experts.

Structured interviews comprised of the questions that helped in collecting their opinion regarding management issues of water supply and sanitation services and means to enhance these existing systems to face the challenges of floods.

3.4.3 Focal Group Discussion

Focal group discussion was conducted to measure the level of understanding, and past experiences of respondents with respect to floods. Two focal groups were designed, one female groups discussion and other included males. The questions were designed to allow the respondents to discuss their experiences and suggestions regarding different types of issues concerning water supply and sanitation services. Respondents above the age of 50 years were included in the focal group discussion to gather information which is not included from primary or secondary sources.

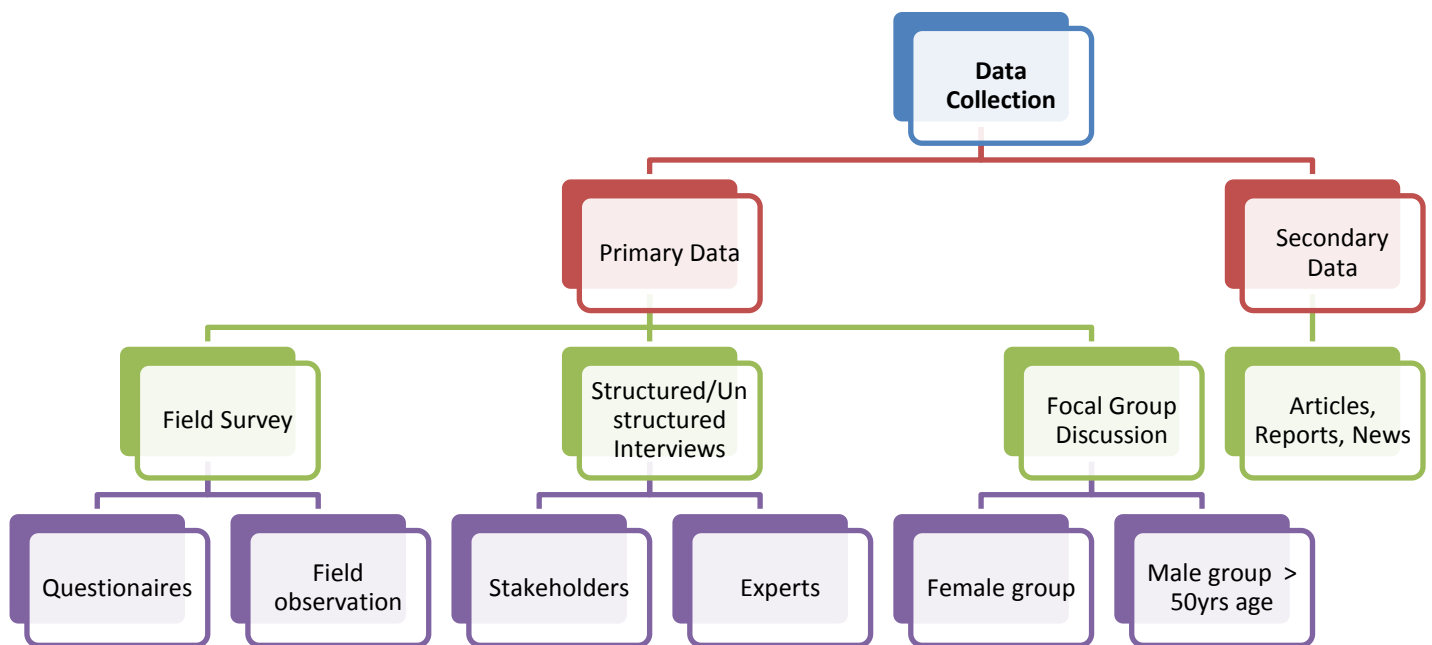


Figure 1: Instruments of Data Collection

3.5 SAMPLE SIZE

The sample size for collection of data was estimated by using Slovin’s formula.

$$n = N / (1 + Ne^2)$$

The population of the D.G.Khan District as per the 2017 census = N = 2.872 million

Total population	Urban Population (N)	Margin of Error (e)	Sample size (n)
2.872 million	547855	0.05	399.708

Marginal Error = e = 0.05

Thus, sample size = n = 400

To remove any biasness, at least 30 percent of the sample size will consist of women participants. The questionnaire for the community, based on literature review were distributed that included closed and open ended questions to help determine the flood impacts on water supply and sanitation services and their level of preparedness while being in the flood prone area.

3.6 SAMPLING TECHNIQUE

To collect the data from respondents, “systematic random sampling” technique was employed. The randomly selected respondents were selected from age group 20 to 62 years in order to get a more applicable data for the assessment of flood impacts on the water supply and sanitation services.

3.7 DATA ORGANIZATION AND ANALYSIS

The data collected from all of the sources was compiled and analyzed with the help of different software like Microsoft Excel and SPSS. The data was organized and processed/analyzed using both qualitative as well as quantitative techniques. Various analysis techniques were used to process the data.

3.7.1 Qualitative

The qualitative data collected from the questionnaires, structured and unstructured interviews, and focal group discussions was arranged.

3.7.1.1 Content analysis

Content analysis helped to ascertain the flood impacts and future challenges faced by the water supply and sanitation services in vulnerable areas. The content analysis provided an overview of the government role during and after flooding events. It also elaborated the issues that exist in flood risk management in the case study area.

3.7.2 Quantitative

The quantitative data was collected from the respondents through questionnaire survey in the field.

3.7.2.1 Descriptive analysis

In descriptive analysis technique, the statistical data was used to illustrate the meaning/summary of the facts and figures. Descriptive analysis technique was used to analyze the data, and to calculate mean, median and mode. Qualitative input of data was processed in the SPSS software to generate descriptive analysis which identified the issues in the existing situation of the case study area.

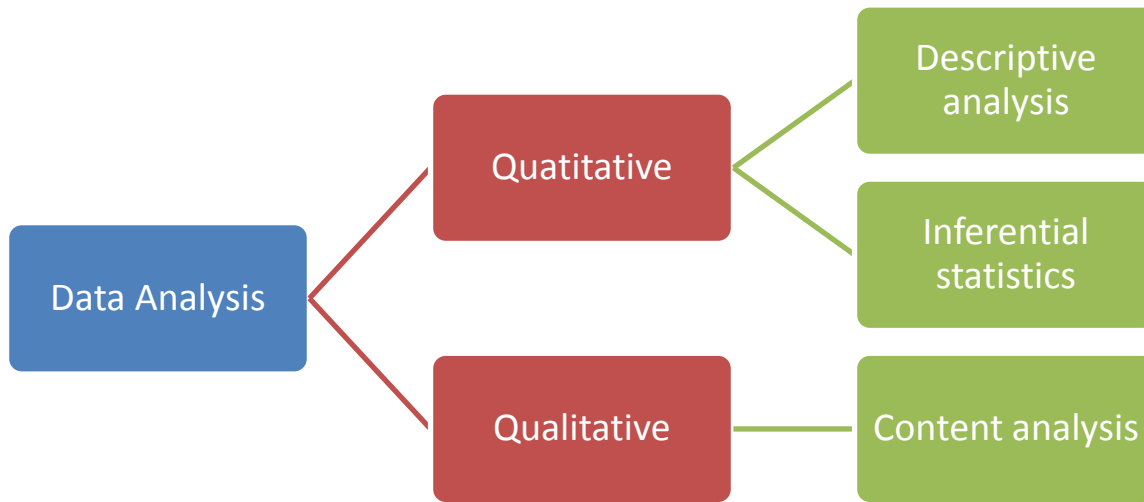


Figure 2: Data Analysis techniques

3.8 METHODOLOGY FRAMEWORK

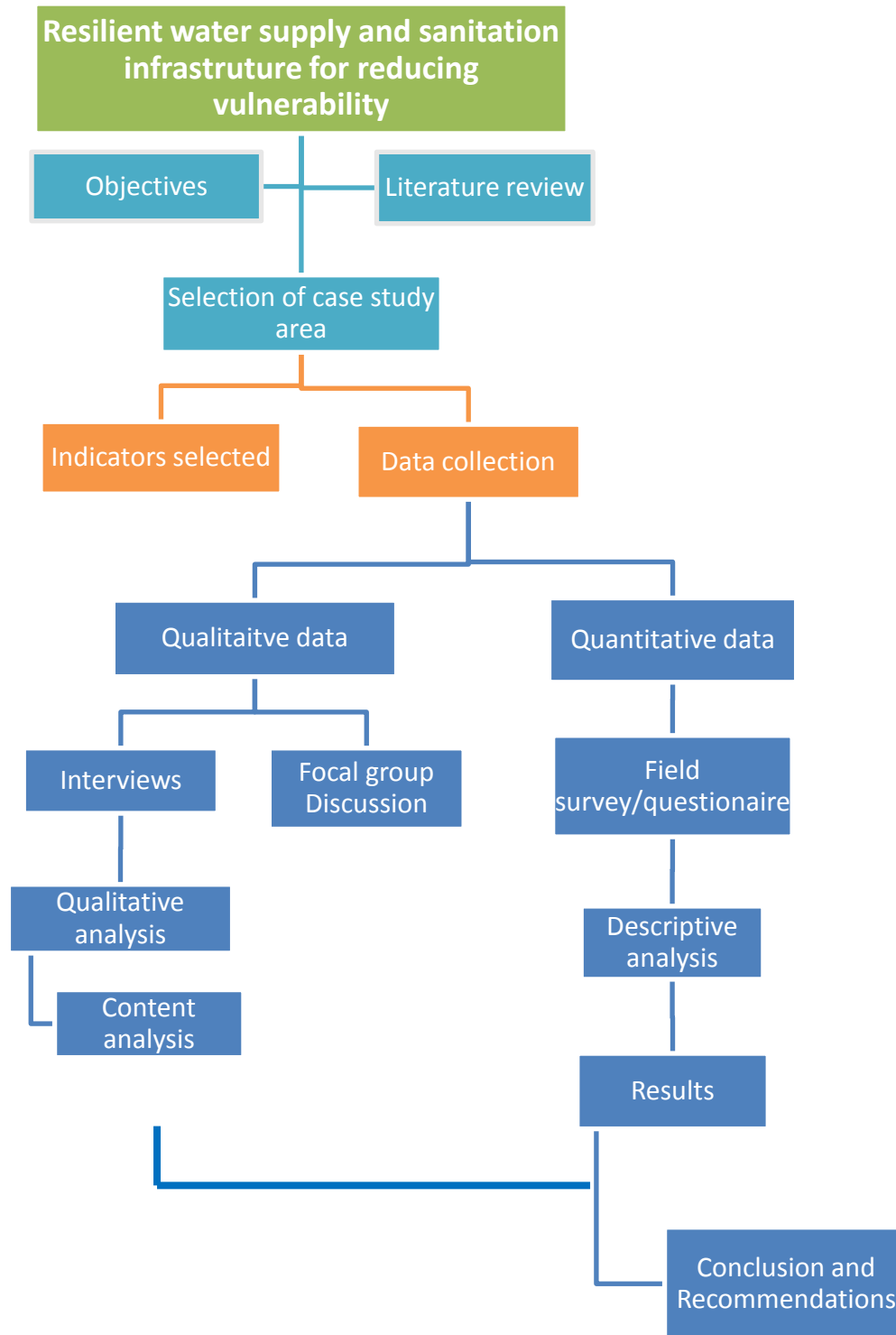


Figure 3: Methodological Framework

CHAPTER 4: RESULTS AND DISCUSSION

In order to examine the impacts of floods on water supply and sanitation services as well as the flood risk management in the District of D.G.Khan, 430 questionnaires were filled face to face by the researcher and the surveyors in the community of D.G.Khan city. Two surveyors volunteered for the fulfillment of questionnaires from the different locations in the city. To gather appropriate from community, communication with elder respondents was done in Saraiki language. D.G.Khan city experiences many issues in water supply and sanitation services as claimed by the District Government.

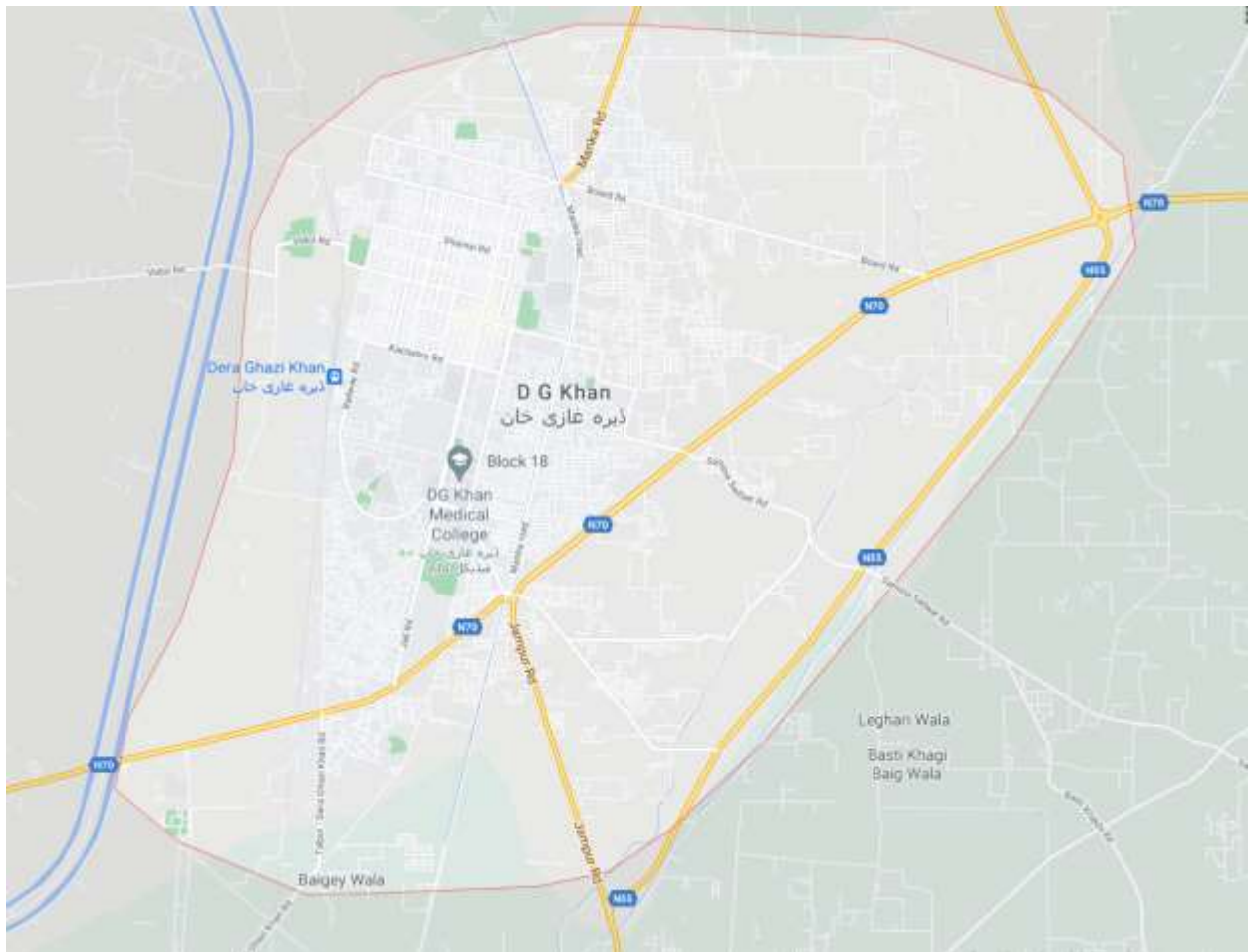


Figure 4: Case study area within the district of D.G.Khan

Source: Google Maps

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4.1 DEMOGRAPHIC PROFILE OF RESPONDENTS

Table 1: Demographic profile of respondents

Variable	Classification	N	Percent
Age (years)	10 to 25	38	8.8
	25-35	148	34.4
	>35	244	56.7
Total		430	
Gender	Male	301	70
	Female	129	30
Total		430	
Education (years)	<5	12	2.8
	5 to 10	163	37.9
	10 to 14	115	2.7
	>14	140	32.6
Total		430	
Years of living	<5	43	10
	5 to 10	181	42.1
	10 to 15	81	18.8
	>15	125	29.1
Total		430	
Household size	<5	78	18.1
	>5	352	81.9
Total		430	

The above table is quite revealing about the demographics of the people living in the D.G.Khan city that are vulnerable to annual flooding. This demographic profile of the respondents gives an insight of age, gender, education level, household size and years of

living in the house in the case study area of research. During the field survey, respondents living in the area were asked questions related to their annual flood experience and after flood impacts, as they are most vulnerable to annual flooding in the area.

Both genders filled the community questionnaires. Among the 430 questionnaires, two-third (70%) of the respondents were males and one-third (30%) of the respondents were females. More than half of the respondents had age greater than 35 years. The age of respondents has been categorized in three groups. 8.8 % responses were gathered from age group of 10 to 25 years, 34.4 % responses were gathered from age group of 25 to 35 years, and 56.7 percent were taken from age category of more than 35 years old. Most of the respondents especially males were asked questions while they were at work while other respondents were asked questions at their home as the data was collected from both offices and homes. It was observed that most of the people in the area work.

In the case study area, majority of the respondents had been living in their house for 5 to 10 years. 10 % respondents lived in their house for less than five years. 42.1 % respondents had been living in their house for 5 to 10 years, 18.8 % respondents had been living in their house for 10 to 15 years, 29.1 % respondents had been living in their house for more than 15 years. The communities have strong connection with each other.

In the case study area, majority of respondents (81.9%) had household size greater than 5. 18.1 percent household had size less than 5 while maximum household size was greater than 5 people. It has been observed in the field survey that people live close to each other. Each household in family shares common living room and baths. Although they have their own personal space but they help share happiness and sorrows with one another.

In the field survey, the Education level of the respondents was also identified. Results show that majority of respondents (37.9%) had education level up to 10 years. 2.8 percent of the respondents have education less than 5 years. On the other hand, 2.7 % people had education up to 14 years of education level and 32.6 percent people had education level more than 14 years.

4.2 BASIC CHARACTERISTICS OF WATER SUPPLY AND SANITATION SERVICES

The basic characteristics of the water supply and sanitation services in the case study are given below in the table;

Table 2: Basic characteristics of water supply and sanitation services in the case study area

	Category	Frequency	Percentage
Source of water supply	Bore well/Hand pump	51	11.9
	Public tap	25	5.8
	Household water supply (piped)	390	90.7
Age of Water supply system	10 years	84	19.5
	20 years	60	14
	30 years	62	14.4
	>30 years	35	8.1
	No idea	189	44
Billing Mechanism for water supply	Monthly	45	10.5
	Bi-annual	202	47
	Annual	85	19.8
	None	98	22.8
Type of Billing Mechanism	Fixed	287	66.7
	Metered	143	33.3
Expenditure on water supply services	< Rs. 150/month	342	79.5
	> Rs. 150/month	88	20.5

Quality of water in previous floods	Low	18	4.2
	Medium	358	83.3
	High	54	12.6
Type of Sanitation system	Piped sewer system	277	64.4
	Septic tank	117	27.2
	Pit Latrine with slab	6	1.4
	Flush/Pour Pit Latrine	71	16.5
Waste collection authority	Public health department	157	36.5
	TMA/District management	156	36.3
	Municipal Committee	117	27.2
Expenditure on sanitation services	< Rs. 150/month	402	93.5
	> Rs. 150/month	28	6.5

The above table tells the source of water supply, age of the water supply system, billing mechanism for water supply, type of billing mechanism, expenditure of respondents on water supply services, quality of water supplied in the previous floods, type of sanitation system they have, waste collection authority in the area, and the expenditure of respondents on the sanitation services.

It has been observed that the source of water supply for majority of the respondents was household water supply (piped). Almost 90.7 percent respondents have household water supply, while 11.9 percent had bore well/hand pump installed in their homes, and 5.8 percent of the respondents used public tap for getting water.

When inquired about the age of the water supply system, that is how old the system has been, almost half of the respondents (44 %) had no idea about it. However, about 19.5 percent respondents believed that the water supply system has been rebuilt after the 2010

floods and is almost 10 years old. Other respondents also provided their view which depicted that 14 percent respondents believed that the water supply system has been 20 years old, 14.4 percent believed it was 30 years old, and 8.1 respondents believed it was more than 30 years old.

The billing mechanism for water supply services in the case study area was assessed. Almost half of the respondents (47 %) told that the billing was bi-annual. Nevertheless, 22.8 percents respondents told that there was no billing mechanism for water supply, 19.8 percent replied that it was annual, and 10.5 percent respondents told that they were charged monthly for the water supply services. More than half of the respondents (66.7 %) told that the type of billing mechanism in the case study area is fixed while 33.3 percent told that the billing was metered. When assessed about the expenditure of respondents on water supply services, majority of the respondents (2/3) told that their expenditure was less than Rs. 150/-. However, 20.5 percent respondents told their expenditure was greater than Rs. 150/-.

Assessing about the quality of water supply services in the previous floods, it was found that majority of the respondents told the quality level was medium. The classes of low, medium, and high water quality were defined; Low: Have taste, smell, color and odor (unfit for use), Medium: Muddy but still usable, and High: Suitable for drinking and other purposes. 83.3 percents respondents told the water quality in previous floods was medium, 12.6 percent respondents told it was of high quality while 4.2 percent respondents told the water quality was low.

Assessing the type of sanitation system respondents have in the case study area, it was found that more than half of the population had piped sewer system. 64.4 percent respondents had piped sewer system, 27.2 percent respondents had septic tank, 16.5 percent respondents had Flush/pour pit latrine, and 1.4 percent respondents had pit latrine with slab.

The waste collection authority in the case study area was asked from the respondents. There are mainly three waste collection authorities: Public health department, TMA/District management, and Municipal committee. 36.5 respondents told that Public health department collects waste in the area, 36.3 percent told that it was TMA/District management, and 27.2 percent told that municipal committee is responsible for waste collection. When assessed about the expenditure of respondents on sanitation services, majority of the respondents (93.5 %) told that their expenditure was less than Rs. 150/-. However, 6.5 percent respondents told their expenditure was greater than Rs. 150/-

4.3 IMPACTS DUE TO FLOODING

4.3.1 Damage to Infrastructure

Due to frequent flooding in the area, floods have caused damages to the following infrastructure.

Table 3: Damage Extent of Infrastructure

Infrastructure	Damage Extent (%)				Damage index (DI)
	NO	Low	Medium	High	
Water supply	6.3	1.9	29.3	62.6	34.84
Sanitation services	4	1.9	23	71.2	36.16
Roads	9.5	16.7	35.8	37.9	30.19
Gas pipelines	13.3	20.5	40.5	25.8	27.9

Electricity	8.1	1.2	72.1	18.6	30.12
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Low: Reconstruction cost less than 1 million Rs.

Medium: Reconstruction cost between 1 to 2 million Rs.

High: Reconstruction cost more than 2 million Rs

The table above shows the extent of damage to various infrastructures in case study area due to annual flooding. The above table depicts that sanitation infrastructure suffered greater destruction from the annual floods. During the field visit, it was observed that the sanitation infrastructure is still damaged, and drains need maintenance. Both water supply and sanitation services were reported to have high damage extent. More than half of the population (71.2%) reported that sanitation services were highly damaged. Also, 62.6 % respondents reported high damage to water supply services.

Road infrastructure, gas pipelines and electricity experienced medium extent of damage. 35.8 % of respondents reported medium damage extent to road infrastructure. 40.5 % of respondents reported medium damage extent to gas pipelines. 72.1 % of respondents reported medium damage extent to electricity.

To formulate the Damage Index (DI) of each of the infrastructure, weight-ages are assigned for each value of damage extent. 10 % for no responses, 20 % for low damage extent, 30 % for medium damage extent, and 40 % for high damage extent. After calculating the damage index for each infrastructure, it was found that maximum damage index (36.16) has been for sanitation services while water supply services had damage index of 34.84.

4.3.2 Unavailability Duration of Services

Flood damages inflicted rupture to the following services in the region resulting in unavailability of the services.

Table 4: Time Extent of Services Disrupted

Service	Time Extent	Frequency	Percentage
Power Supply	< 1 week	416	96.7
	> 1 week	14	3.3
Water Supply	up to 1 week	380	88.4
	up to 2 weeks	50	11.6
Sanitation Services	up to 1 week	279	64.9
	up to 2 weeks	141	32.8
	up to 3 weeks	10	2.3

When respondents were asked about the duration of unavailability period, it was reported that more than half of respondents (64.9 %) reported 1 week duration in which sanitation services were disrupted. Furthermore, it was reported that for 1 week, power supply and water supply services were also unavailable. 96.7 percents respondents reported 1 week of disruption in power supply, while 88.4 percent respondents reported 1 week of disruption in water supply.

4.3.3 Diseases Spread

Flood caused wide spread epidemic breakout. After the floods, following diseases were observed in the case study area.

Table 5: Types of diseases outspread in the case study area due to Floods

Disease	Frequency	Percentage
Malaria	185	43
Diarrhea	231	53.7
Typhoid	98	22.8
Dengue	242	56.3
Skin Disease	101	23.5

The above table depicts that diarrhea and dengue were the most spread diseases. More than half of the population (56.3 %) of the population responded they suffered

dengue, while 53.7 % of respondents reported they suffered diarrhea. 43 % of respondents reported suffering from malaria, 22.8 % suffered from typhoid and 23.5 % suffered skin diseases.

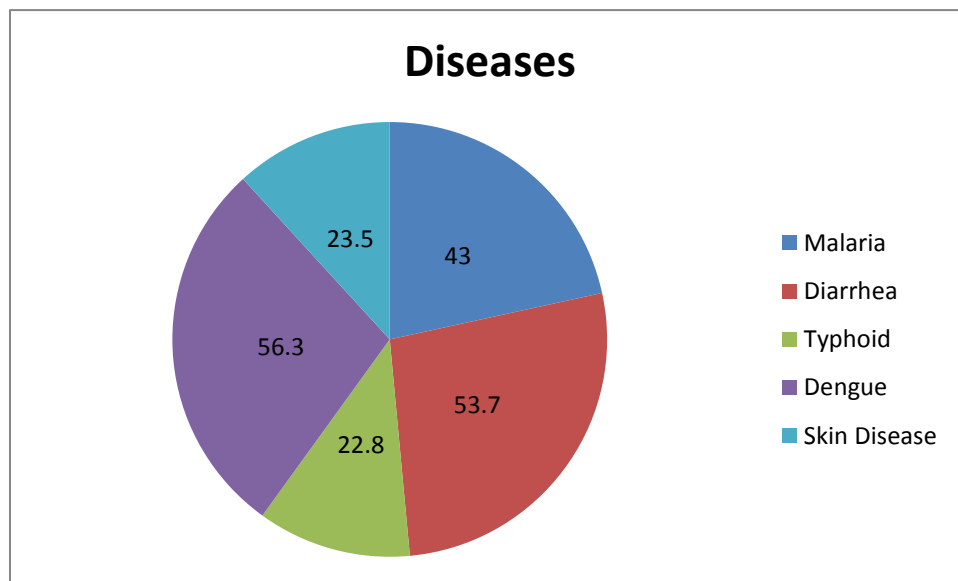


Figure 5: Types of diseases outspread in the case study area due to Floods

The above figure shows that 56.3 % of population suffered from Dengue. The figure also shows the percentages of all the diseases suffered in the case study area.

Table 6: Types of diseases with reference to age, gender, and household size

Variable	Classification	Diseases suffered (n)									
		Malaria	Pearson Chi-square	Diarrhea	Pearson Chi-square	Typhoid	Pearson Chi-square	Dengue	Pearson Chi-square	Skin Disease	Pearson Chi-square
Age (years)	10 to 25	19	0.000	18	0.001	9	0.113	28	0.000	19	0.000
	25-35	37		98		42		101		21	
	<35	129		115		47		113		61	
Gender	Male	141	0.015	150	0.014	86	0.000	162	0.116	83	0.002
	Female	44		81		12		80		18	

Household size	<5	37	0.384	31	0.006	21	0.336	41	0.465	6	0.000
	>5	148		200		77		201		95	

The above table shows cross tabulation of the diseases suffered with reference to age groups, gender and household size of the respondents. Overall, respondents having age greater than 35 years suffered most diseases. The respondents with age greater than 35 years reported that 129 of them suffered malaria, 115 suffered diarrhea, 47 suffered from typhoid, 113 suffered from dengue, and 61 suffered from skin diseases.

The table depicts that there is significant difference in amount of malaria, diarrhea, and dengue cases when compared with gender. It was observed that male population suffered greater cases of diseases overall however, malaria, diarrhea, and dengue suffering amount shows a significant difference. 141 of males suffered malaria, 150 suffered from diarrhea, 162 suffered from dengue, 86 suffered from typhoid, and 83 suffered from skin diseases.

When comparing the diseases with household size, it was observed that households with size 5 to 10 suffered greater number of diseases. There is a significant difference in the values of household size and the cases of diseases suffered. Respondents who had household size 5 to 10 reported that 148 of them suffered malaria, 193 suffered diarrhea, 194 suffered dengue, 88 suffered from skin diseases, and 70 suffered from typhoid. While the respondents with household size greater than 10 suffered lesser diseases.

4.3.4 Impact to Water Supply and Sanitation Services

Cluster analysis is performed to develop number of clusters that will help in representing the data. By applying the cluster analysis, it was found that there are three different classes of impact; A, B and C.

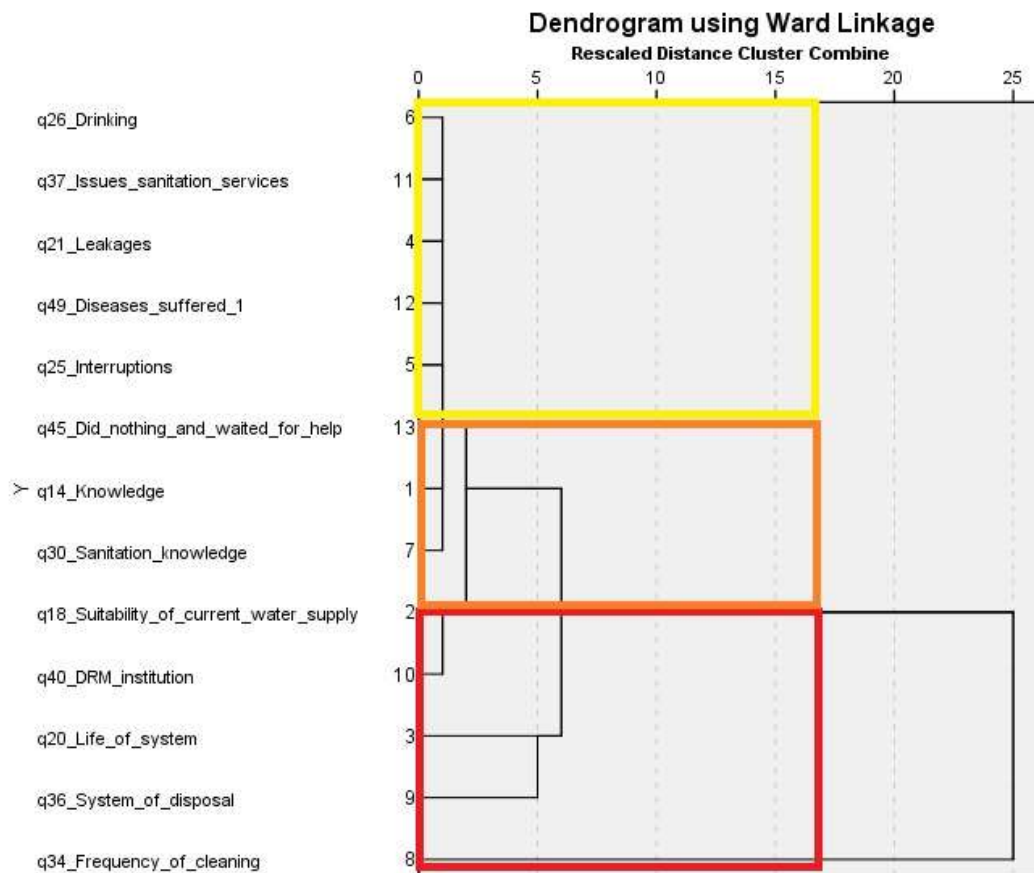


Figure 6: Classes of Variables defined through Dendrogram

The issues caused due to flooding are mainly attributed due to these three main classes.

The different issues within each class are explained below.

Category	Variables
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Class A (Supply Issues)	Leakages in water supply Diseases caused by poor water quality and lacking sanitary services Interruptions in the water supply chain Water is unable for drinking purposes during flooding.
Class B (Awareness Issues)	Lack of knowledge about clean water Lack of knowledge about proper sanitation services Lack of community participation after flooding event.
Class C (Institutional Issues)	No DRM institution present Outdated water supply system No proper disposal of sanitary waste Low frequency of cleaning the pipelines Water supply quality is low

4.4 FLOOD RISK MANAGEMENT IN THE CASE STUDY AREA

Table 7: Type of Support provided by the Institutions

Institutions	Type of Support Frequency (percentages) n (%)		
	Clean Water supply	Emergency shelter with sanitation services	Financial Aid
Political Institutions	10 (2.3)	0(0)	21 (4.9)
Government	50 (11.6)	31 (7.2)	7 (1.6)
NGOs	80 (18.6)	0(0)	0(0)

The above table depicts the flood risk management in the case study area. When the flood hit the case study area, emergency shelter and rescue was provided by the government. When asked about the clean water supply, it was found that government and NGOs played an active role in providing clean water for drinking. Political institutions have a scheme in order to provide financial assistance to the flood affected community. 4.9 percent of the respondents received financial aid from the political institutions while 1.6 percent reported to have support from the government. Over all, the respondents were not

satisfied by this financial help of government. They had to carry out rehabilitation and recovery costs by themselves and believed that financial aid was not given to the deserving people.

4.5 ACTIVITIES/STRATEGIES AFTER FLOODING

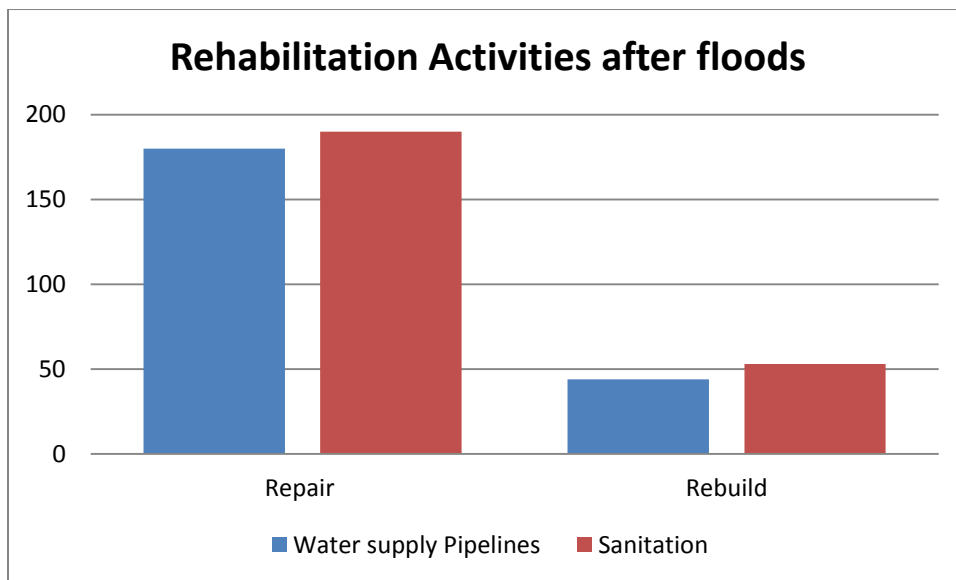


Figure 7: Rehabilitation activities after the floods in D.G.Khan city

The table below shows the pattern and source of recovery from the disaster especially in case of floods in the area. Floods every time cause havoc in the area thereby causing damage to the infrastructure, water supply pipelines, and sanitation service supply. When asked about the source who helped them, it was reported by the respondents that local authorities and government helped them as shown in the table. It has been reported that maximum number of respondents themselves rehabilitated the damage caused to water supply and sanitation services. About 49.3 percent of respondents reported self help in rehabilitating the water supply pipelines while 43.5 percent reported to rehabilitate their sanitation services. Government and local authorities did play their part in the rehabilitation of services, however due to limit resources their role is lesser. It can be

concluded that in the response and recovery from flood disaster, government and local authorities were unable to satisfy the needs of community in the case study area.

Table 8: Rehabilitation sources after the floods in case study area

Source	Water Supply pipelines n (%)	Sanitation Services n (%)
Government	31 (7.2)	53 (12.3)
Local Authorities	187 (43.5)	190 (44.2)
By Self help	212 (49.3)	187 (43.5)

4.6 SATISFACTION LEVEL OF RESPONDENTS TOWARDS GOVERNMENT ROLE IN FLOOD RISK MANAGEMENT

Respondents were inquired about their satisfaction level with various activities of government in the flood risk management. Given below is a table representing the respondents' response to the services and activities of government

Table 9: Satisfaction Level of Respondents (n)

Satisfaction Level	Very Satisfied	Satisfied	Indifferent	Dissatisfied	Very Dissatisfied
Means of communication used to deliver flood warning	-	169	84	84	93
Quality of water supply provided	-	133	-	146	151
Billing mechanism of water supply	-	240	190	-	-
Water services provided during flooding	-	29	62	232	107
Type of sanitation system you have	-	31	26	217	156
Institutional frequency of cleaning the sanitation system	-	15	32	193	190

Working process of disaster risk management institution	-	-	117	188	125
Participation level of local community in DRR activities for water supply and sanitation	-	103	194	133	-
Response of local institutions in fixing/recovering the water supply and sanitation services	-	-	137	203	90

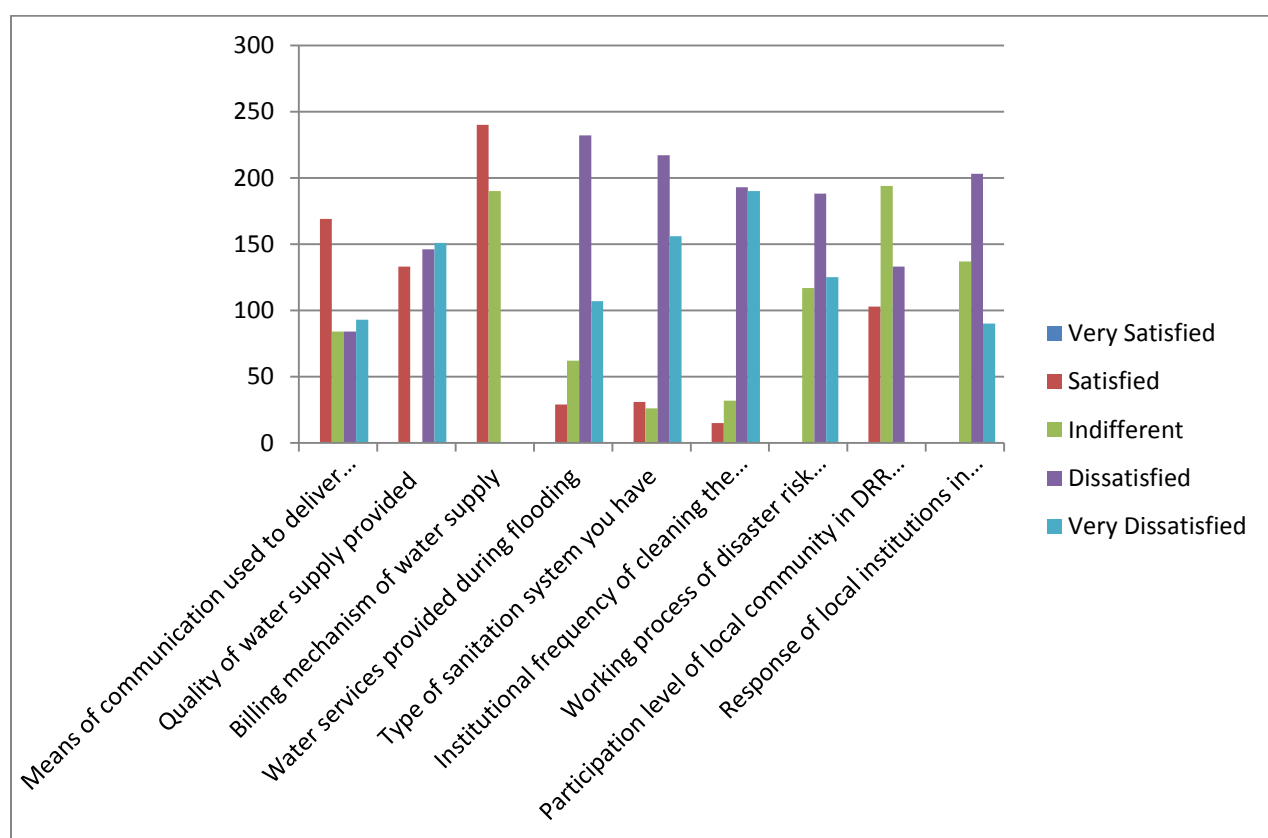


Figure 8: Satisfaction Level of Respondents

The figure above represents the findings of satisfaction level of respondents against various activities.

The level of satisfaction of respondents was calculated by using the Index of Satisfaction developed by S. H. Yeh. This index is employed in the current study for comparison of the level of satisfaction of the flood respondents. This index has been used in various research studies (Anwar, Perveen, Mehmood, & Akhtar, 2008), and has proven to be effective in demonstrating the level of satisfaction or dissatisfaction in various studies.

$$YIS = \frac{(X2 - X1) - (X5 - X4)}{X}$$

Where: X – total number of cases, X1 = very dissatisfied cases, X2 = very satisfied cases, X4 = dissatisfied cases, and X5 = satisfied cases

Satisfaction Level	Very Satisfied	Satisfied	Dissatisfied	Very Dissatisfied	total number	Index of satisfaction
Means of communication used to deliver flood warning	0	169	84	93	430	-0.41395
Quality of water supply provided	0	133	146	151	430	-0.32093
Billing mechanism of water supply	0	240	0	0	430	-0.55814
Water services provided during flooding	0	29	232	107	430	0.223256
Type of sanitation system you have	0	31	217	156	430	0.069767
Institutional frequency of cleaning the sanitation system	0	15	193	190	430	-0.02791
Working process of disaster risk management institution	0	0	188	125	430	0.146512

Participation level of local community in DRR activities for water supply and sanitation	0	103	133	0	430	0.069767
Response of local institutions in fixing/recovering the water supply and sanitation services	0	0	203	90	430	0.262791

Table 10: Table of Satisfaction Level Index of Respondents

YIS	Level of satisfaction
(-0.6) to (-0.3)	very low
(-0.2) to 0	low
0 to 0.3	somewhat satisfied

The values of index are negative, which depict the very low satisfaction level of the respondents. The respondents were however, satisfied with the means of communication used to deliver warning about floods. The respondents told that the government organizations were not active in fixing or resolving the leakages in water supply and sanitation services. Even after repairing the pipelines, there was no monitoring and evaluation system as the pipelines get cracks and are in critical condition presently.

4.7. ANALYSIS OF THE CHALLENGES FACED BY FLOODS:

Table 11: Co-relation Table between Variables

Variables	Knowledge about clean water	Knowledge about improved sanitation	Participation in local community activities concerning DRR	Diseases/Illness in the household in previous floods
Gender	-0.34	-0.151	0.87	-0.008
Age	-0.18	-0.039	-0.079	0.032
Qualification Level	0.581	0.491	-0.017	0.1

The above mentioned table provides correlation between different variables. The mentioned Pearson value for each correlated variables helps to understand their relationship. A high degree of correlation is observed between 'age and participation of local community in activities concerning DRR' and 'gender and participation of local community in activities concerning DRR'. This indicates the effect of these two variables is very large. Both of these variables have a strong correlation.

Given below is a list of challenges faced in this area concerning water supply and sanitation services.

- There is lack of coordination among the government and community when it comes to disaster risk management.
- 93.3 % of respondents had no knowledge about the presence of any disaster risk management institution in the area
- 41.1 % of respondents were dissatisfied with the means of communication used to deliver flood warning
- There is no emergency system for water supply and sanitation services during the event of flooding.
- 72.8 % of respondents were dissatisfied with the working process of government regarding disaster risk management in the area. 68.1 % respondents were dissatisfied with the government regarding their activities concerning response and recovery of water supply and sanitation services.

- It was also observed that there are interruptions in water supply, leakages in the pipelines, issues in sanitation services, and drinking water quality is affected the most due to flooding event.
- Furthermore, there is no proper system for sanitary waste disposal. Most of the respondents (49.5 %) indicated that open dumping is used to dispose off sanitary waste.

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

The analysis of previous flooding in the district D.G.Khan revealed that there was major communication and policy gap in the management of flood risk. The flood risk management needs to be upgraded, and community resilience should be built within. It has been found that water supply and sanitation services were badly affected by flooding, locals were able to restore the services but the long term vulnerability of these services exposed them to further issues. Furthermore, there was no planning and coordination between government and local community for flood risk management due to which the satisfaction level of affected people towards government initiatives for emergency relief were found to be very low. Hence, the strengthening of local government at union council and district level is one of the major implications for disaster impact mitigation as found by (Deen, 2015). The people were also not satisfied with the assistance provided by the organizations in reconstruction and repairing programs of building back the water supply and sanitation services. The study has also revealed that lack of institutional involvement in resilience building under DDMA has impacted the services in the area. The study conducted by (Schelfaut et al., 2011) helps to highlight the ways in which the challenges can be tackled and provides guidance on opportunities and ways to build resilience within the community. It reveals that the participation of all stakeholders including community and the government can enhance the resilience against flooding. Through the utilization of different tools for flood management, such as flood management plan, early warning systems, and emergency system for providing water supply and sanitation increases the awareness and preparedness of the people. Similarly, the risk communication during the

flooding event can help in cooperation and coordination among government and community to prepare for emergency services.

5.1 RECOMMENDATIONS:

- First and foremost important measure of improving the flood resilience of water supply and sanitation services in the area is to increase its level of awareness and train the local population, so that they are prepared to deal with flooding. For example, people should be able to recognize the early warning system and know the emergency procedures, using good quality water pipelines, and proper restoration plans.
- Government should conduct focus training and mock drills of flood prone community for emergency response such as evacuation. There is dire need for proper channel of communication because lack of awareness can cause people to panic. Although people give less time to such trainings and awareness programs however, it is important to provide some form of incentive so that people take part in such activities.
- Furthermore, the policy making and risk analysis process must focus on water supply and sanitation services. This will allow the government to know the response of public to flood hazard and will improve the communication for all decision makers. Communication generally includes the awareness of people and their preparedness for dealing with disasters.
- Flash floods are the main cause of flooding in district D.G.Khan and impact the water supply and sanitation services, thereby causing health issues within the community.

Government should build flood protection bunds and focus on improving community awareness on WASH, DRR, environment and health.

- In order to make DRR effective government needs to develop a strategy which will provide a permanent solution to the issue of interruption of water supply and sanitation services. It is crucial that the government conducts need assessment and resource planning where the main focus is on preparedness and early recovery in case of flooding. Identifying and advancing the technical tools will help foster transparency in the management of these services.
- Integration of remote sensing, GIS, and other models can help manage the flash flood risks, and allow the management to use flash flood in water deficit areas.
- Additionally, there must be contingency plan for flood risk management. The community and line departments must follow all the guidelines.
- The capacity of water reservoirs should be increased and renovated. The infrastructure of water supply and sanitation services must be revised and developed according to the consequences of flooding.

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High: Reconstruction cost more than 2 million Rs

13. Were the following services disrupted in the previous floods?

Sr. No	Services	Yes	No	Duration of Unavailability
1	Power supply			
2	Water supply			
3	Sanitation Services			

Water Supply Services

14. Do you have knowledge about clean water quality?

Yes No

15. Do you have access to clean drinking water?

Yes No

If yes, what is the source? _____

16. Who operates the water supply in your area? _____

17. What is the source of water supply in the area?

- Bore well/hand pump
- Public tap
- Community well
- Household water supply (piped)
- Other

18. Is the current supply of water suitable for drinking purposes?

Yes No

If No, specify reason _____

19. What is the usage of water in your house?

- Drinking
- Bathing
- General household purposes
- Animals
- Others _____

20. How old is the water supply system?

21. Are there any leakages in water supply services?

Yes No

22. Do you store water in your house?

Yes No

If yes, how? _____

23. Do you pay for water supply?

Yes No

If yes, what is the average bill for water supply? Rs. ____/- per month.

24. What is the billing mechanism for water supply?

- Monthly Bi-annual
- Annual

Is the billing fixed or metered? _____

25. Are there any interruptions in water supply during floods?

Yes No

If yes, how long? _____

26. What activities are mostly affected by interruption in water supply?

- Drinking
- Bathing
- General household purposes
- Others _____

27. What was the quality of drinking water during previous floods?

- Low Medium
- High

Low: Have taste, smell, color and odor (unfit for use)

Medium: Muddy but still usable

High: Suitable for drinking and other purposes

28. How did you use water during floods when clean water is unavailable?

- Boiling
- Filter
- Buy clean water

29. What issues arose during unavailability of clean water supply after floods?

- Health issues
- Cleanliness issues
- Disruption of daily activities

Others _____

Sanitation Services

30. Do you have knowledge about improved sanitation?
 Yes No

31. Does your household have access to improved sanitation?
 Yes No
 If yes, mention what type of sanitation system do you have?
 Piped sewer system
 Septic Tank
 Pit latrine with slab
 Flush/pour pit latrine
 improved pit latrine Ventilated Ecological toilet

32. What is the system of sanitary waste collection in your area?

33. Are there storm water drains available in your area?
 Yes No
 If yes, where are they located? _____

34. What is the institutional frequency of cleaning the sanitation system?
 Daily Weekly
 Monthly
 Bi-annual Annual
 None Other

35. What is your expenditure on sanitation services? Rs. _____/- per month

36. What is the system of sanitary waste disposal?
 Open dumping On-site disposal
 Further treatment Others

37. Are there any issues in proper sanitation services during floods?
 Yes No
 If yes, how long? _____

38. What happens when you have problems with your sanitation?
 Toilet overflows
 Water comes back up sink/shower/bath
 Gully trap overflows
 Other _____

39. How often does this happen?
 Every time it rains During flooding
 Several times a year Once a year

Community Participation

40. Is there any disaster risk management institution present?
 Yes No
 If yes, name the institution

41. Do you have a water and sanitation system for emergency situation?

System	Yes	No	If yes, what system?
Water supply			
Sanitation			

42. Did you get support from the local social institutions?

Social	Yes	No	Type of Support

	Institutions			Clean Water supply	Emergency shelter with sanitation services	Financial aid	Others
	Political Institutions						
	Government						
	NGOs						

43. Do you participate in local community activities relating to DRR for water supply and sanitation services?

Yes No

If yes, how? _____

44. What knowledge did you gain about water pollution after the previous flood experience?

45. How did your community work together to get back to normal routine after the previous floods?

Cleaned houses and community

Gathered material and helped themselves

Did nothing and waited for the help

Other

	Services	Time to recover after floods	Clean-up activities after floods	Who fixed the issues
	Water Supply			
	Sanitation			

46.

47. What did you do with your house after previous event concerning the following services?

	Repair	Rebuild	Others	Who helped you?
Water supply pipelines				
Sanitation facilities				

Health Concerns

48. Which of the diseases anyone in your household suffered in the past floods?

- Malaria Diarrhea
 Typhoid Dengue
 Skin disease
 Others _____

49. Did you get any diseases/illness in your household due to floods?

Yes No

If yes, then specify,

	No of family members	
1	Gender	
2	Age	
3		

50. Which of these issues occurred in the past floods?

Issues	Yes	No	Flooding year
Water-borne diseases			
Vector-borne diseases			
Standing water			
Damage to water supply system			
Damage to sewerage system			
Insufficient supply of drinking water			
Power outage			
Disruption in underground pipes			

51. Were there trauma care/healthcare services available in the area?

Yes No

52. Is your household affected by some other natural disaster or event that has affected your water supply and sanitation system?

Yes No

If yes, please mention: _____

Satisfaction Level

53. What is your satisfaction level with respect to the following:

	Satisfaction Level	Very Satisfied	Satisfied	Indifferent	Dissatisfied	Very Dissatisfied
1	Means of communication used to deliver flood warning					
2	Quality of water supply provided					
3	Billing mechanism of water supply					
4	Water services provided during flooding					
5	Type of sanitation system you have					
6	Institutional frequency of cleaning the sanitation system					
7	Working process of disaster risk management institution					
8	Participation level of local community in DRR activities for water supply and sanitation					

9	Response of local institutions in fixing/recovering the water supply and sanitation services						
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