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USE OF GIS TECHNOLOGY FOR REDUCING FLOOD HAZARD RISKS ALONG THE RIVER CHENAB IN THE AREA OF MANDI BHAUDDIN

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Abstract
The present research was conducted to study the flood inundation by (GIS) techniques of Geographical Information System. With the help of this advance research area, we also get a track of making an effective solution to control the flood hazard. The idea of this research was to make a bond of new strategies in the field of Geo innovation to achieve more valuable techniques to reduce flood hazard risks along the River Chenab in the area of Mandi Bhauddin. Techniques of other countries are also compared with the flood inundation mapping. To complete the flood analysis Geographic Information System (GIS) techniques were used.

Key Words: *River Chenab, GIS, Remote sensing, Mandi Bhauddin*

INTRODUCTION

Among all the natural disasters foold is measured as the most terrible. It is normal in humid and sub-tropical climate areas, particularly during the monsoon season; river flooding is a typical standard question. Floods are the most frequently occurring and damaging natural hazards in the country. Of all population who are affected by natural hazards, 90% are subjected to flooding (Tariq, 2012). The number of districts in Punjab, located near the rivers, suffered heavy floods inundating, a large area including rural and urban areas in the sixteen worst hit districts of the Punjab. Flood inundations have the potential to cause fatalities, displacement of people, and damage to the environment, to severely compromise economic development (Di Baldassarre, 2009). The need for higher spatial and temporal resolution data is pinpointed by recognizing that destructive floods or landslides can be launched by intense, short-lived storm cells a few kilometers in extent. The height and width of rivers, as well as rainfall intensity and amounts, need to be measured hourly during storms (Tralli, 2005). It is common that poor people's live near the flood plains. As they cannot have enough cash to purchase approved land, they use arrive close to the Riverside. Arranged settlements are additionally based on landfills in marsh regions. Considered in concert they indicate the severity of inundation as well as its distribution in space and time. Summing up, exposure indicators confer specific information about hazardous threats to the various elements at risk (Meyer, 2005).

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Flood: "An extensive amount of water covering a range of land that is typically dry".

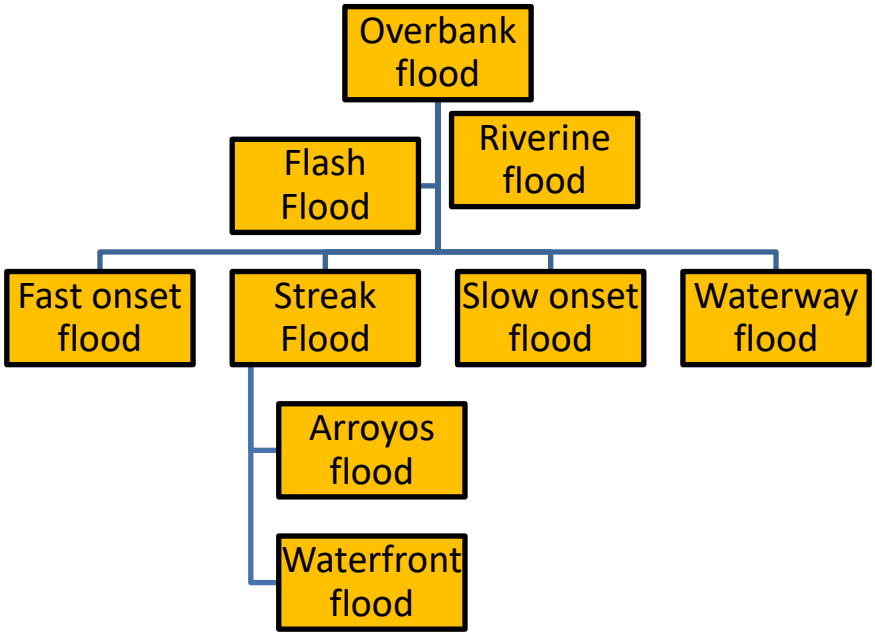

Figure 1.1: Types of Flood

Flash flooding is a type of natural disaster that affects the lives of many human beings. People's lives are lost during these disasters, and the built environment may be destroyed (Jianping Chen, 2016). Flood water enters the cities, it damage the lives and properties and organizations, crush belongings, harm fundamental framework. Frequently the impacts of floods are long haul and can be excessive, problematic and upsetting for groups included. The flood damage to individuals who are found by walking or going in vehicles in influenced zones. As focused on flood inundation in Punjab Province of Pakistan, flood impacts in Punjab will be discussed with detail. Regardless of the way that Punjab encounters flood for all intents and purposes incongruously, Flood organization approaches are generally according to the assistant's decisions. The people who moves to the cities for jobs are have limited sources so they have limited choices of living , those people are usually poor or job less , they don't think about hazards they could face but rather are concerned with more instant needs they take advantage of whatever locations are available to them, lands frequently susceptible to flooding and other hazards.(Parker, 2000).

More recently the availability of increased computing power and detailed descriptions of Flood plain topography available through remote sensing (Bates a, 2010). Dams are human made and used to hold underground water and utilized as to create power. Flood control dams impound floodwater and then either release them under control to the river below the dam or store or divert the water for other uses.

LITERATURE REVIEW

The data get from different composition examines are discussed in the given segment to understand the establishment about the floods and their dangers, and moreover, the damage of flooding. On the other hand, all channels and floodplain zone models are of 1-D or 2-D hydrodynamic studied independently. This chapter summarizes past research and basic

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techniques on flood inundation modeling. Haile, (2005) during the transformation or re-sampling of the original DEM data of relatively high resolution to a lower model resolution, important topographic details are lost mainly as a result of averaging. As such, there is a need to quantify the effects such averaging has on model performance and, more important, the reliability of simulation results. Jian,Chen,(2009) urban areas, where much of the land surface is covered by impervious materials, are characterized by reduced infiltration and accelerated runoff which causes flooding unrelated to a flood- plain. Historically, riverine flooding and flash flooding along flood- plains have received considerable attention. Tariq, (2012) floods are the most frequently occurring and damaging natural hazards in the country. Of all the population who are affected by natural hazards, 9o% are subjected to flooding.

Yosufzai,(2009) flood risk is measured in terms of probability of happening of events and the related consequences Merwade,(2008) sincedata for low-frequency events (e.g., precipitation, water surface elevation, river discharge) are usually unavailable, flood is simulated by using hydro- logic and hydraulic models calibrated against gauged low flow. Büchele, (2006) in spite of these technical standards and advances in practice, it can be noted that Flood -risk assessment remains a quite challenging task, especially regarding the uncertainties related to extreme events exceeding the design flood or to the damage due to failures of Flood control measures. Flood comes in the biggest natural disaters . In 100 years, humans have discussed taking early precautions to prevent their lives and properties from saving them from flooding. Regardless of making different frameworks, Flood even now continues to have ruin in each impact of the planet.

2.1 Used of Flood Inundation Mapping Techniques in Other Countries

2.2.1Flood inundation mapping in Nigeria

Nigeria comes in the significant nations of Europe and it's every now and again strike by floods. Kaduna North and South Water Works stood up to most disaterous flood threat with an extension in flood compose from the five years back period. These techniques are used with LANDSAT ETM and DEM. These techniques are most important to know water conditions, water level and water flow.

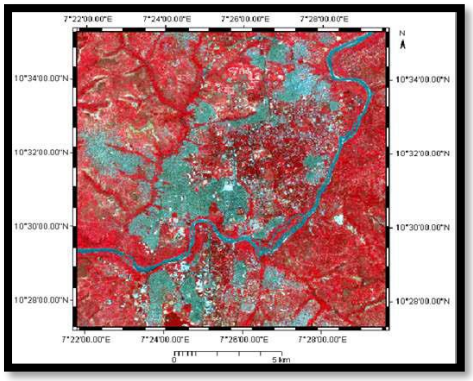

Figure 2.1: The GIS and RS Imaginary area of Nigeria (The land sat ETM of inundated area)

Satellite remote sensing observations are providing insights into how stress is transferred between fault systems from depth and to the surface, how much energy is released by earthquakes and other modes of deformation (Argus et al., in press) and how faults fail mechanically (Tralli, David M.Blom, 2005).

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2.2 Flood Inundation Mapping in Pakistan

The repetition of floods in Pakistan, specifically in last few years has broadly expanded. From the data of 2010-2015 and 2016, its look flood is a part of Pakistan every year. Due to the absence of successful coordination among administration for the establishments required in flood.

2.4 Floods in Pakistan

Pakistan has a fluctuating climate. Normally its climate is hot and dry in Pakistan but in last few years significant climate variations have seen in Pakistan. Most districts and cities located near the river bank always on risk of flood. i.e. riverine flood, flash flood and urban floods particularly in Punjab & Sindh provinces.

2.5Flood Control Objective and Need

Flood management planning in Pakistan is being carried out to essentially cover the following three specific objectives:

i. To reduce or eliminate damages to existing properties.
ii. To prevent future increase in damages; and
iii. To mitigate the residual hazards.

Major Rivers Framework of Pakistan

Pakistan is not having many dams and the nearby are not sufficiently fit to manage fast constrain and load water of Rivers. Pakistan's river arrangement begins from the snow-secured Himalaya and the Karakorum. The framework involves, for the most part, five waterways that go for the most part through the Punjab area: along these lines the name
"Punjab" — "panj" which means five and "AAb" which means "Water".The five major rivers of Pakistan are Indus, , Jhelum, Chenab, Sutlej.

River Chenab

It courses all the way during the Jammu district of Jammu and Kashmir into the green land of the Punjab, framing limit among the Rechnna and Jecch rivers (Doabs in Persian). It is connected by the Jhelam River at Trimu and after that by the River at the place of Ahmad PurSiyaal. It then assembles with the Sutlej River close the UuchShareef to shape the Punjnad or the '5 Rivers'. The Chenab then joins the Indus at Mithankot. The approximate length of the Chenab is around 961 kms. Flood extent and flood depth are usually calculated for a flood event with a specific return period (De Moel,2011).

Table 2.1: Existing Flood Protection Infrastructure in Mandi Bhauddin Lahore Punjab Pakistan

Sr.	No. Zone/Region/ Agency/District	No. of Protection Works
1.	Lahore Irrigation Zone	251

Source: Federal Flood Commission, Ministry of Water & Power

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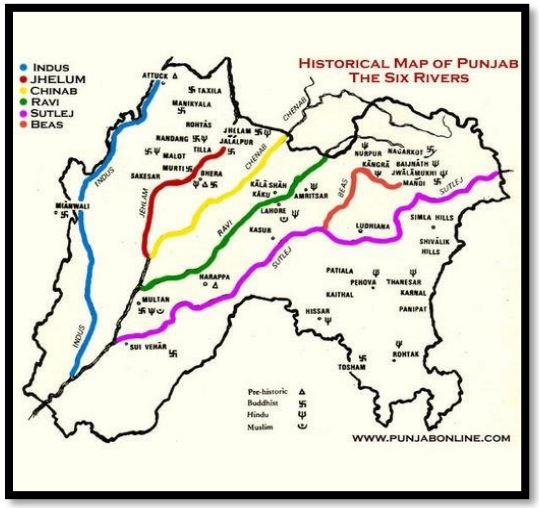

Figure 2.2: Map of Major Rivers of Pakistan

List of Floods in Pakistan

In Punjab Province

In 2010, every part of of Pakistan was influenced when horrible flooding created by evidence breaking downpours hit Khyber-Pakhtunkhawa and Punjab. The quantity of people influenced by the flooding surpasses the joined aggregate of people influenced by the 2004. Indian Ocean tidal wave, the 2005 Kashmir quake. At the slightest 2,000 individuals kicked the bucket in this Flood and just about 21 million individuals were influenced by it. In Sept. 2012, almost 100 people kicked the bucket, and a huge number of homes crashed, and also huge number of arable lands also affected. Subsequently of rainstorm downpours (see 2012 Pakistan Floods. In September 2014 due to enormous rainstorms in Jammu and Kashmir and additionally Azad Jammu and Kashmir and in Punjab. Constituted Flood circumstance in River Chanab and River Jhelam. The Floods are impacted:

Table 2.2: Flood during 1950-2010

Year	Effected Area	Causalities	Economy
1950 to 2016	623,568 sq/km	14,289	$53 million

The NDMA says the floods have so far affected 81, 674 people of 333 villages, damaged 135,076 acres of crops, completely destroyed 2,533 houses and partially damaged 1,782

Recently, demonstrated the uncertainty arising from different steps in producing a flood inundation map by using simple examples, and made a case for a probabilistic flood inundation map to reflect these uncertainties." (Neal, 2010) Modeling urban flood inundation using a distributed model without detailed hydrological data is difficult, given the computational and data requirements of 2-D distributed hydrological models (Werner, 2001), in addition to the increased requirements for ''dual drainage" modeling (Chen, J. H. 2009).

PDMA

The atmosphere design everywhere throughout the world has changed; Pakistan is additionally gravely influenced by this environmental change wonder which requires realigning the arrangements, approaches and exercises to better get ready for Disaster Risk Reduction and

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Disaster Management at the PDMA level. Prior, in the region of Punjab, the event of debacles was occasional; be that as it may, now the fiascos have turned into a regular event, once in a while in the type of a tremor and once in a while in the state of yearly Floods, tornadoes and so forth.

River Chenab Flood Latest Update 2015 (Source: Geo Channel)

Qadirabad Head works and Hafizabad at high risk due to the High Flood level in River Chenab while the city is similarly going up against danger of getting inundated in the Flood water. Many towns were severely influenced, a few abandoned, by astoundingly high glimmer Floods, in the Rivers Chenab and Jhelam and annihilating exuberant rains in the locale of Sialkot, Narowal, Gujrat, MandiBahaud din, Gujranwala, Hafizabad, Sheikhupura of focal Punjab. River Chenab was in a blaze Flood at the place of Head Marala torrent close Sialkot as a pinnacle of 486,000 cusecs in River Chenab was going through the Head Marala blast close Sialkot right then and there. “There is a general consensus on GIS literature about the two broad classes of models of geographic information: field-based and object-based. While the former deals with spatial distributions over a geographical region, the latter deals with discrete, identifiable entities on the geographical space. (Gilberto Camara, a, 2000). Raster data sets could be used as such for DEM generation while the depth and elevation contour lines had to be transformed into point format. (J. Pohjola, 2009)

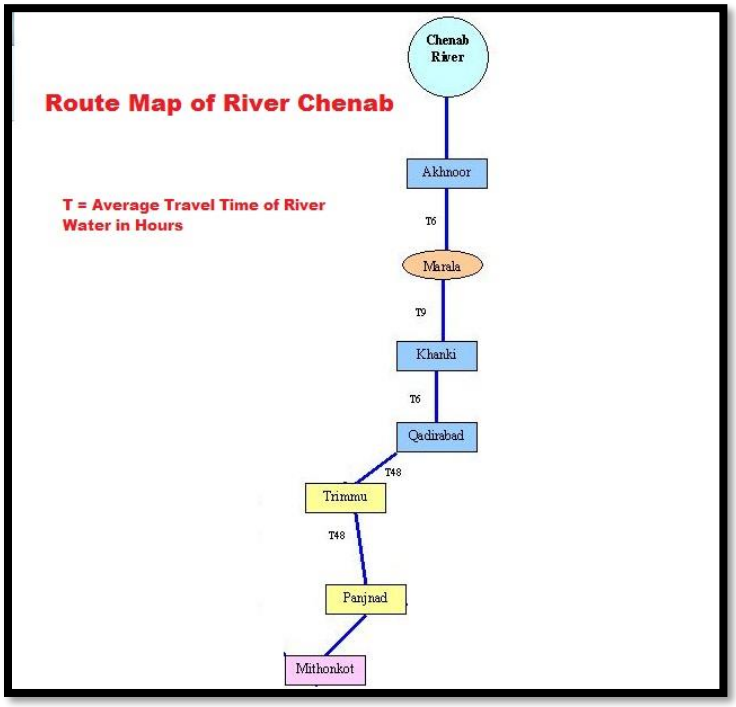

Figure 2.3: Route map of River Chenab
Source: Pakistan Meteorological Department

“One of the major requirements of flood disaster management is the real-time monitoring of maximum flood extent for taking up immediate response, short- and long-term recovery, and future mitigation activities ". (Wilson, 2007)

2.10 River Chenab Super Floods

2.10.1 Sept.6th 2014

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Towns like Sialkot, Narowal, Gujrat, MandiBhaud din have been affected, a couple of destroyed by high level floods in the Chenab River and Jehlum River.

2.10.2 Sept. 15th, 2014

Sialkot, Wazirabad, Hafizabaad, MandiBahaudin, Chiniot, Jalal purJattan, Phaliaa and PindiBhatian were openly hit by the flood which also destroyed a number of roads, bridges and important installations.

Flood Hazard Mapping

Flood risk mapping depicts flood hazard regions along Rivers and lakes utilizing configuration flood levels set up as a feature of flood danger examines. Flood risks have not been recognized in all groups and may exist in regions without flood danger studies or mapping. GIS innovation is utilized to show the flood danger maps. A rapid web association is required notwithstanding taking after least PC details: In inundation modeling there is often considerable uncertainty in interpreting the true extent of inundation from satellite data because of the variations in backscattering and image speckle that can arise from features like waves and emergent structures and vegetation (Pappenberger, 2007). The route to a new set of equations for fast inundation modeling in two dimensions was identified in the urban model bench (Paul D.Bates; 2010). A digital elevation model (DEM) is a digital representation of the Earth's relief that consists of an ordered array of elevations relative to a datum, and referenced to a geographic coordinate system (Forkuo, 2011).

2.12 Aims and Objectives

- The principle goal of present research is to evaluate the effect of the 2016 flood on the vegetation cover, infrastructure and human beings in the MandiBhaudin,Chiniot and Hafiz abad district and to decide momentum condition of recovery utilizing Remote Sensing and Geographic Information framework advances and strategies.
- The objective is to find out how much area has been destroyed due to flood 2016 District Hafizabad, MandiBhaudin, and Chiniot especially along the Chenab River.
- Furthermore it was also to be find out how much cultivated area is lost and how much infrastructure destroyed due to flood in 2016. This area is no longer cultivatable.
- Moreover, another objective was to assess damage before and after the flood. Whether it's increased, decreased or no change.

MATERIALS AND METHODS

Study Area

The Chenab River is a major river of India and Pakistan. It is bordered on the northwest by the Jhelum River, on the southeast by the Chenab River, and on the southwest by the Sargodha District. The district has an area of 2,673 square kilometers

The district forms a central portion of the Chaj Doab lying between the Jhelum and Chenab rivers. It lies from 30° 8' to 32° 40' N and 73° 36' to 73° 37' E. The tehsil headquarters towns of Phalia and Malikwal are 22.5 and 28.5 kilometers (14.0 and 17.7 mi) from Mandi Bahauddin, respectively. It is bounded north by the Jhelum River, which separates it from Jehlam district; on the west by Sargodha district; on the south by the river Chenab (which separates it from the Gujranwala and Hafizabad districts); and on the east by Gujrat district. The total area of the district is 2,673 square kilometers (1,032 sq mi). The district comprises the Mandi Bahauddin, Phalia, and Malikwal tehsils.

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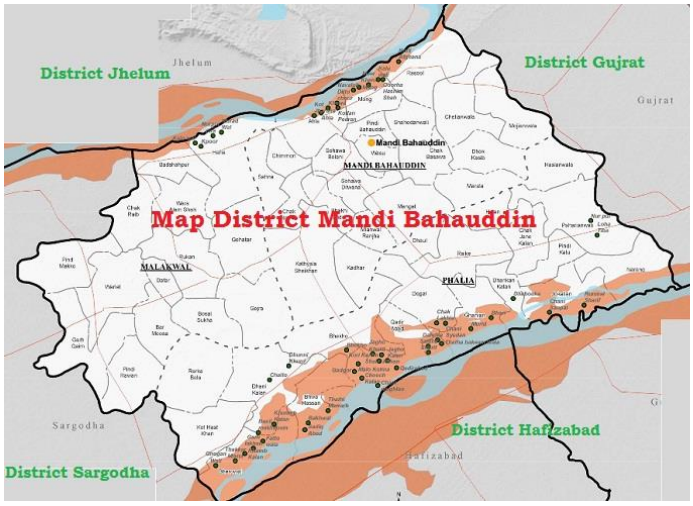

Figure: Mandi Bahauddin

The Chenab waterway begins in the Kuloo and Kangraa regions of the Himachal pardesh, areas of India. The 2 boss Rivers of Chenab—the Chandar and the Bangar—rise height of nearly 16,000 feet. These join at Tandi in the state of Jammu and Kashmir. Inspired by unlimited tributaries on the long adventure from its headwaters, the river increases tremendous power above Kashmir. It enters in Pakistan through Sialkot close Diawara Village. The route to a new set of equations for fast inundation modeling in two dimensions was identified in the urban model (Paul D Bates; 2008).

River Chenab Flood Plain Areas

The elevated Flood traveling from River Chenab has obtained on the colossal devastation the rural districts from Marala Headworks. The Flood has also broken the boulevards and hurt various stages and establishments. The cyclone of high water has furthermore started arriving down in Kashmir and Punjab.

Related Villages

Our study area contains the following districts Gujrat, Sialkot, Gujranwala, MandiBhauddin, Multan, Muzaffargarh, Khanewal, Jhang, Dera Ghazi Khan, Chiniot, Sargodah, Hafizabad, Faisalabad, TobaTek Singh, Multan, Lodharan, Jalal PurJattan.

Sources and Data Acquisition

- For this purpose, the following data is used
- Shape files used for districts and villages, G.T road, different settlements, main canals, River Chenab and affected flood areas.
- Topographic maps are used to extract different types of info layers of the study area: administrative boundaries, rivers, and land use and land cover categories.
- District shape files were obtained from the Urban Planning and Development Unitone.
- The village shape file is pointing shape file and mentioned with names of villages. While main canals and river shape file is polygon.
- Distributaries branched and main canals are polygon shape files too. Accumulations lines shape file contains attributes of node.

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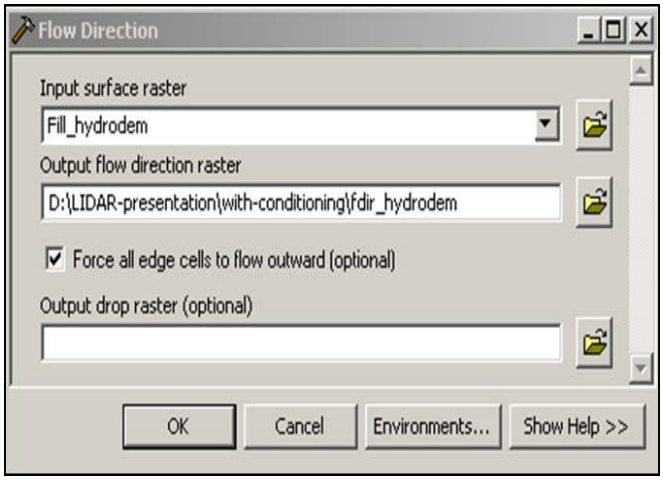
Method

GIS based Flood inundation system includes a few techniques and tools to make it conceivable and simple to monitor flood risk areas. To make flow accumulation lines I performed the following steps. I utilize Arc/info 10.2 and Arc view for GIS data manipulation and display. Quick access to satellite based on remote sensing (RS) data and improvement of business practices have increased the use of GIS and RS in preparing flood susceptibility maps. In this regard, numerous modeling techniques have been proposed and used to assess flood disasters. So, GIS and RS techniques have found wide application in the analysis of flooding (Khosravi, 2016). The GIS technique is a more powerful technique toassess the flood risk. As for Pakistan, this technique is usedto assess flood risk in flood-prone areas near Rivers (Yosufzai, (2009). Using the digital elevation model (DEM) as an input, flow direction, flow accumulation path, and channel network around the Sukkur barrage region were generated using ArcHydro tools in ArcGIS environment (Gaurav, 2011). To begin this, the stream.shp file was imported into an Arc Map 10.2 geodatabase. Suitable data for evaluating flood inundation models may exist in the form of internal hydraulic measurements such as discharge and stage, ground surveyed inundation extent measurements or aerial photographs and remotely sensed images (Pappenberger, 2007).

For example, the estimation of design flow is still based on techniques that were produced over 20 years ago, and one-dimensional (1D) modeling is still the standard practice in simulating the design flow along a river to delineate a flood inundation map.

Flow direction

Open tool box in Arc Map , open spatial Analysis tools—hydrology—flow direction than do the required entries .



Flow accumulation

Open toolbox in Arc Map, open spatial Analysis tools—hydrology—flow accumulation than do the required entries. The cell with accumulation value is dense or heavy flow regions and is helpful in stream networks.

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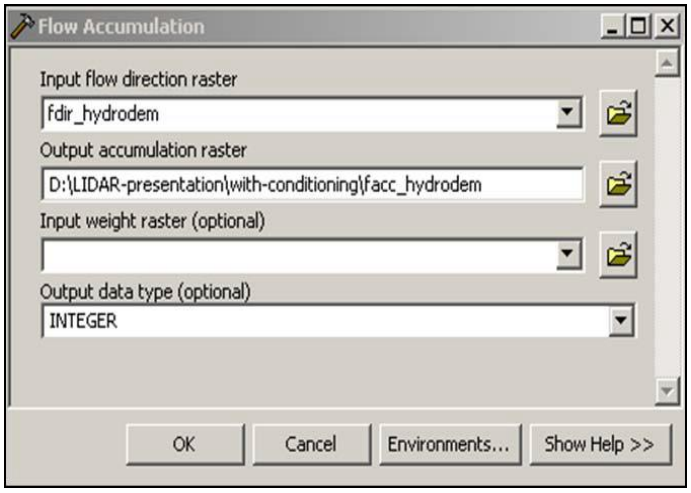

The Geo- graphic Information Systems (GIS) technology has been applied for flood management based on utilizing unit hydrographs (Dawood, G. &. 2011).

Maps

Then the data with borders like districts, divisions, villages and other related elements like Rivers, main canals and head works are shown in maps. Maps show the condition of floods and that area which are under threats. These maps show the inundation of flooding. The maps are made on scale 1:100,000Kilometers. Digital Elevation Model is used to know the flow direction, flow accumulation and flow fill. The total area of study is divided into 15 indexes. Indexing is done on the bases of River Chenab and carried out by following grid index features. All maps are showing the zone river (Index) district boundary, villages, and affected villages, maincanals, branch canals, flood bunds and settlements. Different colors showing area of flood extents.

Results

Almost whole area covered by River Chenab has shown in the maps, and these maps could be very helpful in extent of River Chenab and also important in the flood risk areas. Punjab Province has total 36 districts and these districts have area of 205,344 km². But in this work 21 districts which are in link with River Chenab and affected by flood are selected. The area of 21 districts of Punjab is119,853km²and in 2016 flooding affected area is 7867 km² and after calculations its shows affected area during flooding is 6.56%.

Flood affected areas graphical representation

After shape files attribute table exported and graph drawn between total district area and flood affected district area. The following bar graph generated. The graph shows during flood in 2016 highly affected areas were Jhang,TobaTaik Singh, Chiniot,MandiBhaudin ,Sialkot, Dera Ghazi Khan, Hafizabad, Nankanasahib, and Khanewal.

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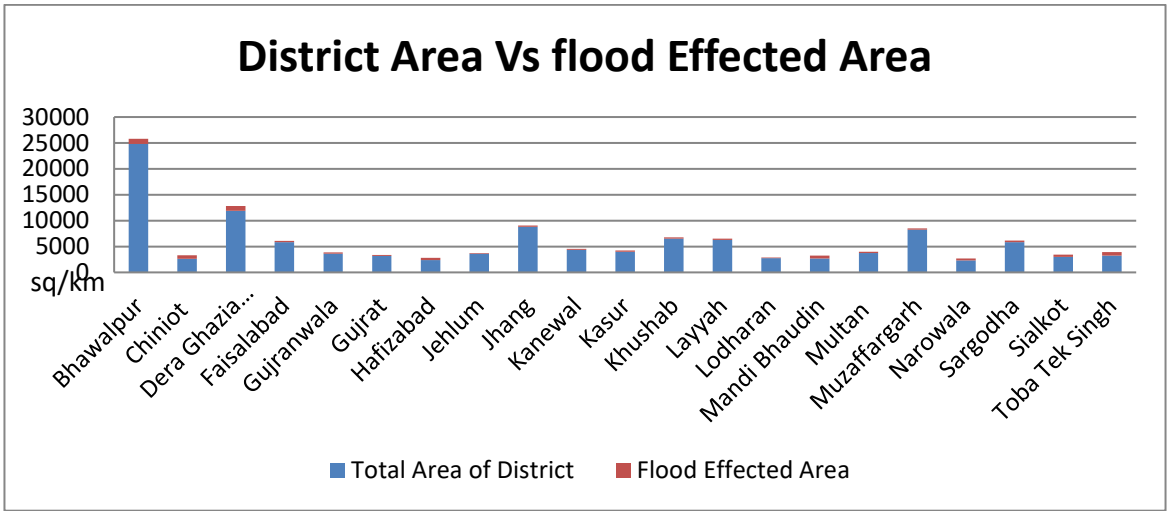

Figure 4.1: District areas Vs flood affected areas

4.2 Discussion

According to the map, it's clear which district and its related settlements were more affected by flood. Which districts in Punjab strike by flood frequently and most also known. The weaknesses of those areas were also clear. By studying the maps, 3 districts were chosen that were on highly flood risks and these districts were Mandi Bhauddin, Chiniot and Hafizabad.

Mandi Bhauddin flood hazard analysis

In the given figure of Mandi Bhauddin, it's shown that accumulation lines are weak, that's why Mandi Bhauddin district is affected by flood. It can be seen in maps that Mandi Bhauddin district is actually affected by flood in 2016. This district is 220 meters above sea level and River Chenab is in its south 39 km away. Three tehsils of the district effected MandiBhauddin, Phalia and Malkwal.

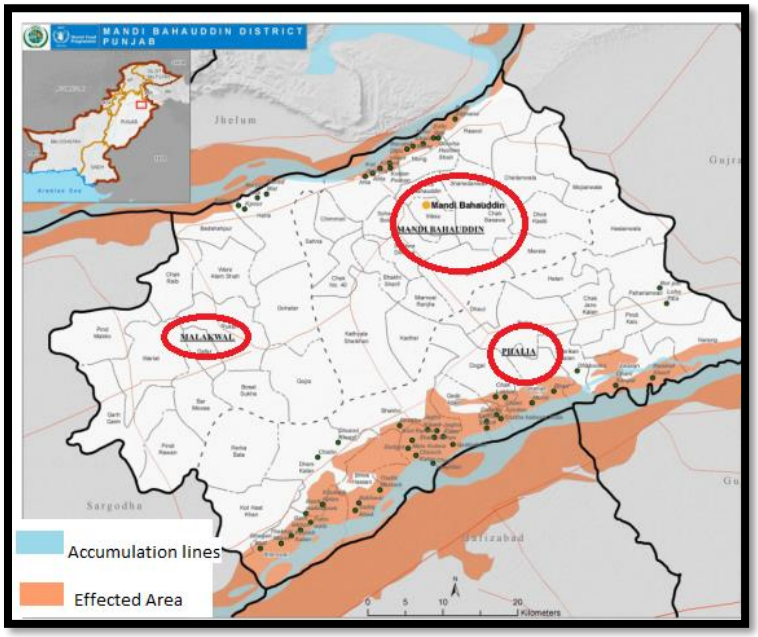

Figure 4.2: MandiBhaudin flood hazard analysis

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Total area of MandiBhauddin =2673 km²
Effected area of MandiBhauddin by flood = 545 km²
% damaged area =20.39 %
Total population of MandiBhauddin = 1160552
Population affected by flood = 35000
% population Effected= 3.0 %
Number of Villages affected=104

This proposed flood inundation system will help us and clear the areas of flood risks, the weak accumulation lines which cause flooding are a warning sign for the coming time period and generation to make flood monitoring system faster and more applicable to save the damages from flood in future.

If we study the past flood damage in this study, we can see there is less damage the reason is government is working on flood monitoring applications and doing work to manage or safe land, property, infrastructure, live stocketc from future flood.

The aftere ffects of this overview show that the dominant part of the casualties of the Flood are focused on the Flood hazardous situation and as a method for exhibiting the activity, the Chenab River preoccupation as a Flood control measure on the River Chenab, was embraced and started in a couple of years back. The technique has yielded positive outcomes, as the Flood rate has diminished both in recurrence and seriousness, from that point forward. This, in this way, recommends the requirement for considering the general population's supposition that, an arranging program in light of the current examples of the general population's social and financial conduct is probably going to be promptly satisfactory to the provincial population.

Conclusion

Floods are natural disasters; we cannot control their damage but by getting information’s before time or at time its disaster impacts can be reduced. It is very difficult to come up with the specific location which is at the high risk of flooding in Punjab, but from results it has come to know that the North and South areas were flatter to flooding in Punjab Pakistan. These areas have a larger population than the other areas. Floods affect east and west parts of Punjab, but those areas were not that much affected by floods.

5.2Recommendations

The suggestions I decided for the future are totally based on the resources and implementation:

- The “Provincial Disaster Management Authority (PDMA)” most guarantee complete recognition of improvement rules on behalf of the Punjab as respects the progress of flood fields particularly at MandiBhauddin, Lodharan, Sargodha, Chiniot, Lalian, Jhang, Multan and Hafizabad.
- The Government of the Punjab ought to give flood cautioning frameworks.

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