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Assessment of River Shahpur for Flood Risk in Northern Pakistan

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During 2010 flood, great losses to human and properties were reported in the study area. In terms of land and property loss, 74.1 hectare agriculture land, 2719 to 3114 houses were fully and partially damaged. This study was carried out with an aim, to explore flood risk assessment of river Shahpur in District Shangla. For the future perspectives ‘River Habitat Survey was used for flood risk assessment and ‘Spot Check Key Models’ are used to derive guidelines. Settlements and agriculture activities on the river banks were some of the major causes of the reported catastrophe in the study area. Most of the damages were reported on the right bank of river Shahpur due to the topography and structure of soil. This study recommends the construction of check dams and river embankment on river Shahpur to mitigate flood destruction in the future, coupled by flood prediction; early warning systems and risk assessment procedures should be integrated in both local and national planning so that both fertile land and precious lives can be saved.
Keywords: Flood Risk, Flood Risk Assessment, River Habitat Survey, Spot Check key.

1. Introduction

Flood is a condition that occurs when water overflows the artificial or natural boundaries of a stream, river, or other body of water enter into normally dry land. A flood happens when an area of land, usually low lying is covered with water. The worst floods usually occur when a river overflows its river banks. Flooding from the sea and from rivers is probably best known but prolonged, intense and localized rainfall can also cause severe flooding, overland flow and groundwater flooding, (PSFRM, 2009). In 2010, almost all of Pakistan was affected when massive flooding caused by record-breaking rains hit Khyber Pakhtunkhwa and Punjab. The number of individuals affected by the flooding exceeds the combined total of individuals affected by the 2004 Indian Ocean tsunami, the 2005 Kashmir earthquake and the 2010 Haiti earthquake. At least 2,000 people died in this flood and almost 20 million people were affected by it. Flooding has significant impacts on humans; it can threaten precious lives, valuable property and the overall environment. Assets at risk can include houses, transport, and public service infrastructure, commercial, industrial and agricultural enterprises. The health, social, economic and environmental impacts of flooding can be more significant. The frequency, pattern and severity of floods are expected to increase as a result of climate change, (The Planning System and Flood Risk Management, 2009).

Flood risk assessment (FRA) is the identification, quantification and communication of flood risk using the source pathway receptor model. It examines the sources of flood and the pathways by which floodwaters might reach receptors i.e. peoples, property and the environment and to determine the likelihood of them being affected by flooding. It also examines the flood hazards that are likely to arise and the vulnerability of receptors to such hazards. Flood Risk can be assessed at different scales, i.e. national, regional and local to site-specific, (The Planning System and Flood Risk Management, 2009).

The assessment of flood risk requires an understanding of where the water comes from (i.e. the source), how and where it flows (i.e. the pathways) and the people and assets affected by it i.e. the receptors (PSFRM, 2009).

2. Materials and Methods

2.1 Study site

District Shangla lies at 34-31^0 to 33-08^0 north latitude and 72-33^0 to 73-01^0 east latitude. It is situated at an elevation of 3164 meter above the sea level. The total area of District Shangla is 1,586 square kilometers. High mountains and narrow valleys dominate the topography of District. These mountains are the western extremities of the great Himalayan range (UNDP, 2007). The geography of District Shangla consists of geological features, Rivers System, Flash Flood, Land Use and Climatic and weather patterns. Shangla is located at more than 2,000 meters above sea level. Union Council Shahpur is situated at a distance of about 27 km in Northeast from main town of Alpuri Shangla. Total area of Shahpur is 11296 Acre. Its height from sea level is 4400 feet. The UC area falls in the moist Temperate Zone thus receiving summer monsoon (July, August) and winter snowfall. The climate in summer is moderate and pleasant and average rainfall ranges from 1500-2000 mm/year. The slopes in the upper portions are steep and comparatively moderate in the lower portions.

2.2 River Habitat Survey (RHS)

The River Habitat Survey (RHS) method is based on the visual assessment of the stream characteristics. The survey method consists of two parts: ten spot-checks and a sweep-up. Spot-checks were recorded for every 200 meters, where channel features, as well as, right and left bank features were individually assessed (fig.1).

RHS was done through ten spot checks at equal distances and a sweep up of the whole reach. At each spot check the channel, banks and the bank tops are assessed in terms of their physical attributes, land use and vegetation structures. The sweep up assesses the whole reach in terms of land use, bank profiles and the extent of features. The RHS was done by surveying a network of sites chosen as the stratified random sample with the set survey form and recording the results in the database.

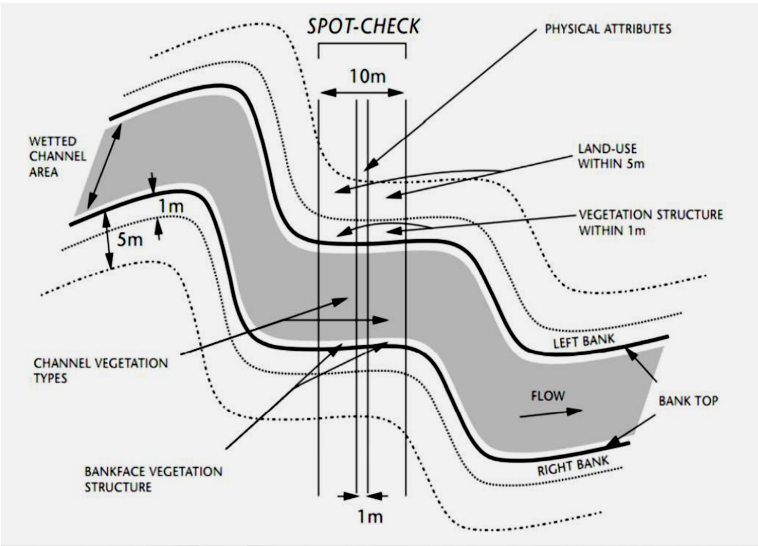

Figure. 1. Spot-check procedure (EA, 1998)

2.3. Visual assessments

The visual assessments involve walking along the river floodplains and banks and filling in a structured note sheet.

2.4. Measuring tape

Ordinary tape was used to measure equal distances between the spot checks on the floodplain or the bank.

2.5. Physical features and flow type assessment

Physical features and flow type assessment were assessed on a meter transect of the location. Channel vegetation types, bank face vegetation structures, bank top and land use are all assessed on a ten meter transect. The land use extends 10 meters above the bank top and vegetation structures were assessed within one meter of the bank top. The sweep-up ensures that all the features has been recorded during the spot checks and accounts for valley form, as well as for any modifications, artificial features and features of special interest even between the spot-checks. In addition, the surveying involves choosing a representative location, preferably a riffle, to record cross-sectional data on the reach, i.e. water and bank full width, bank height and water depth.

3. Results and Discussions

3.1. Predominant Materials of Left and Right Bank

According to manning formula

$Q = 1/n * R^{2/3} * S^{1/2}$

As at our site slope is maximum with sudden increase, if we keep all the factor of manning formula constant then $Q \propto 1/n$ As n = co-efficient of roughness. Therefore, 57% of the Boulder, Cobble, Sand and Gravel increase the co-efficient of roughness. Thus decrease in discharge at any point is due to increase in roughness co-efficient. A harder crossing the river in its flow, putting impacts on pressure per unit area. Increase in impact causes flow or erosion of sand particles in between gravels and cobbles. Thus erosion is directly related to river side sliding. It also increases the flood damages. Due to the large amount of boulder (BO) and Gravel/Sand (GS) it may also cause the sediment loss.

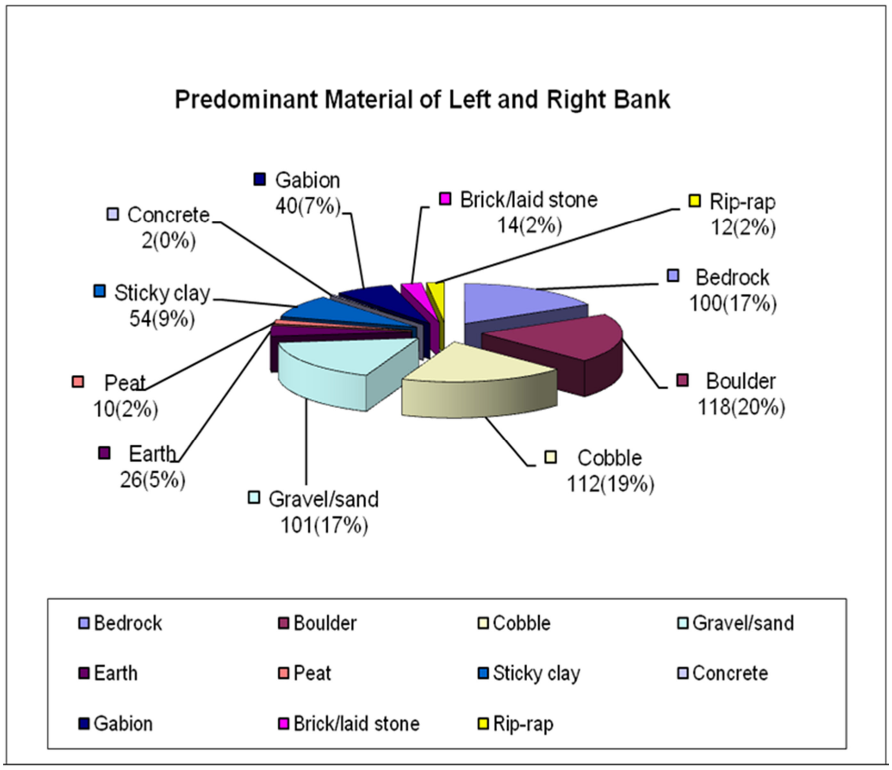

Figure.2. Predominant Material of Left and Right Bank

3.2. Bank Modifications of Left and Right Bank

Embanked, Resection, Artificial berm and Poached are 85 % therefore it may cause great impacts on water. Large amount of Embanked (EM), Resectioned (RS), Artificial berms (BM), and Poached bank (PC) can create the Braided and Meandering channels in the river. Replacement of the Embanked (EM), Resectioned (RS), Artificial berms (BM), and Poached bank (PC) will make it more prone to flooding.

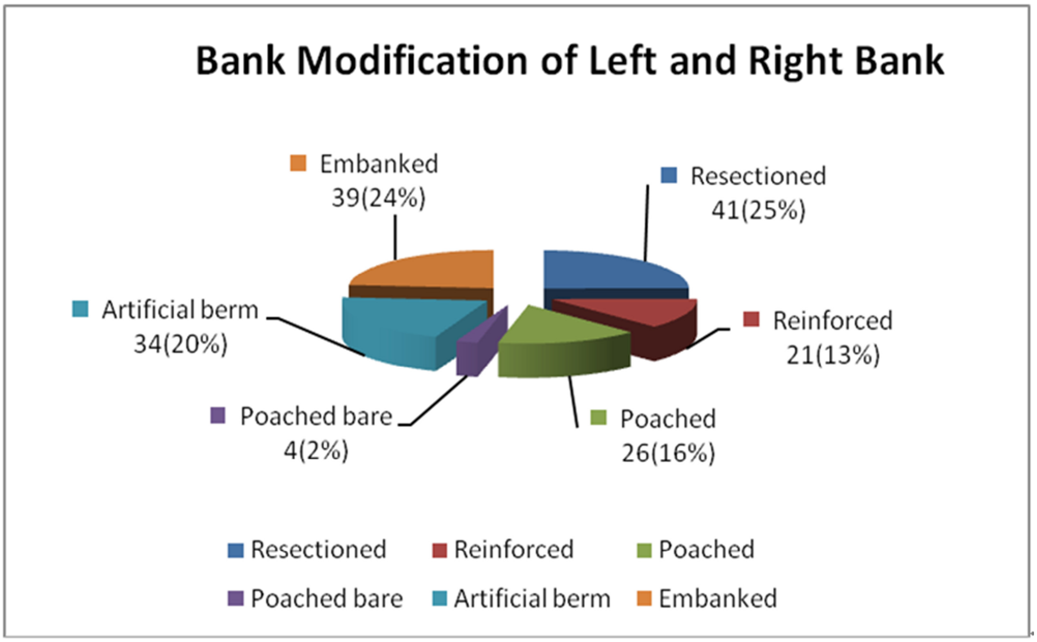

Figure.3 Bank Modifications of Left and Right Bank

3.3. Marginal and Bank Features Of Left and Right Bank

Eroding cliff is present in the amount of 21 %, which is the preservation behavior of the marginal and bank features. Water leaching effect increases due to the eroding cliff and the amount of sediment is very low.

Eroding cliff create the effect of water pilling, which increases the sliding effects. Environmental pollution may also be creating by the eroding cliff.

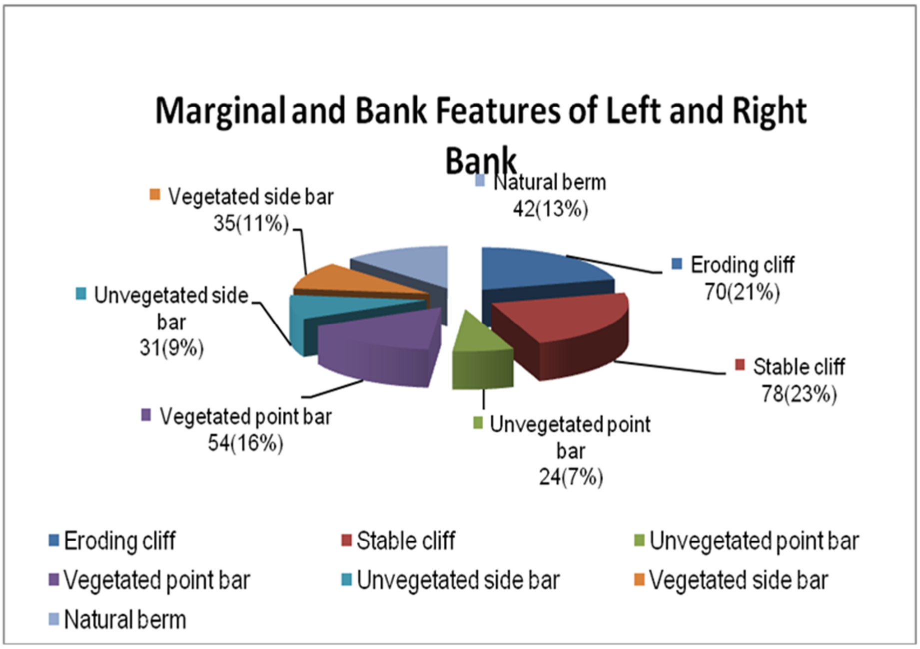

Figure.4. Chart of Marginal and Bank Features of Left and Right Bank

3.4 Predominant Substrate

The silt, sand and clay are 27 % in the structure of predominant substrate. The channel's outer layer is made up of silt, sand and clay. When flood comes water easily erodes the first layer of silt and then the sand and clay respectively. In predominant channel substrate the major components are Sand (SA), Cobble (CO), Clay (CL), Earth (EA), Gravel/pebble (GP), Silt (SI), boulder (BO) and bedrock (BE). This may be the main reason of huge damage during flooding.

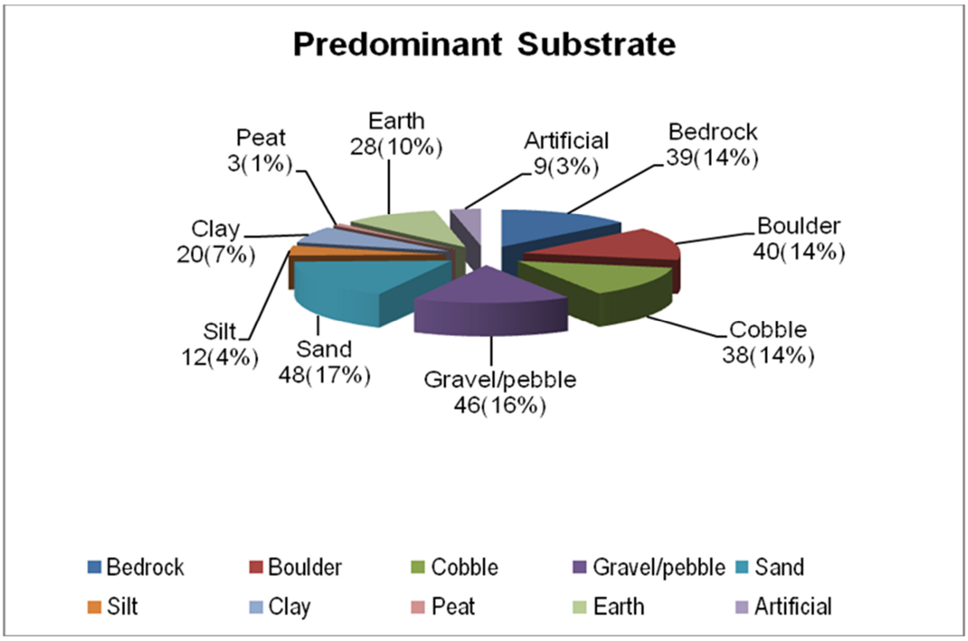

Figure.5. Chart of Predominant Substrate

3.5 Predominant Flow-Type

The predominant channel, dominant flow types are chaotic flow and rippled which can cause great change in momentum (rate of change of velocity) of the river, due to this the sides of river can easily erode and cause huge damages in flooding.

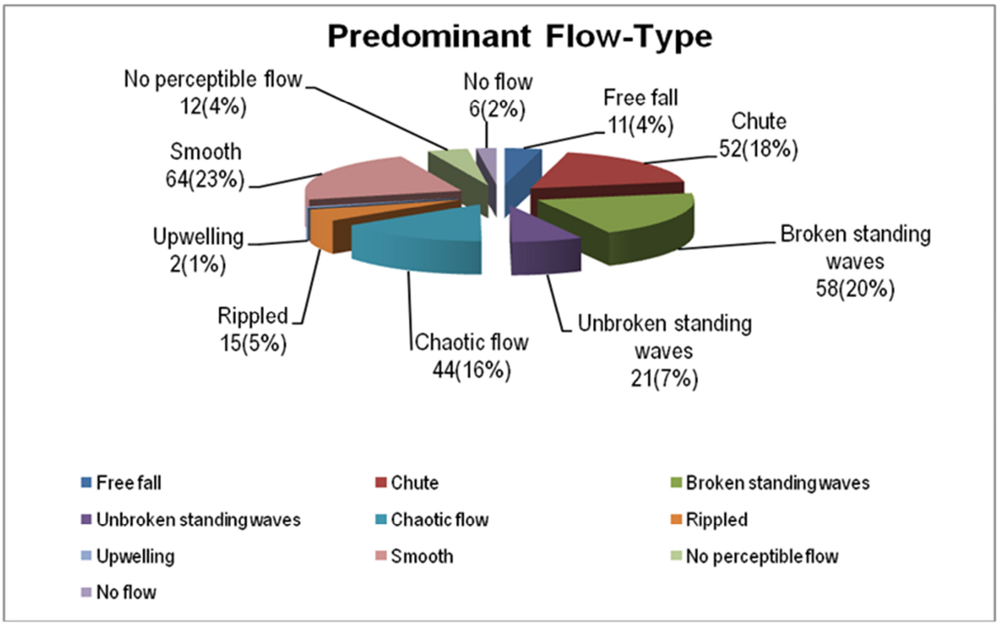

Figure.6 Chart of Predominant flow-type

3.6 Channel Modifications

Channel modification is the artificial fording place and channel bed which can be easily eroded during flood. As there is no consistency in the river bank and this will enhancing further break down of channels, as the bank will erode during flood and channel bed may badly damage.

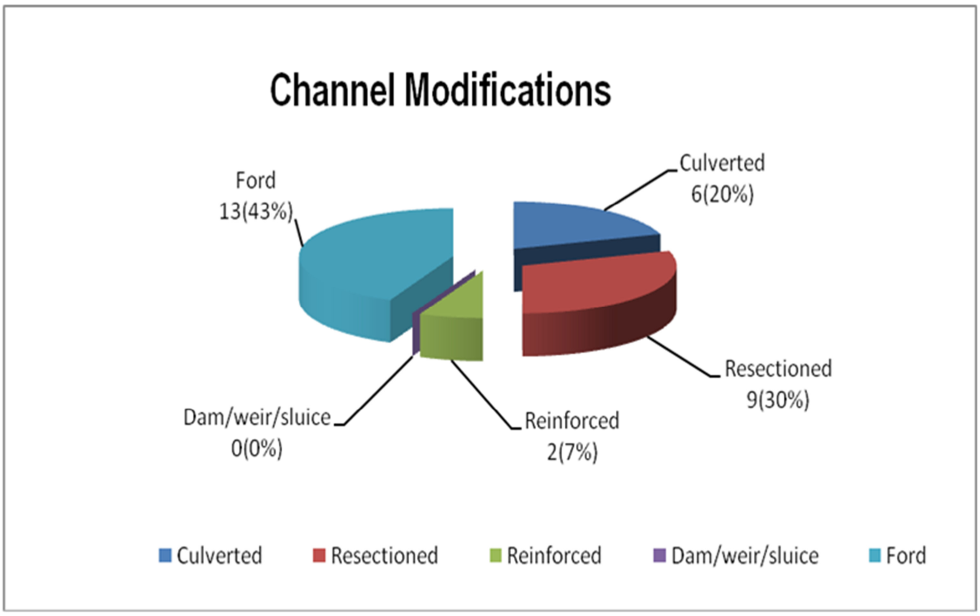

Figure.7 Channel Modifications

3.7. Channel Features

Exposed bedrock produce falls and spill generation of water in river, ultimately increase the braiding effect, which is also increases the flooding effect hazardously.

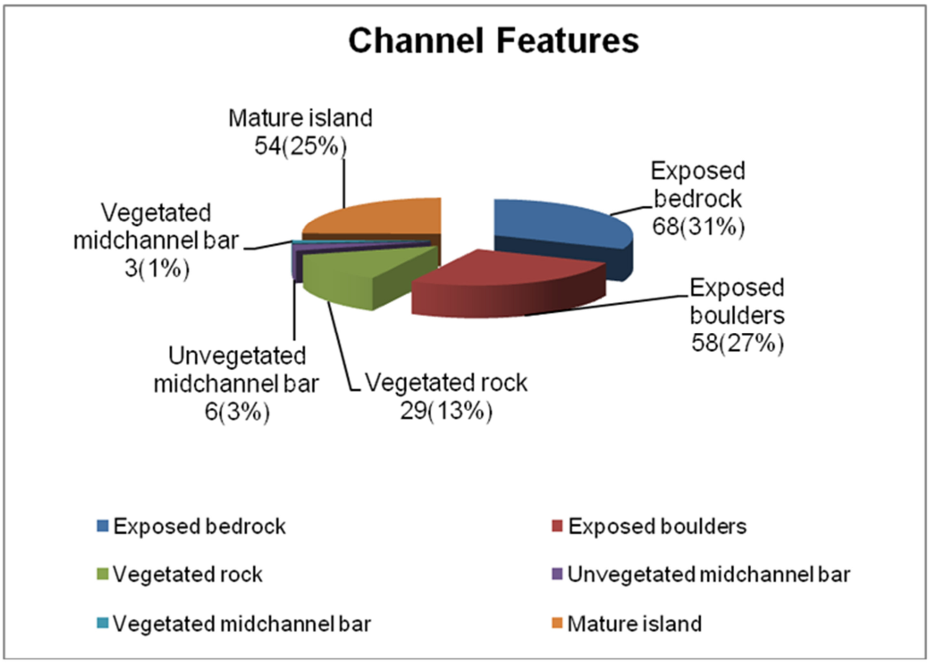

Figure.8 Channel features

3.8. Land-Use within 10m of Bank Top Left and Right Bank

Land-use within 10m of bank top left and right bank include mostly sedimentary rocks and irrigated land. In case of flood the sediment from the sedimentary rocks and irrigated land may loss and irrigated land may completely washouts which will also increases the severity of flooding effect and the environmental pollution may also be increased.

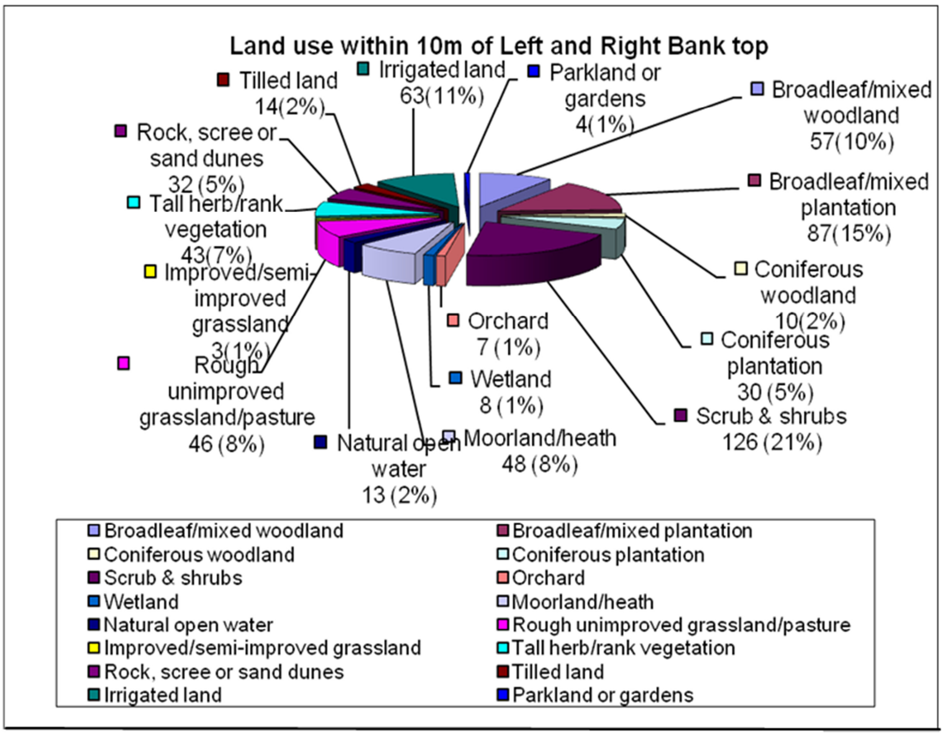

Figure.9 Land-Use within 10m of Bank Top Left and Right Bank

3.9. Bank Top and Bank Faces Vegetation Structures

There is no line of protection (levee) present at lift and right bank top and this will causing high braiding and meandering effects and sometimes river diversion to the valley causing harm to humans, population and property.

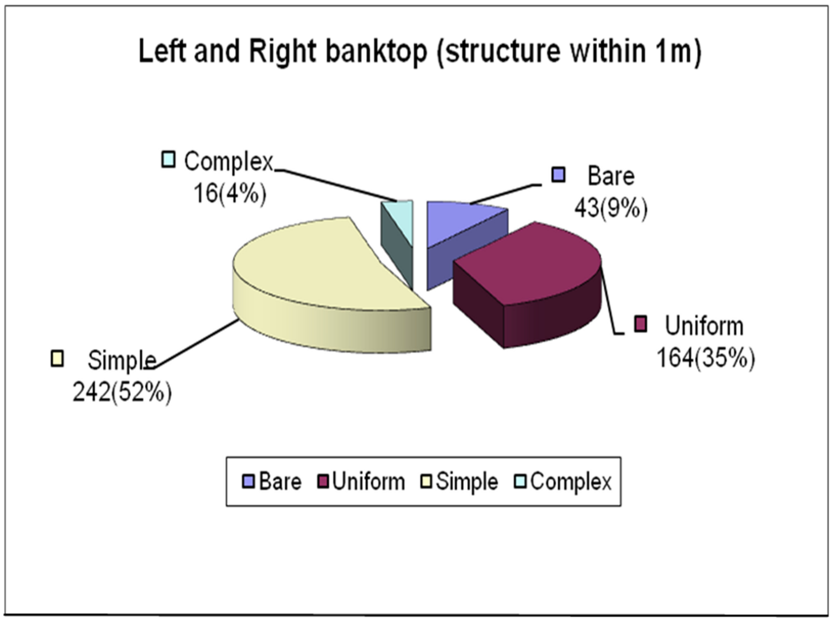

Figure.10 Left and right bank top structure

3.10. Left and Right Bank Face Structure

On the left and right bank face structure 46 % is the floodplain and 7 % is bare. From previous river flood it was concluded that due to the absence of flood protection structure these huge damages were observed. River banks bareness may also be the cause of damage in future if protection structures were absent.

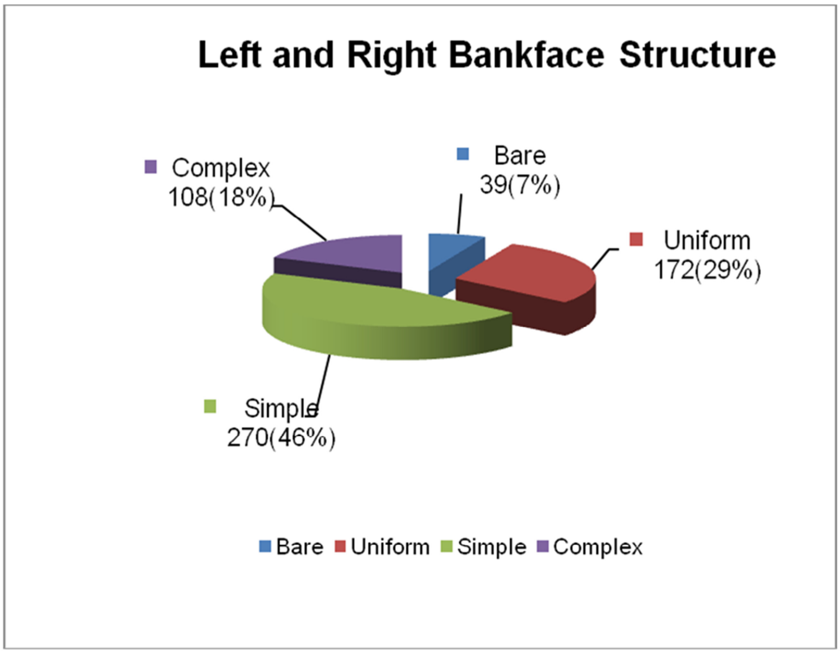

Figure.11 Left and Right Bank Face Structure

Conclusion and Recommendations

River Habitat Survey has been used in this study for flood risk assessment and 'Spot Check Key Models' are used to derive guidelines for the prevention of future flood risk. Land use pattern i.e. settlements and agriculture activities on the river banks could have been some of the major causes of the reported catastrophe in the study area. Most of the damages were reported on the right bank of River Shahpur due to the topography and structure of soil i.e. having low or no resistance against the eroding force of flood.

The local communities should be trained, and be involved in the flood risk assessment, its planning, implementation and management and its revision on the basis of five year duration or after a major flood which come before, as a major stakeholder. Early warning systems should be developed and communities, villages and town peoples should be involved in the system and their committees should be framed. Necessary stockpile, emergency evacuation plains and maps should be framed and provided to the local communities. A forestation should be done as the water flowing on; to stop the soil erosion and sweeping effects of flood on slopes. The river embankments must be metaled in a way that they may resist the flooding force of the water. Checkdam must be build to mitigate the impacts of the flood water. The river habitat must be declared as no-human activities area.

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