3rd Conference on Sustainability in Civil Engineering (CSCE'21)
Department of Civil Engineering
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GIS-based Identification of River Bank erosion and Flood Water Management

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***Abstract*:** Indus River in Southern Punjab, Layyah started to erode the residential as well as agricultural land at the left bank (31°4'0.321"N, 70°49'41.066"E) in 2000. At that time the local Government constructed the spurs on the left bank to tackle the erosion problem of the flowing river. It proved to be a short-term solution because in 2010 despite the construction of spurs the river started to erode, eventually resulting in the construction of spurs at the left bank once again. The present research emphasizes, training the river in the peak flow duration and analyzing the river shifting behavior as well as applying the Geological information sources (GIS) and Remote Sensing (RS) methods for geomorphology analysis progress. To gather Remote Sensing information and topographical information for 20 years shifting of the river bank. Because the geomorphology of the Indus River is continuously changing, causes a decrease in the area of the Indus River day by day. GIS mapping of river erosion shows that from 2000 to 2010 the natural river cross-section is disturbed by 50km^2 to 48. 83km^2 and from 2010 to 2020 reduction of river area is from 48. 83km^2 to 31.02km^2. The Results Show that the change in the stream bank is because of different common and synthetic exercises like a flood, flow velocity, deposition of eroded materials, uprooting of the vegetation covers, and soil stability disturbances. Furthermore, around 200 interviews were also conducted with local community individuals discussing river erosion and floodwater management during the month of peak discharge. The statistics show that 59% of remarks were related to "inappropriate river training works" and 43% of remarks were about "poor floodwater management".

Keywords-: *Land sat Images, Geographic Information System, erosion, Remote sensing*.

1 Introduction:

The largest catchment and span-wise river is the Indus river of Pakistan. The Total agricultural land of Pakistan depends upon the Indus river irrigation system. The total length of the Indus River is 3481km from the North to the Arabian sea **[1]**Bank erosion is a natural geomorphic process or disturbance that occurs during or soon after floods. Riverbanks are temporary boundaries, between the aquatic and native ecosystems, and they regularly change under naturally dynamic hydrologic conditions. Although abundant research suggests that bank erosion is a basic ecological process[2]**.** Brahmaputra river which is situated in India pointed toward evaluating the genuine bank disintegration along the time of eighteen years (1990-2008). The study length of this river is a stream of Dibrugarh to town dhubri which is near about Bangladesh that's spanwise is 620km utilized for the geographic information system and remote sensing. Satellite images were used for study analysis from 1990 to 2008 [3]**.** The Bank of the river is very important like Ganga is one of the largest rivers in the world. It is the river of the Himalayas countries which devastated water every year by flooding. Mostly major river system changes the morphology every year. Like most major river systems, it changes course in space and time in the rugged plains. This study counted the variability in the parameters of the river by using historical and monthly discharge data [4]**.** In this research area GIS and Remote Sensing are used for river shifting measurement. Morphological changes occur due to discharge, LULC variations[5]**.** The morphometric boundaries, for example, the approximation of the zone to the level of the Cincinnati, Braided Ness Index, and the complete waterway of the island zone, were estimated from Landsat from 1955, 1977, 1990, 2001, 2003, and 2005. IRS satellite imagery investigations show that all the time these limits are brought together and all things are extended on a basic basis. The examination revealed that the bank's frustration was due to the obstruction of certain components such as riverine soil excavation, presence of hard rough zone, excessive piles of dirt and excavation, and obstruction of development of Farakka blast as a Common waterway[6]**.**

The principal objective of the paper with useful ideas for control the bank disintegration and moving of the Pravara River. An endeavor has been made here, to mechanism the GIS and RS strategies for stream change recognition utilizing customary to progress topographical information sources. The advances in Remote Sensing information and Topographical information are to actualize for acquiring 35 years' progressions brings about waterway stream. The angle or slant, water

volume, water speed, and nature of the waterway are mindful edges for changing the stream's shape and size **[7].** River channel mapping is measured by using a Geographic information system also remote sensing. Local variations in riverbank and waterway centers existed regularly reviewed, and efforts were made to link these Inputs findings to appropriate natural and human interference affecting the river morphology[8]**.** In this study area, river banks identify by Remote sensing during the period of 103 years (1912-2015). River found highly shifting and meandering with sinuosity index[9]. The main reason for channel shifting in the southwest is the influence of natural river flow disturbance by human activities. There are some further dynamic changes like discharge capacity of the river, channel deposition load, the transport capacity of the river disturbed by human activities. The influence of river training is no relation between the engineering structure and the development of natural river flow streams[10].

The purpose of this literature study is to evaluate the shifting of Indus river erosion about 28.4 km along the part of Indus river in district Layyah Punjab Pakistan. In this study river is shifting toward the left bank in a 20-year time period this is called a temporal change in behavior of the natural channel. Furthermore, River channel mapping is measured by using a Geographic information system also remote sensing. Local variations present in riverbank and waterway centers were regularly reviewed, and efforts were made to link these Inputs findings to appropriate natural and human interference affecting the river morphology. This study aims to evaluate shifting river and total area of water streams by using the temporal change method with the help of a geographic information system and Remote sensing.

2 Methodology used for Analysis

Study area

Indus river is the largest river in Pakistan, which is an important river in the Asian region. Indus river length is 3,180km from source to mouth. A bulky part of the Indus River flows into the Karakoram and Himalayan mountain ranges. The main branches of the Indus River coordination are the Kabul, Jhelum, and Chenab rivers, which cause floods due to surplus water flow in the monsoon season. The study was conducted to highlight the erosion and flooding of the Indus River and its damages along Layyah in an area of about 65 km^2. The district covers a total area of 6,291 km^2 having a width of 88 km from east to west and a length of 72 km from north to south. Layyah district was hit by severe floods for many years, namely 1950, 1956, 1957, 1958, 1963, 1965, 1973, 1976, 1988, and 1992 and then till 2020. More than 31,658 houses, 154,000 families have been affected and washed away in the district Layyah, 500,000 all over Punjab Province in the major floods of 2010[11].

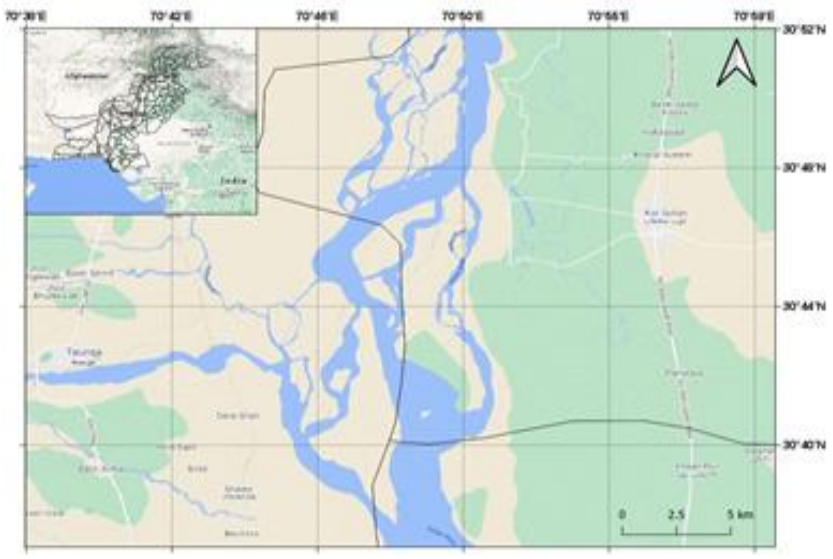

Figure 1: Study area of Indus river in district Layyah

3 Methodology Framework

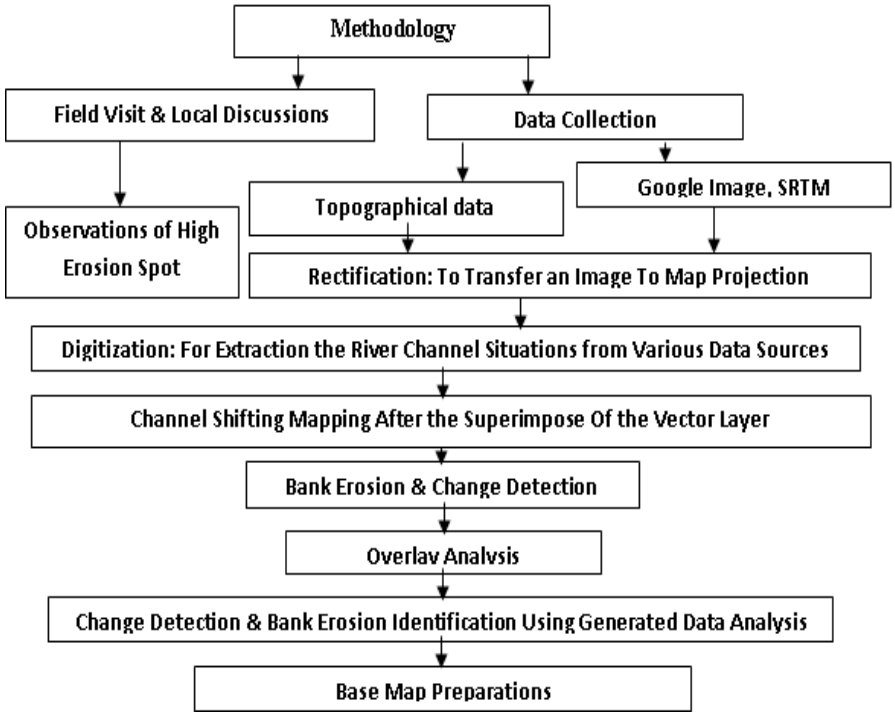

Figure 2: Flow chart

3.1 Geographical Information system analysis

ArcMap 10.4 GIS programming is used to investigate stream bank information. Satellite images were developed earlier in 2000, 2010, and 2020 to obtain the necessary information about the research zone. The additional segment captures the arrangement of satellite images to extract data. In this investigation, satellite images of Landsat Way 151, Line 039 were used for the years 2000, 2010, and 2020 and are ready to obtain the necessary data. The digital elevation model of 30 meters is used for this research study. The current research study includes both high and low flood season data. The table1 records the important limits of the information used in this research. The spatial analysis has been done by using DEM 30m. The Landsat images downloaded from USGS were chosen with accessibility.

Table 1: Data Source Used

Satellite	Date of acquisition	Season	Resolution	Path &Row	Source
Landsat 4,5	2000	High flow +Low flow	30m	151&39	USGS
Landsat 7	2010	High Flow +Low flow	30m	151 & 39	USGS
Landsat 8	2020	High Flow +Low flow	30m	151 & 39	USGS

The projection of Landsat images is WGS 1984 UTM Zone north 43 DATM Level -1B. Mathematical adjustment is a preparation phase, that is applied to avoid mathematical contradictions in the picture. It creates links between beautiful image arrangements and geographical directions. Therefore, to assure position information, I have included GPS from Google Earth and all images of the landscape connected**.** The NDWI technique is used to enhance the features and visibility of open, water, satellite imagery. Normalized difference water index (NDWI) enhance water properties when removing clouds error and other plant features from the surface. Water is extracted from selected satellite images using the following index. There is an equation for this.

$$NDWI = \frac{GREEN-SWIR}{GREEN+SWIR} \quad \text{.....} \quad \text{Equation 1}$$

ArcGIS has developed a model that focuses on green and shortwave infrared (SWIR) groups related to landscape information and NDWI image. The nominated variety is then improved by converting it to a polyhedron. This model was run on each of the 12 images of the high and low stream season. After that, a research study based on a questioner (https://docs.google.com/forms/d/e/1FAIpQLSe5XtlYO3ffoa6kQnIdbWrffR5ifwZZVUKl8wrJXRQ5r5m6A/viewform?usp=sf_link) consisting of about 200 interviews is being conducted which involves a discussion regarding river erosion and the main reason behind flooding.

4 Results

The stream disintegrated due to the deposition of silt in numerous places all through the local morphology of the Indus river. It tends to be seen from spatial information analysis of river erosion and area of water streams shifting that is maximum in left banks from 2000 to 2020. From Table 2, information uncovered that the zone of around 28.4 km has been dissolved from the Left bank from 2000 to 2020. GIS mapping of river erosion shows that from 2000 to 2010 the natural river cross-section is disturbed due to changing the area of water body 50km^2 to 48. 83Km^2 and from 2010 to 2020 again reduction of river area is from 48. 83 Km^2 to 31.02Km^2. Figure 3 shows the river shifting scenario along the Layyah district from 2000 to 2020.

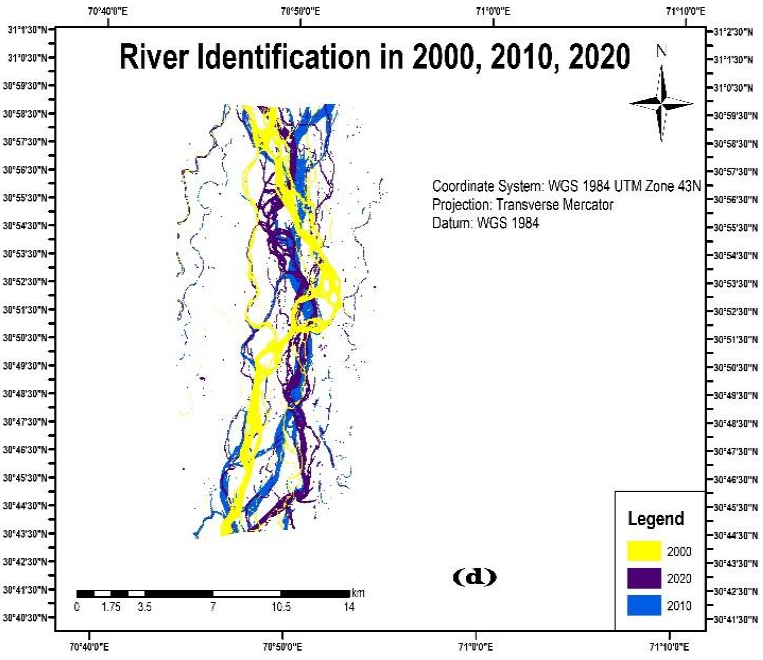

Figure 3: River shifting

Table 2:Indus river flow area

Satellite	Date of acquisition	Season	Area of watershed
Landsat 4,5	2000	High flow +Low flow	50km^2
Landsat 7	2010	High Flow +Low flow	48.83km^2
Landsat 8	2020	High Flow +Low flow	31.02km^2

The Results Show that the change in the stream banks is because of different common and synthetic exercises like flood, flow velocity, deposition of eroded materials, expulsion of the vegetation covers, and soil stability disturbances. Figure 4 shows that the hydrograph of 2000,2010, and 2020 present peak discharge in June, July, and august in this time duration Government Should have to train the natural river flow.

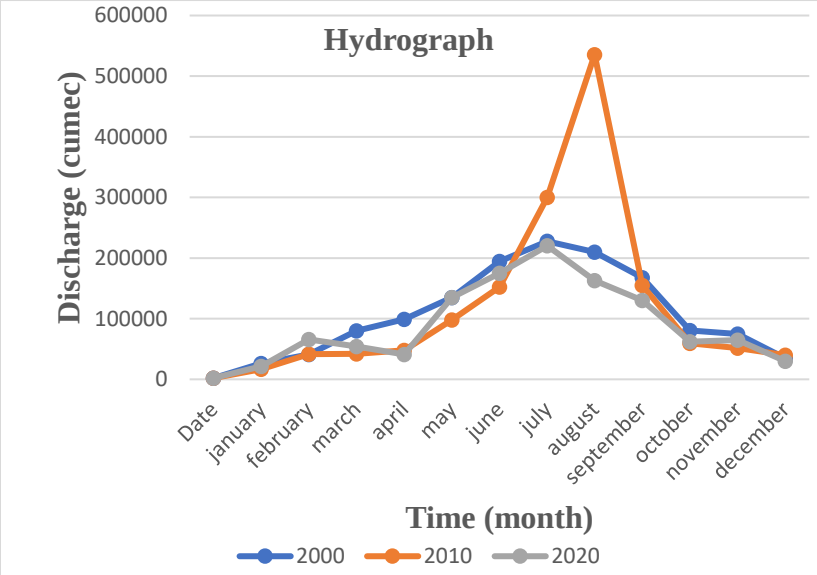

Figure :4

The Authors have interviewed about 200 people from the local community of the study area to discuss river erosion and floodwater management during the monthly peak eruption. Statistics in figure 5,6 show that 59% of the comments were about "improper river training" and 43% were about "poor flood management".

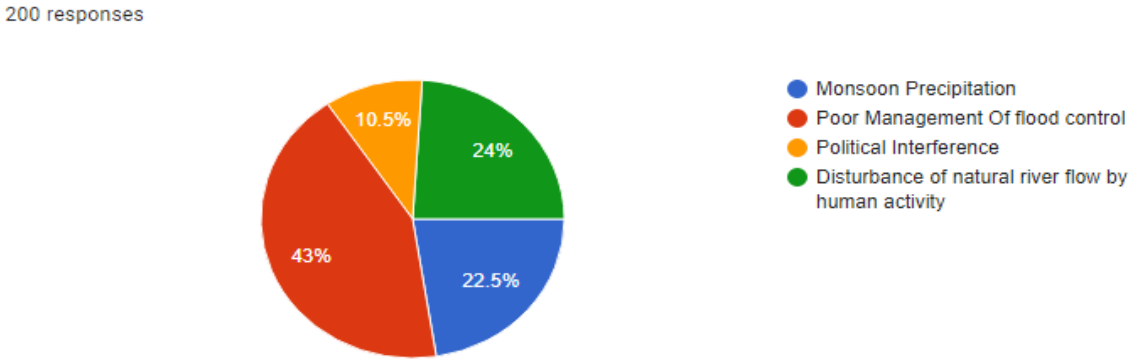

Figure 5: Survey Analysis of Layyah district community

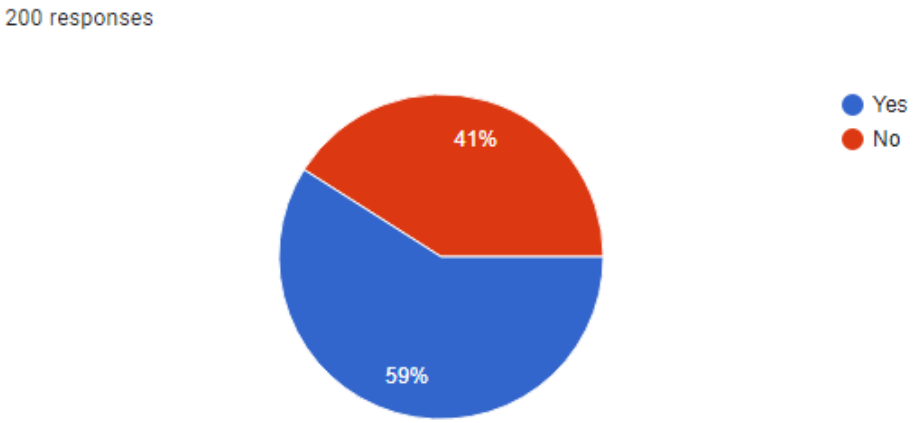

Figure 6: Survey Analysis of Layyah district community

It is about understanding and predicting more complex processes suggest practically through administrative results. Study area results will help in taking useful steps to keep safe agriculture land and lives near about Indus basin, not only in Pakistan but all over the world it saves the economy.

5 Conclusion and Discussion

Following conclusions and discussion can be drawn from the conducted study:

1. Protection against Bank Erosion by constructing dikes is not a long-term solution as sometimes it becomes more effective for disturbing the river path flow by minimizing the natural river flow.
2. GIS mapping of river erosion shows that from 2000 to 2010 the natural river cross-section is disturbed by changing watersheds of 50km^2 to 48. 83km^2 and from 2010 to 2020 reduction of river watershed is from 48. 83km^2 to 31.02km^2.
3. The change in the stream bank is because of different common and synthetic exercises like a flood, flow velocity, deposition of eroded materials, uprooting of the vegetation covers, and soil stability disturbances.
4. Around 200 interviews were also conducted with local community individuals discussing river erosion and floodwater management during the month of peak discharge. The statistics show that 59% of remarks were related to "inappropriate river training works" and 43% of remarks were about "poor floodwater management".

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