Remote Sensing for Flood Plain Monitoring in Sindh

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The Indus river originates from the glacial Tibetan mountains and gushes into Pakistan with all its might from the northern areas. The landforms in the plains of the Punjab and Sindh have been formed by the Indus and its tributaries. The landforms can be divided into: 1) Active flood plains 2) Meander flood plains 3) Cover flood plains 4) Channel levee remnants 5) Scalloped interfluves 6) Tidal delta and 7) Deltaic flood plains. Civilizations emerged on the banks of Indus river and meandering and migratory tendency has also ruined cities and settlements in the historical past. The known history of floods in Indus shows flood frequency of 7.7 year before the independence of Pakistan which increased to 3.6 year after partition. The floods are now expected to revisit frequently. The availability of high resolution along with regional scale satellite imagery has enabled us to monitor disasters and emergencies and study the flood plain and its peculiarities in an optimum manner. Physiographically the province is divided in 6 broad categories 1) Western Valley, 2) Khirthar mountains, 3) Kohistan or Kachho, 4) Eastern Valley, 5) Thar Desert and 6) Delta. The Sindh province is the tail of the Indus river, hence silt deposition and meandering phenomena is more dominant and visible in the province. Near past traces of river course changes/channels are observed in satellite imagery bordering Kohistan and Khirthar mountains in the west and Thar desert in the east. Physiographic distribution of Sindh overlaid on satellite imagery is shown in Figure-1. The east and west borders of Sindh are elevated due to Khirthar range, Kohistan and sand dune formation in the Thar Desert. These elevated boundaries have restricted the Indus to change course within Eastern and Western valleys in the past. The limestone hills near Sukkur and Ganjo Takkar near Hyderabad are the only elevated landforms within Eastern and Western valleys. The slope of the land is less than 0.2m per km. Regional topography of the province has been extracted through satellite imagery and is shown in Figure-2. The present flood plain in Sindh is bounded by flood protective infrastructure including embankments, guide embankments, diversions (barrages), loop and spurs and linearly stretches to 626 km from Kashmore to Keti Bandar. After the construction of embankments a large land area within the flood plain was declared for reserve forests. The forests provided a shield against the soil erosion process and helped as a natural safeguard for the protective

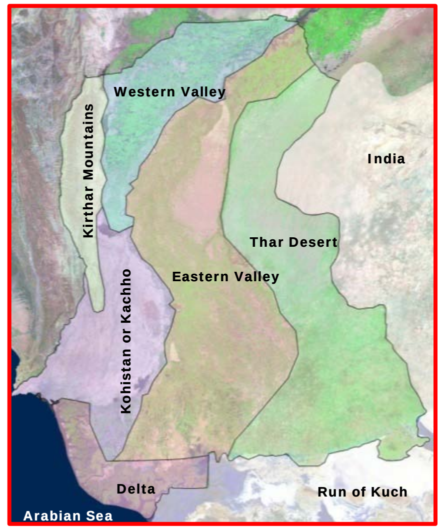

Figure 1- Physiographic Division of Sindh

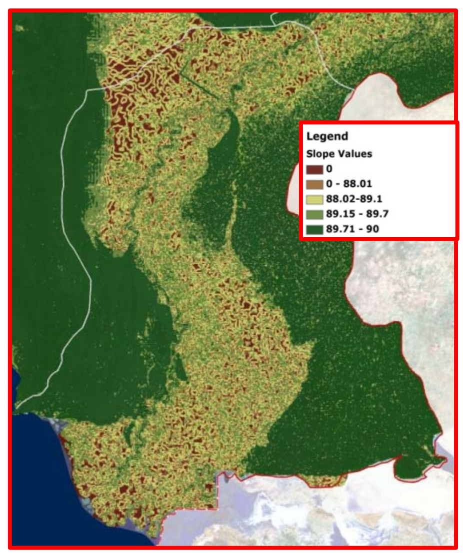

Figure 2- Topographic Map derived from ASTER Satellite imagery

infrastructure. In addition, there were oxbow lakes formed by river meandering and channels which worked as natural storage of water. Unfortunately, during the last couple of decades extensive human intervention has destroyed the natural ecosystem of the present flood plain. Satellite imagery is highly useful in mapping and delineation of landuse/landcover in flood plain of Sindh. The landcover comprises the natural landforms found within the flood plain which include the main river course, river channels, natural forest, sand bars and developing soil particularly in the vicinity of changing river course. On the other hand agricultural fields, fallow land and infrastructure fall under the landuse. Image based analysis of the flood plain suggests extensive human intervention in the present flood plain which results in excessive damage during flood. This information is extracted through satellite imagery and boundaries of present flood plain are shown in Figure-3.

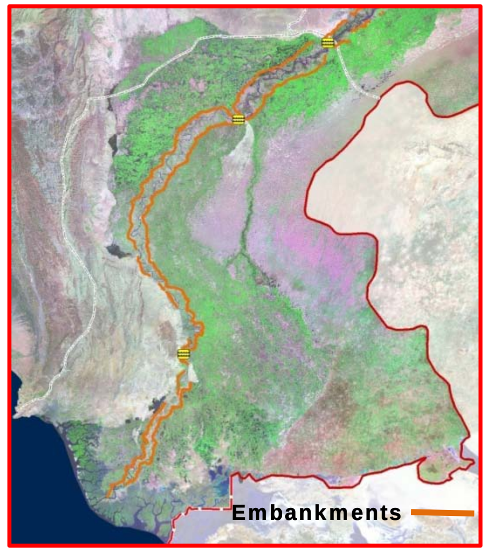

Figure 3-Present Flood Plain

For flood management and mitigation planning understanding of the river morphology is highly important. Silt deposition and erosion are one of the fundamental agents for river migration. Mapping of the main river flow, meanders and elevated sand deposits can lead to better strategic planning. Satellite imagery and its products are quite effective for mapping of river morphology. Migration of river course near Sehwan within a 9 years span (1990-1999) is shown in Figure-4. Post flood study is highly important to understand river geomorphology in order to understand changes in channel and land forms. Super floods such as Flood-2010 cause major morphological changes in the flood plain. Post flood satellite image shown in Figure-5 depicts traces of flood water after Tori breach and deposition of fresh silts as encircled in the image. Flood protective infrastructure such as embankments and levees are vital to be monitored before floods in order to plan against flood vulnerabilities. Satellite imagery offers a great deal for monitoring flood protective infrastructure and its condition. If the condition of the infrastructure is not up to the mark, plans may be initiated for maintenance. Erosion, cuts and human intervention in embankments can be mapped through satellite imagery. Figure-6

Figure 4- River course changes- Red color shows river during 1990 and Yellow during 1999

Figure 5 - Deposition of silt after flood-2010. Areas with similar color also represent after flood silt deposition

shows human settlements on embankments. Such conditions of embankments can cause flooding and emergency situations.

Figure 6 - Embankments occupied by settlements near Kandh Kot

Conclusion

It is now a globally established fact that satellite remote sensing technology can be utilized for effective flood plain monitoring and ultimately flood mitigation strategies. Having understood the nature of floods we can develop plan for its mitigation. Today's technologies can be very efficient supporting tool for such planning. It is time to get maximum benefit of these technologies for planning long term strategies to minimize the disaster caused by floods.