

Remote Sensing Based Analysis on River Dynamics and Fluvial Process, A Case Study of Udupi District, Karnataka

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ABSTRACT: Drainage system of an area is a dynamic system of the earth which always keep on changing in response to the changes in the earth-atmosphere system. In the present investigation, an effort has been made to study the stream dynamics of the Udupi district using Remote Sensing and Geographical Information System techniques. To determine the changes in flow dynamics, meandering and Entrenchment Ratio(ER) of the Sita, Swarna, Kolluru, Haladi and Chakra river satellite data of LISS IV (2014), LISS III (1972), TOPOSHEET (1910) and Google Earth Image has been used. The bankfull width, central flow lines of the river for all three years were digitized and compared to find out flow dynamics, meandering, Sinuosity Index(SI) and Entrenchment Ratio(ER). All the rivers are west flowing and meets the Arabian sea. The analysis divulged that the Kolluru River is a highly meandering river with Sinuosity Index of above 2 where the river has been suffering enormously with the deposition problem and shifting characteristics. River width has been reduced because of Littoral movements and sand mining over the long period. Kolluru river has been undergone maximum deposition of 411.77 ha area and Sita river has the highest erosion rate of 233.1 ha area. Based on the result, the new river islands were formed along the river banks between the year 1972 and 2014. The study revealed that RS and GIS techniques are useful to find out the stream dynamics of the river.

KEYWORDS: Stream dynamics,flow dynamics, Entrenchment Ratio (ER),Sinuosity Index (SI),Littoral movements.

I. INTRODUCTION

River channel changes such as bank erosion, down cutting, and bank accretion are natural processes for an alluvial river (Yao et al., 2013). The nature, rates and causes of channel change have a particular relevance to the areas where high levels of disturbance threaten engineering structures and property (Gilvear et al., 1999) and are important for conserving the biodiversity of vegetation communities within the river corridor (Gilvear, 1993; Marston et al., 1995; Bravard et al., 1997). Regional developments such as sand mining, infrastructure construction on the riverbank, artificial cutoffs, bankrevetment, reservoir construction and land use alterations have changed the natural geomorphologic dynamics of rivers (Surian 1999; Kesel 2003; Surian and Rinaldi 2003; Batalla et al., 2004; Vanacker et al., 2005). Change detection and quantification of erosion and deposition of riverbanks is such a study that is facilitated by application of RS, GIS and GPS. Remote sensing and GIS are widely used tools for detection and monitoring of changes of the physical environment. In addition, the ability to quantify errors, which affect the precision of analytical results, is greatly improved by Gurnellet al., (1994). Important studies by Gurnell et al. (1994) and Gurnell (1997) have provided a valuable insight into the possibilities that GIS offers for river channel change analysis. The natural flow of water supplied either from melting of glacier or rainfall regularly or intermittently over the crust of the earth following its slope in a definite channel due to gravity is generally referred to as river. Such natural flow of water has the greatest influence on the growth and development of human civilization. Nature in the form of rivers helps mankind to settle and flourish their lifestyle,

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somewhere it creates great problems of irrigation and navigation. But since the appearance of the man on earth, rivers have been its cradle of civilization as it is the main carrier of human cultural traits from place to place. History and archaeology proved that the major river basins have been the principal hearths of human civilization. All the ancient towns and cities all over the world are located on the banks of major or minor rivers. In spite of its helping nature, man has also faced many problems associated with rivers. The problems are multiplied with the increasing controlling attempts of the rivers by man.

II. OBJECTIVES AND NEED FOR STUDY

The main objective of the project is study the dynamics of the rivers in Udipi District.

specific objectives of the project is:

- To analyze the long-term river dynamics of the study area.
- To understand the recent evolutionary fluvial processes in the study area.
- To assess the positive & negative impacts of river morpho-dynamics
- The morpho-dynamics of meandering river channels play an important role in the understanding of the functions of river-floodplain ecosystem, sedimentation patterns and processes, and hydrological and ecological processes in floodplain environments.
- All the rivers in Udipi originate from Western Ghats and flow towards west, meets the Arabian sea. The study area have undergone several tectonic movements in the past decades. This impact the river flow in its path and the meandering pattern.
- The meandering of river affects the riparian vegetation and the area where the vegetation have grown, changes its nature and the pattern. The area where meandering happened also introduces new vegetation. The change in meandering also affects the landforms by erosion.
- The study area has more opportunity to do the project, since there is no research studies available for this area.

III. MATERIALS AND METHODOLOGY

PRIMARY DATA

- IRS P6 LISS IV SATELLITE IMAGE(2014)
- LANDSAT TM 1974
- 1910 TOPOSHEET

SOFTWARES USED

- ARC GIS 10.1
- ERDAS IMAGINE 9.1

- MICROSOFT OFFICE 2010.

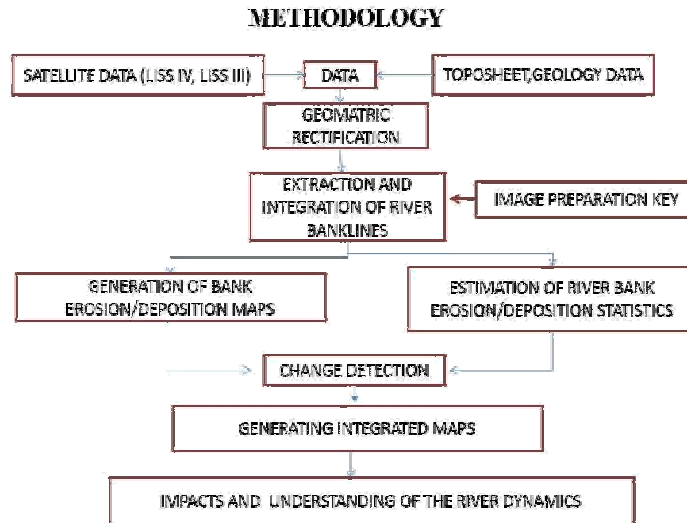


Figure 1 METHODOLOGY

IV. RIVER MEANDER CHANGE DETECTION

All the rivers have undergone meander from 1910 to 2014. In this, the river meander is more at some locations and some locations doesn't meander much.

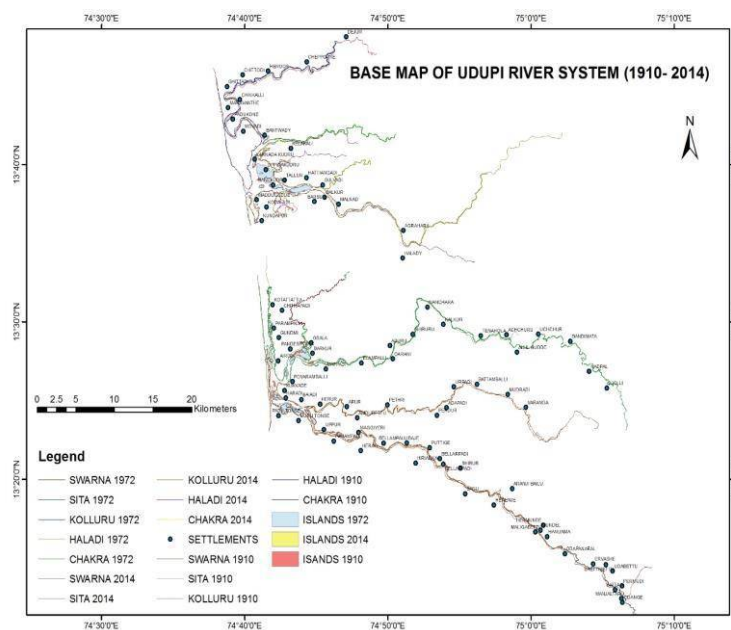


Figure 2 BASE MAP

A. SINUOSITY INDEX:

SI will be 1.0 if there is no shifting of the channel at all and it will be any value more than 1.0 in case of rivers. For the present study, Rosgen classification (1994) of streams is considered. In terms of sinuosity index, the major rivers of the district can be classified as under:

Table 1 SINUOSITY INDEX OF RIVER (1910,1972,2014)

YEAR	RIVER	CHANNEL LENGTH (km)	STRAIGHT LENGTH (km)	SINUOSITY INDEX
2014	SITA	73.03	43.195	1.69
	SWARNA	64.406	50.952	1.26
	KOLLURU	52.39	22.117	2.34
	HALADI	41.25	28.507	1.45
	CHAKRA	39.255	25.553	1.54
1972	SITA	64.52	41.24	1.56
	SWARNA	67.43	55.56	1.21
	KOLLURU	51.75	22.321	2.32
	HALADI	41.89	28.345	1.48
	CHAKRA	41.60	27.655	1.50
1910	SITA	60.68	38.303	1.58
	SWARNA	70.11	56.784	1.23
	KOLLURU	49.2	22.418	2.19
	HALADI	42.86	30.256	1.42
	CHAKRA	40.68	30.036	1.35

The above table clearly shows that, the Kolluru river has the highest meander characteristics. The chakra river has the less meander characteristics.

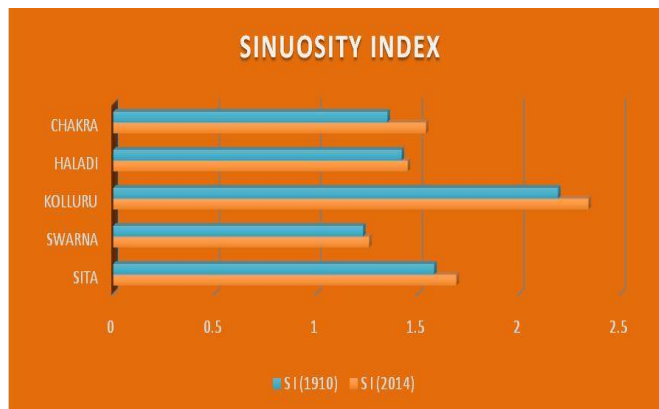


Figure 3 GRAPHICAL REPRESENTATION OF SINUOSITY INDEX

B. ENTRENCHMENT RATIO:

The lateral entrenchment ratio has been calculated for the five major rivers of the district- Sita, Swarna, Haladi, Chakra and Kolluru. The low resolution of Liss III and Toposheet does not allow to calculate the lengths of the two banks as this river appears to be a single line stream in the imagery. The same is true for the rivers Sita, Swarna and Kolluru in case of Liss III image. However, during the last 30 years, it is found that there is no change of lateral entrenchment ratio of the three rivers. River Kolluru shows a fluctuating left to right bank shifting over the study period.

Table 2 ENTRENCHMENT RATIO

YEAR	RIVER	LLB	LRB	ER
2014	SWARNA	79.95	77.5	1.03
	SITA	81.11	78.15	1.04
	KOLLURU	40.4	43.8	0.92
	CHAKRA	23.91	23.33	1.02
	HALADI	57.06	60.4	0.94
1972	SWARNA	57.06	53.95	1.06
	SITA	67.73	65.31	1.04
	KOLLURU	39.84	42.1	0.95
	CHAKRA	22.23	23.33	0.95
	HALADI	59.23	60.43	0.98
1910	SWARNA	46.22	54.85	0.84
	SITA	13.4	22.82	0.59
	KOLLURU	35.49	37.71	0.94
	CHAKRA	9.63	8.27	1.16
	HALADI	27.53	32.4	0.85

Figure 4 GRAPHICAL REPRESENTATION OF ENTRENCHMENT RATIO

C . BANK EROSION AND ACCRETION MAP

The study is carried out with the help of RS data, topographic sheet and the data collected from the field. All this data were individually processed and analyzed in a GIS environment. Here are prepared the bank erosion's thematic maps:

Table 3 EROSION AND ACCRETION

RIVER	EROSION(ha)	DEPOSITION(ha)
SITA RIVER	233.1	208.075
SWARNA RIVER	133.95	643.82
KOLLURU RIVER	96.26	411.77
HALADI RIVER	189.1	244.418
CHAKRA RIVER	38.544	150.241

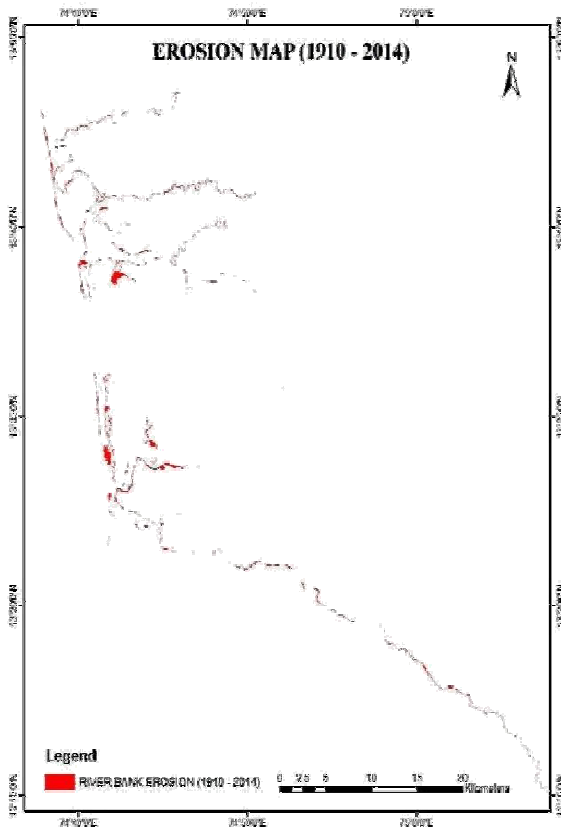


Figure 5 EROSION MAP

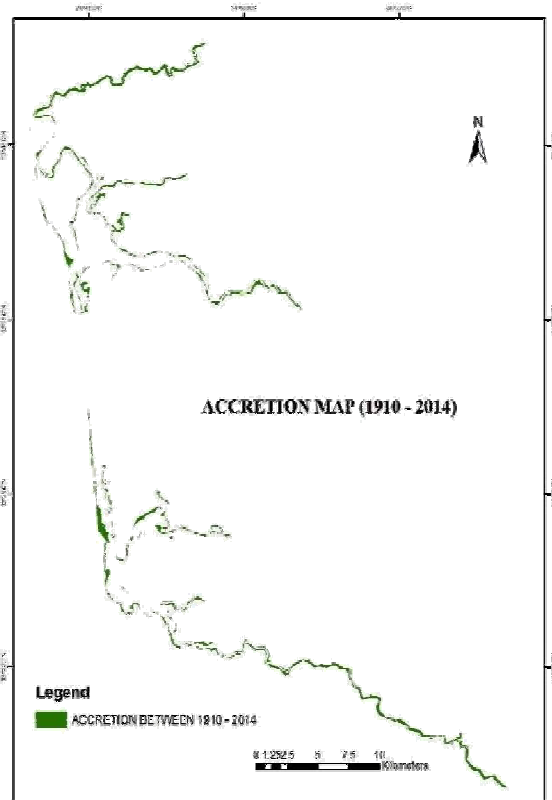


Figure 6 ACCRETION MAP

**EROSION(ha) DURING
1910 TO 2014**

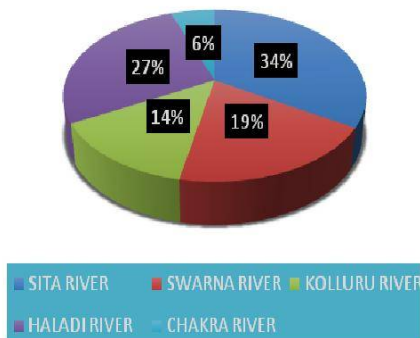


Figure 7 EROSION AREA

**DEPOSITION(ha) DURING
1910 TO 2014**

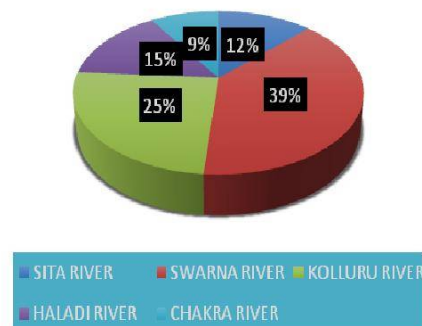


Figure 8 ACCRETION AREA

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V. CONCLUSION

Thus, it can be stated beyond doubt that GIS can be a very efficient tool in the process of identification and mapping of river changes and bank erosion. In this case study it has become clear that the Remote Sensing digital data can give the better results than the conventional methods. The channel of Kolluru River shifted to the both bank side, which results obtained by super imposing of topographical maps and Satellite images of Kolluru River. Throughout this case study showing that river stream changes owing to various natural and manmade phenomena. Finally, it can be said that in spite of some changes, topographical remote sensing data and GIS studies can help to change detection and other field of

fluvial sciences. The river bank shifting is based on the Littoral movement happened in the region. This paper demonstrates the application of recent GIS and RS techniques for bank erosion and change detection mapping as well as present the capabilities of RS data with GIS analysis for river study.

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