RESEARCH REVIEW JOURNALS
Volume-03
Issue-01
January-2018

ISSN: 2455-3085 (Online)
RESEARCH REVIEW International Journal of Multidisciplinary
www.rrjournals.com [UGC Listed Journal]

A spatio-temporal analysis of Bank line Shifting of Sankosh River in India

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ARTICLE DETAILS

Article History

Published Online: 28 January 2018

Keywords
bank line migration, seismic instability, bank erosion

ABSTRACT

Rivers are the dynamic feature of the environment and these are responsible for the surficial changes on the earth. The Sankosh River during monsoon regime are highly charged with water discharged and sediment load which are causing changes in channel pattern, bank line migration and other morphology of the channel in the study area. As a result, the bank lines of Sankosh River in the study area are extremely unstable characterised by highly variable pattern of channel shifting. The Sankosh River in the study area has a general tendency to shift its channel westward since time immemorial. The westward shifting is attributed partly to seismic instability of Himalaya also.

INTRODUCTION

Shifting of river courses in the alluvial system is dynamic response to geomorphic, geologic, hydrologic, climatic influences. Shifting courses are very sensitive indicators of fluvial dynamics of rivers which can readjust to variations in discharge, sediment load and active tectonics. One side shifting of river courses can be detected by its asymmetric location in the river basin and the evidences of its spatio-temporal shift in one direction (Schumm, et al., 2000). A numbers of rivers originated from Himalaya have shown sptio-temporal changes of their courses. It is also mentioned that among many other rivers of Himalaya over a period near about 6-7 years the Gharghra River in Uttar Pradesh has shifted by about 5km on side of the active channel at places (Tangri, 1992) which is attributed to neo tectonic movements. One of the largest shifts of a river traced is that of the Vedic Sarswati (Ghose, et. al., 1979). In fact about five past courses of the Saraswati were well-known and ahead of meeting the Indus River it used to drain in parallel to the Rann of Kuchchh, Gujrat and Rajasthan. The courses of the Sankosh river has also shifted from its original channel to western direction during the period of 1980 to 2016 andwhich causing changes in channel pattern, shifting of courses and morphology of the channel in the study area.

OBJECTIVE

1. To analyse spatio-temporal changes of bank line of the Sankosh river.
2. To find out the factors responsible for the shifting of courses of the Sankosh river in the study area.

METHODOLOGY

The methodology of the present study is divided into three part i.e., pre-field work, field work, and post field work. In the stage of pre-field work, secondary data has collected from various sources i.e. topographical map from Survey of India, satellite images from NRSA etc. On the other hand, primary data has collected from the field with the help of field survey by using necessary instruments e.g., GPS, survey instrument. After collection of data, empirical and quantitative techniques have been applied and necessary maps prepared on the remote sensing and GIS platform.

FINDINGS

Sptio-temporal analysis of bank line shifting:

The spatio-temporal changing pattern of bank line of Sankosh River in the study area in India during 1991 to 2016 is presented in the figure no. 1 and the planimetric measurement and related data are presented in the table no.1. The figure shows the position of bank lines of different year, i.e. 1991 and 2016 of upstream, middle stream and downstream reaches.

Table-1: Shifting of bank lines along Sankosh River reach, 1991 to 2016

River reach	Bank	Average bank line shift		Net progressive shift (sq.km)
		Progressive shift (sq.km)	**Regressive shift (sq.km)**	
Upstream reach	Left	10.10	3.47	84.21
	Right	47.25	1.10	
Middle stream reach	Left	6.52	10.90	
	Right	4.23	1.188	
Downstream reach	Left	4.43	11.45	
	Right	11.68	0.86	

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As an evident from the table no.1, the progressive shift on eastern bank line of the upstream reach of Sankosh River in the study area enhanced by erosion during **1991 to 2016** is 10.10sq.km and the regressive shift is 3.47sq.km. So the net shifting rate is 13.57sq.km. On the other hand in the western bank the bank line has its progressive shift of 47.25sq.km and regressive shift is 1.10sq.km during 1991 to 2016 leaving a net bank line shift is 48.35sq.km.

It is calculated that the east bank line of the middle stream reach of Sankosh River in the study area during 2016 have undergone progressive shifting of 10.75km and regressive shifting of 120.088km which recorded net progressive rates 84.21km. On its west bank the progressive nature of bank line shift takes place in the order of 4.23km which measures a net progressive shift of 10.75km during 2016.

Along the downstream reach, the erosion induced progressive shift of east bank is 16.11km against the deposition induced regressive shift of 12.31km during the 2016 with a net progressive shifting of 84.21km.

In the study area as revealed during field observation, shear failure in the upper bank materials seems to most wide-spread of bank failure. It caused by undercutting of the upper bank materials during high flow producing overhanging cantilevered bank which collapsed later. The bank constitutes the recent alluvium soils which mostly sandy and silt and at the same time the materials of both banks of the reaches are non-cohesive and less compact. For this reason, the erosional process is more active along the bank line causing channel changes spatially and temporarily. Moreover bank erosion more active during the falling stage of water. Furthermore, the behaviour of the river bed during flood stage is considered as an important factor for channel change. In the study area, it is observed that during the falling stage of water discharge, bank erosion becomes more active as in this period the excess sediment is deposited on the river bed and at the sometime on the bank side as bars. As a result, the local diversion of flow and consequent channel changes is generally occurred which accelerate the process of the formation of abandoned channels on the both banks of Sankosh river in the study area.

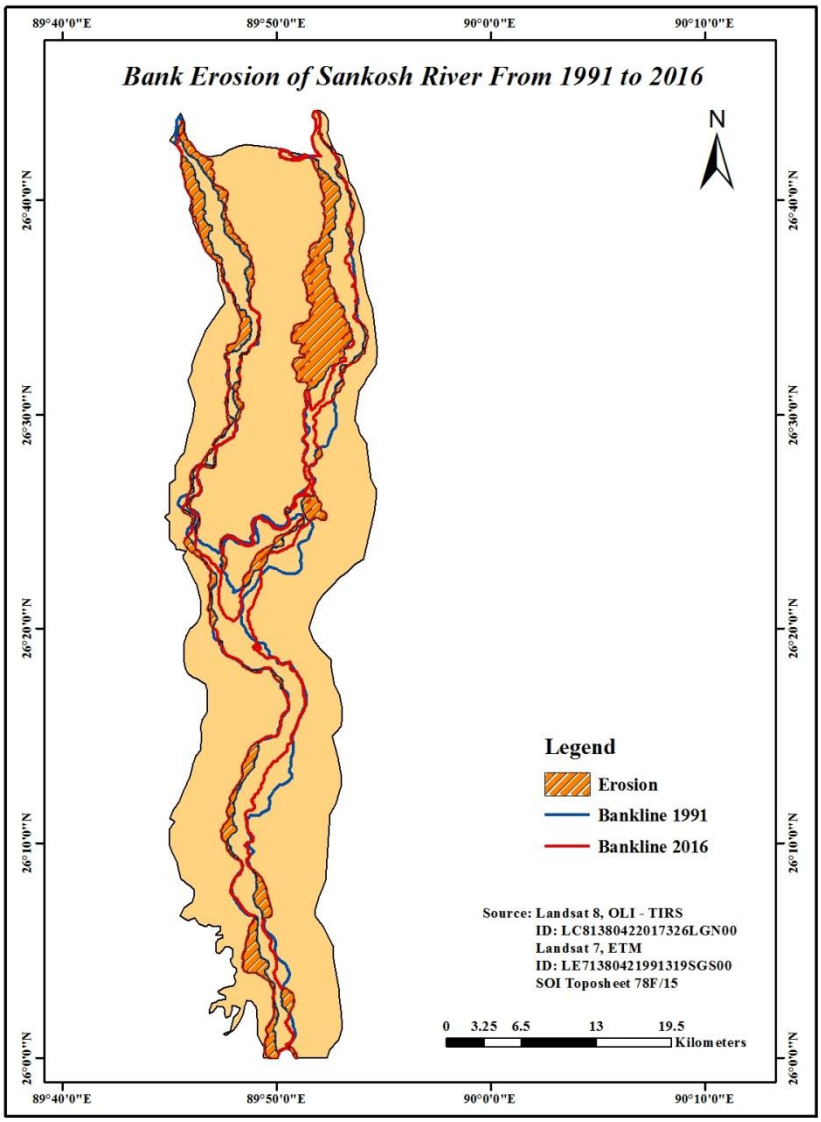

Fig-1: Bank line shifting during 1991 to 2016

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FACTORS CAUSING SHIFTING OF RIVER COURSES:

By many of references shifting courses of rivers in the world it can easily be seen that a number of geomorphic, tectonic, seismic, climatic and other factors are attributed to change in the courses of rivers. Alluvial courses are very sensitive indicators of channel change and can re-adjust to variation in hydrology, sediment load and active tectonics (Schumm, et al., 2000). There is several factors cause to shifting the river courses and among most of them some are very specific to cause the shifting of River Sankosh.

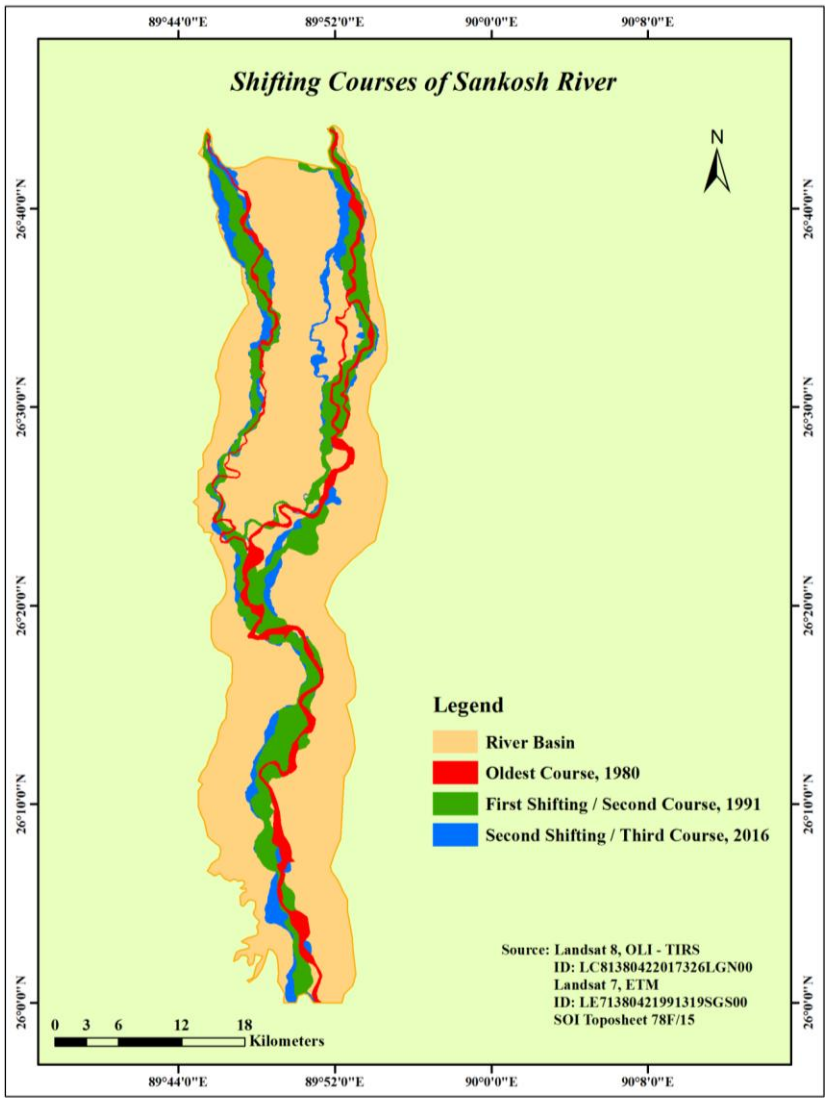

Fig-2: River course shifting during 1991 to 2016

TECTONICS:

The term tectonic refers to any structural change in rocks brought about by their deformation or displacement (Holmes, 1965). The tectonically active areas of the Earth exhibit landforms which are result of vertical and horizontal movement of the crustal rocks and erosion or deposition of surface processes. In spite of the practical significance of active tectonics, only a few investigators have considered its effects on alluvial rivers in the world. It is likely that this condition exists for the reason that variations of channel morphology and actions can also be attributed to downstream variations of discharge and to the quantity and type of sediment load. The faults have been and continue to be active, registering various lateral and vertical movements in the geological past. As a consequence, there was uplift and sinking or lateral displacement of the ground has been occurred. Under such conditions tectono-physiographic upheavals, the rivers were frequently forced to change their courses, sometimes gradually, sometimes abruptly in the study area.

SEISMICITY AND EARTHQUAKES:

When rocks are suddenly distributed, series of vibrations spreads through the surface in all directions from the source of disturbance. An earthquake is a passage of these vibrations (Holmes, 1965). This is known as Seismic waves. On the basis of nature bodies of water and land surface respond to seismic waves because earthquake in any region of the earth surface but its frequency is different depend on land and water surface. Extreme changes take place in the landforms in the come round of earthquakes by which river courses are affected in

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several way i.e. shifting of courses, floods etc. Such changes are also observed in the study area after the mega earthquake 1897 and 1950 in Northeast India which prone to seismic activity.

FLOODS:

According to Leopold, et al. (1964) aggradations dominate degradation during the short term floods and whatever sediments are removed by erosion not transported to long distance from its source. The monsoon-dominated rivers in India are different from other tropical rivers in several aspects as they undergo large seasonal fluctuations in flow and sediment loads (Kale, 2009). Migration of the course of a river and floods in its valley belong to the river dynamics. Shifting of a river course means that at a particular point of time and space a river abandons its original course and starts flowing along another course (Thornbury, 1954). In the study area, occurrences of floods in the past causing changes of the courses of the river Sankosh.

CLIMATIC CAUSE:

Shifting courses of a river sometime has associated with climatic change e.g. melting of ice, increasing rainfall, frequent flood, increasing discharge etc direct link to changes in discharge and sediment load of that particular river. Therefore climate change sometimes affects river magnitude whereas river course change is the ultimate result. From the field data it is evident that a number of massive floods have been occurred due to heavy rainfall in the past over the river Sankosh and as a result river course has also been shifted from its original path to westward. Moreover, the *Equilibrium Line Altitude* (ELA) the line separating the accumulation zone from the ablation zone of a tropical glacier is relatively more sensitive to changes in air temperature than that of a mid-latitude glacier (Kaser, et al. 1996). Due to snow peak dependent river basin i.e. River Sankosh has more possibilities to changing its course by any glacier advances e.g. GLOF

DISCHARGE AND SEDIMENT LOAD:

River discharge and sediment load both are influenced by Geological structure of that place and climate variability. According to *Holmes, 1965* when the channel fills up to the bank full stage and stream overflows its valley in places, the change brought about far greater than those intervening months of years. The changes may be slow or rapid, but it is a rule rather than exception that banks will erode, sediments will be deposited and flood plains islands, cuts and side channels will undergo modification (Schumm, 1977).This factor may also applicable for the shifting of course of the river Sankosh.

CONCLUSION:

The bank lines of the Sankosh River in the study area are extremely unstable characterised by highly variable pattern of channel shifting. The Sankosh River in the study area has a general tendency to shift its course westward. There are various factors responsible for that and which explained in detailed here. It is mentioned that the net progressive shift is 84.21sq.km in the study area. Moreover, it is also noticed that such character of the river Sankosh causing changes in bank line migration and other morphology of the channel in the study area.

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