Weather and Climate Extremes 13 (2016) 68–72

Contents lists available at ScienceDirect

Weather and Climate Extremes

journal homepage: www.elsevier.com/locate/wace

Evaluation of course change detection of Ramganga river using remote sensing and GIS, India

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A R T I C L E I N F O

Article history:
Received 7 February 2016
Received in revised form
17 July 2016
Accepted 17 August 2016
Available online 17 August 2016

Keywords:
River course change
Ramganga
NDWI
GIS

A B S T R A C T

Visibility of Ramganga river course change detection was made using Remote Sensing and GIS in study area among period of forty-one years from 1972 to 2013. Landsat MSS, TM, ETM+, LISS-III satellite images from 1972, 1989, 2000, 2006, and 2013 respectively were used to delineate the historical changes of the river course. This study shows that for a long time this area has been suffering due to erosion problem and shifting characteristics of the Ramganga River. The Ramganga river course has been shifting and the overall shifting is towards the south-west direction in different places which leads to the village erosion. The area has remained undeveloped due to infrastructure damaged by flood, changing course. This study may be helpful for the overall river management and planning for future prevention of food, changing coursing, loss of properties.

1. Introduction

A river is a natural water course, usually freshwater, flowing towards an ocean, a lake, a sea and another river (Hooke, 1984). In a few cases, a river simply flows into the ground or dries up completely at the end of its course, and does not reach another body of water. River bank erosion is a common geomorphological process of alluvial flood plain rivers (Nath et al., 2013). River is an essential component of the human existence which is continuously changing from its evolution. The cycle of river is starting after the uplifting of the land mass (Panda and Bandyopadhyay, 2011).

River course change is a natural phenomenon which takes place majorly due to flood occurrence (Mahmood et al., 2015). Rivers flowing downhill, from river source to river mouth, do not necessarily take the shortest path (Pan, 2013). In this study, we have focused on the river course change detection of Ramganga River.

2. Study area

The study area of Ramganga river lies between latitude 23°9′45″N to 27°57′0″N and longitude 79°57′45″E to 79°15′44″E (Fig. 1) and drainage area is 1193 km^2. The duration of study is considered from 1972 to 2013. Ramganga River joins to the Ganga at 120 m elevation in an Ismilpur village in Kannuaj District. The average slope of the study area is 0.070.

River Ramganga is a spring fed river and important tributary of holy river Ganga, originated in the southern slopes at Dudhatoli (3110 MSL) of the middle Himalaya of Uttrakhand state. The total catchment area of the basin is 32,493 km^2 and river is divided into four segments A, B, C and D for the better understanding of the river course change detection during the study period.

3. Methods and methodology

Geographical Information System (GIS) software was used to visualize the change of channel pattern of Ramganga River (Nath et al., 2013; Pan, 2013). ArcGIS 10.1 (Esri, Redlands, California, United States) and ERDAS IMAGINE 2010 (Hexagon Geospatial, GA USA) were used to analyze the collected image. First of all, images are mosaic through ERDAS IMAGINE 2010 and AOI (Ramganga) is extracted from the images and Normalized Difference Water Index (NDWI) is calculated for the study area and from study area using

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http://dx.doi.org/10.1016/j.wace.2016.08.001

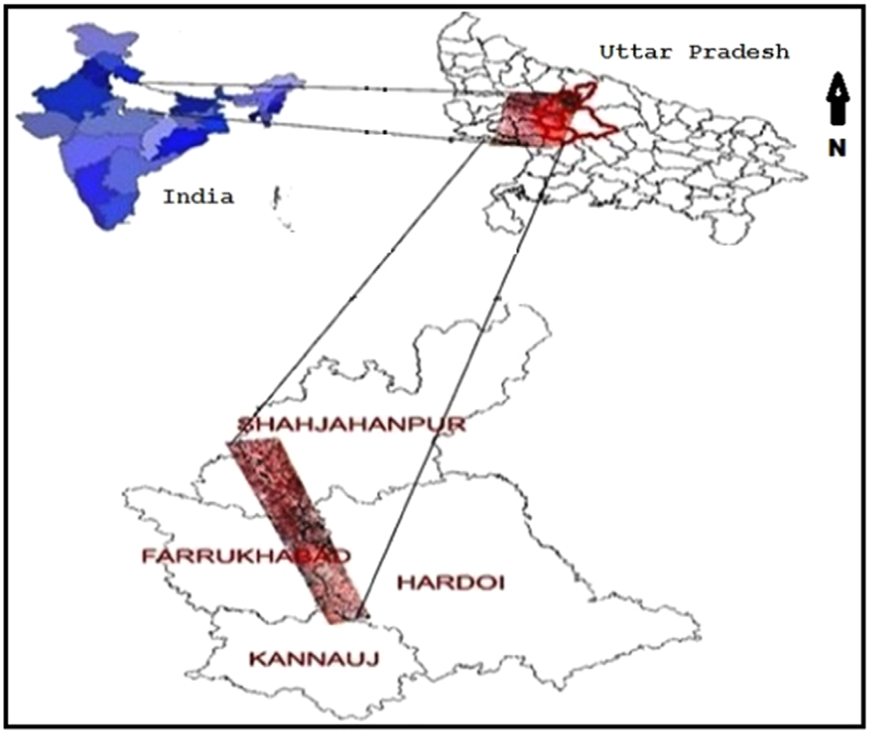

Fig. 1. Location map of the study area.

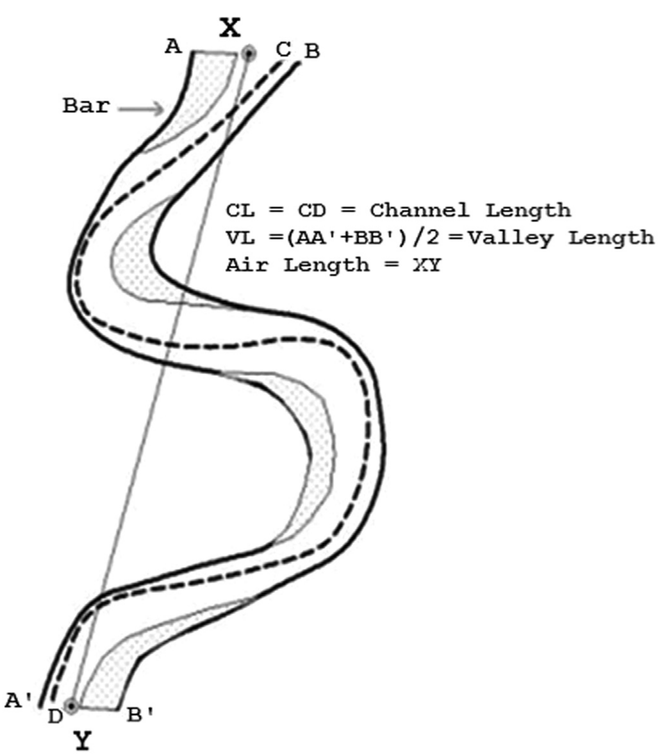

Fig. 2. Sinuosity index evaluation system.

ArcGIS software the Ramganga river is extracted and some area is edited through editing tools in ArcGIS and also overlapped bank line of different periods of Ramganga river image. Stream length and Valley length are also measured for calculating Sinuosity ratio. Total sinuosity ratio of 1.5 was selected by Leopold and Wolman to differentiate sinuous from meandering. Rivers having a sinuosity of 1.5 or greater refers meandering, and below 1.5 straight.

For calculating Sinuosity Index, the following formula was used based on Fig. 2 (Morisawa, 1985).

$$\text{Sinuosity Index} = (\text{Stream Length}).(\text{Valley Length})^{-1}$$

$$\text{Sinuosity (P)} = (\text{Lcmax}).(\text{LP})^{-1} = (\text{CD}).(\text{XY})^{-1}$$

Where, Lcmax is the length of the midline of the channel (in single-channel rivers), or the widest channel (Multiple channel rivers). And LP is the overall length of the reach.

For calculation of river sinuosity Index river is divided into four segment as A, B, C and D (Fig. 3) and polygons convert into the polylines and the field geometry is calculated to know the river length and Measure Tool is used to measure the shortest length and Field Calculator are used to calculate the sinuosity index in ArcGIS environment in Table 1 (Morisawa, 1985).

Some GCP (Ground Control Point) has selected on the left bank of 1972 river course and based on the measured direction distance between GCP and river course is measured during study and it has been estimated that how much river in which direction is shifted during study duration.

4. Results

4.1. Analysis of river course change detection

River course change detection has been done from 1972 to 2013 with consideration of 1972 as base year shown in Figs. 4–8. It is clear that the maximum river course changed in B segment at