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RESEARCH ARTICLE

POST DISASTER DAMAGES AND BANK EROSION BY BHAGIRATHI RIVER IN PART OF BHATWARI BLOCK, UTTARKASHI, INDIA

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ABSTRACT

This study is focused on the post disaster damages and recent trend of bank erosion in part of Bhagirthi River koil Bhatwari village. The changes in the river channel for the years 2004, 2011 and 2014 were analyzed using geoinformatics techniques The area of the river of the particular area is extended laterally from 141916.38 sq.m in 2004 to 51642.41 sq.m in 2011 and 226055.70 sq.m in 2014. As a result of it 90592.13 sq.m road, 10895.26 sq.m settlement, 1605141.05 sq.m grass land, 17123.59 sq.m and the agriculture land has been eroded away. It is happen mainly due to increases of intensity of rainfall and increases of frequency of flash flood. Due to increase of sudden discharge in river basin, the kinetic energy of the river is also increased. As a result of the lower part of the river is eroded more than the upper part. It leads to subsidence. But still now the human activities are going on in this hazard prone area. It is a big threat of this area. This study is helpful for planner to development of this area.

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INTRODUCTION

In the Himalayan Region, cloudburst is a recurring phenomenon (Vikram Gupta *et al*. 2013). According to Indian Meterological Department (IMD), cloudburst is a natural phenomenon and it is characterized by high intensity rainfall, usually more than 10cm per hour within short span of time, over a small area. Cloudburst in India occur when monsoon clouds associated with low- pressure area that travel northward from the Bay of Bengal across the Ganges plain on to the Himalayas and 'burst' in heavy downpours (75-100mm per hour). The States of Himachal Pradesh and Uttarakhand are the most affected regions due to steep topography (Das *et al*. 2006). The phenomenon of cloud burst often leads to flash flood, debris flow, river bank erosion etc. Nowadays, not only the frequency of such hazards is increasing with time but also their intensity and impact on the lives and livelihood of the people living in the area is also increasing severely (Singh and Kumar, 2011). On 16th July 2003 in Kullu district of Himachal Pradesh, on 6th July 2004 in Chamoli district of Uttarakhand, on 6th August 2010 in Leh town of Ladakh region, on 15th September 2010 in Almora district of Uttarakhand, on 9th June 2011 near Jammu, On 14th September 2012 in Rudraprayag district of Uttarakhand, on 15th June 2013 in the Kedarnath and Rambaba Region of Uttarakhand, on 6th September 2014 in Kashmir Valley is notable examples (NIDM). According to Schumn and Litchy (1963), floods of very high magnitude may be a contributing factor to channel widening and river bank erosion along with associated changes in the channels pattern. At the time of the flood due to under cutting of the bank, the upper portion of the bank sometimes over hanged and led to fall. Sometimes due to migration of thalweg part of river the bank is eroded and over steeping.

It also led to fall of bank (Goswami 2002). The bank erosion due to flash flood is prominent in the downstream of Bhagirathi section. Here eroded loose material is seen on the both side of the slopes. Tourist rest house is badly affected in this area. Due to bank erosion number of fresh landslide had been generated in the stretch of Bagirathi River (Gupta *et al*. 2013). The entire Himalayan region is vulnerable to multi hazard. So, development in this area is a challengeable issue. The developmental activities in these regions should be free from disaster risk. The present study aims to analyze the recent trend of bank erosion i.e. widening of river due to varying flood levels Bhagirathi river and its impact on the land use and land cover in part of Bhatwari block of Uttarkashi district through Geoinformatics technique.

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The region heavily affected during the 2013 flash flood and destroyed the region heavily in terms of land use changes due to heavy erosion of Bhagirathi river bank. This study is helpful to indicate vulnerability and risk that is linked with the planning and management for the development of this area.

Study Area

Uttarkashi is located in the northwest region of Uttarkhand in the lesser Himalaya. Bhatwari is the northern block of Uttarkashi district. This study has been carried out in parts of Bhatwari block, which is the area in and around the Bhatwari village located adjacent to the Bhagirathi river (Figure 1). Bhagirathi is the main river flowing in this region, which originated from Gangotri.

The study area belongs to a sub tropical climate. The summer (Apr-June), monsoon (July-Sep), and winter (Oct-Mar) are the main climatic seasons exist here. The temperature varies in summer from 15°C to 30°C, while in the winter season it varies from 0°C to 20°C. Most of the rainfall occurs in this region during monsoon period. The greatest amount of precipitation occurs in the August with an average of 463mm. Between 1982 and 2009, highest rainfall (1900 mm) occurred in 2003 and lowest rainfall (600 mm) occurred in 1991. The average annual rainfall is approximately 1200 mm (Kumar *et al*. 2008).

MATERIAL AND METHODS

The Google Earth satellite images of the year 2004, 2011, and 2014 were used to map the land use and land cover features

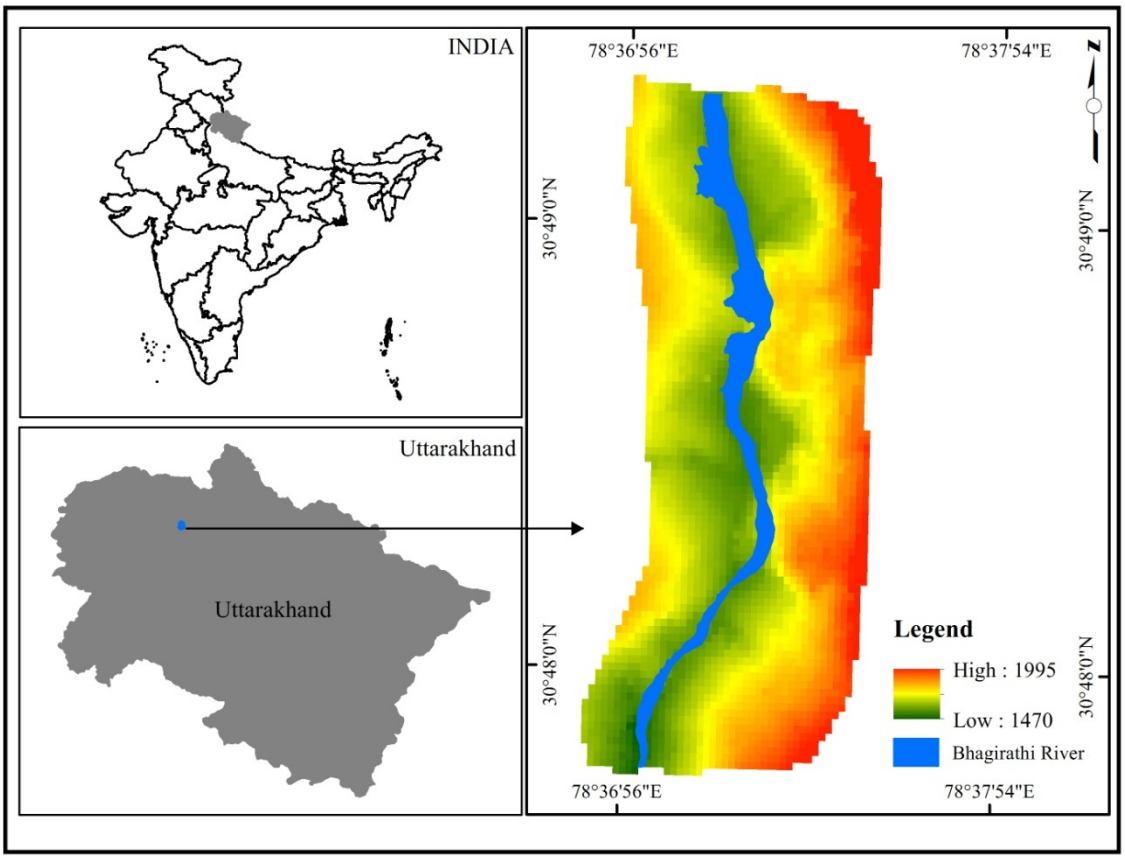

Figure 1. Location of the Study Area – Part of Bhatwari Block, Uttarkashi District

It is extended from 78°37′01.96″E, 30° 49′18.51″N to 78°37′14.38″N,30°47′48.64″N. The study area is elevated from 5080 ft. to 6025 ft above mean sea level (MSL) and covered 3 sq.km area. The area is characterized by rugged topography (Singh and Kumar, 2011). Moderate slopes with gentler terrace are found in the Bhatwari area (Rawat and Gairola,1999). The lithology of the study area varies from low-high grade metamorphic green–schist to upper amphibolite facies. It has been deformed repeatedly. The landforms in this region are structural, glacial, fluvial and denudational in origin. The region is characterized by deep gorges and narrow valley carved by numerous channels. This region is highly dissected and mainly controlled by the geological structure (Agarwal and Kumar 1973).

and Bhagirathi river course using Geographical Information Systems (GIS). The Bhagirathi river course of the three different years were captured and compared for the purpose of identification of bank erosion. Further, the river course map of 2014 were superimposed over 2004 LULC map to find out the area affected due to bank erosion of the Bhagirathi river.

RESULTS AND DISCUSSION

Through land use and land cover mapping, the river, road, settlements, vegetation patch/grassland, Nali (Major Gads), Eroded land, and agriculture land were interpreted from Google Earth satellite image of the year 2004 and 2014 (Figure 2).

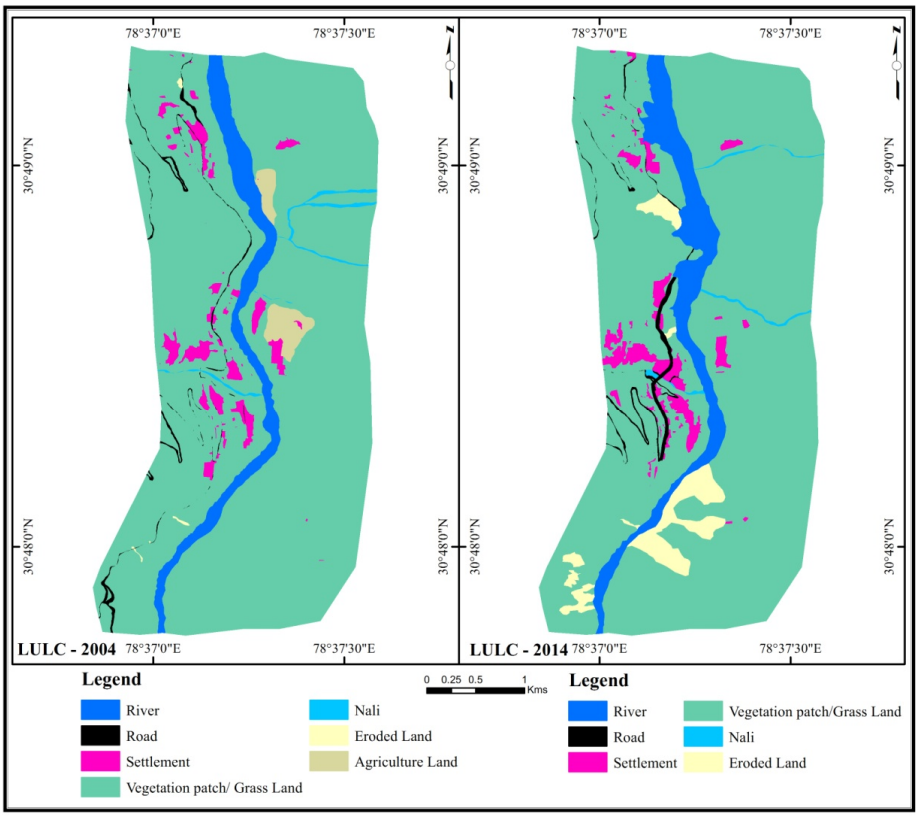

Figure 2. Land use and land cover maps (for the year 2004 and 2014) interpreted from Google Earth satellite image

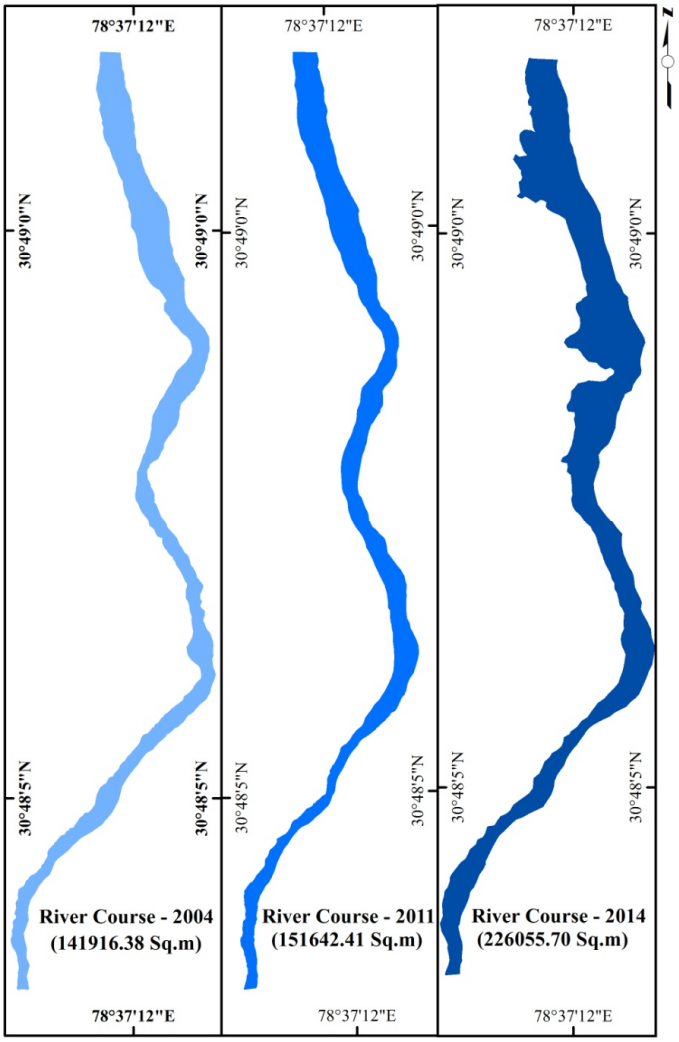

Figure 3. Area coverage of river course from 2004 to 2014

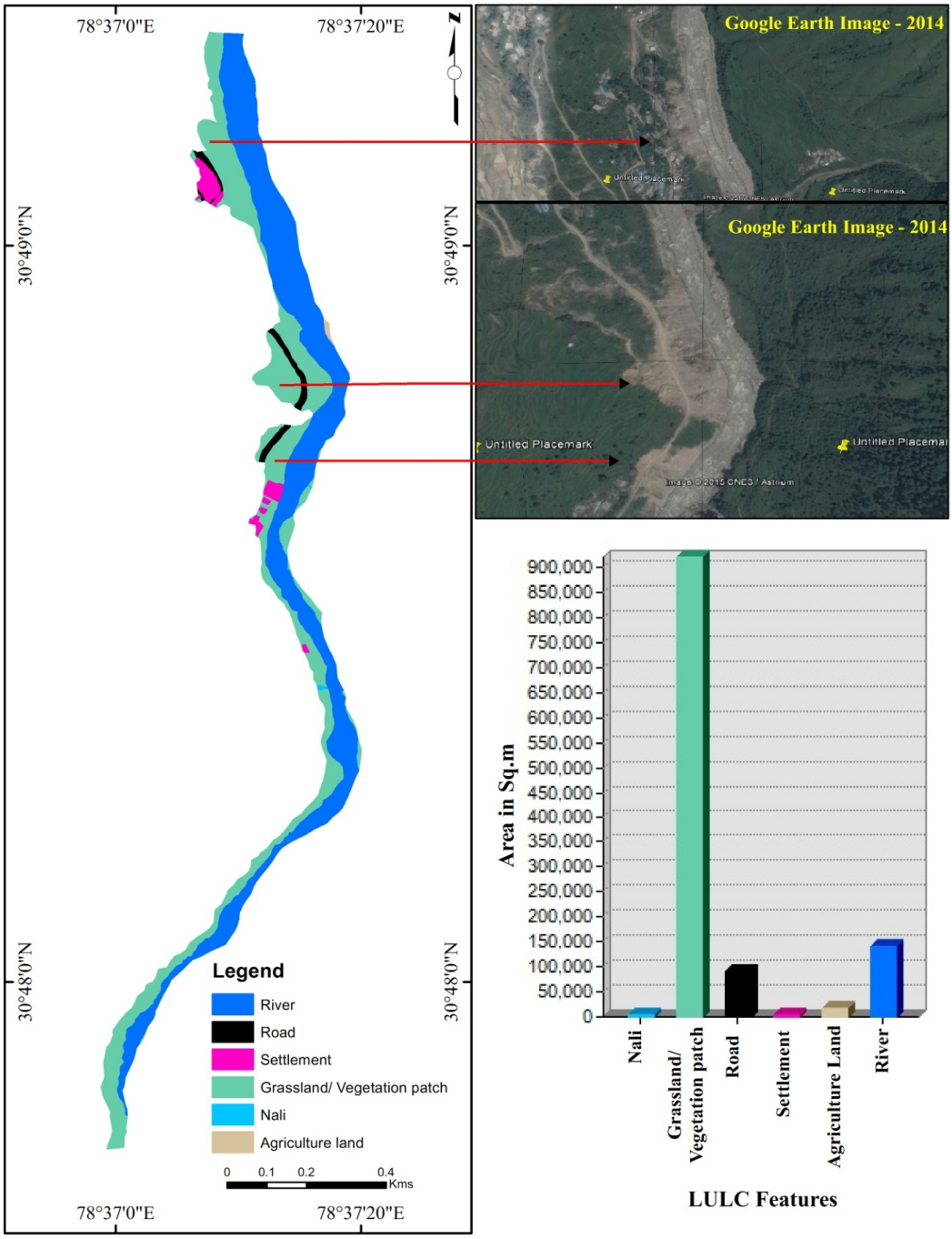

Figure 4. Damaged areas along the river course from 2004 to 2014

Table 1. Land use and land cover features and its aerial coverage for the year 2004 and 2014

Land use and Land cover Featues	Area2004 (in sq.m)	Area2014 (in sq.m)
River	141916.38	226055.70
Road	98380.21	42747.88
Settlement	101170.45	100437.05
Vegetation patch/ Grass land	2213705.42	2133335.67
Nali	111109.02	17274.91
Eroded land	6829.51	110295.30
Agriculture land	46042.87	-

Table 2. Damaged areas along the river course from 2004 to 2014

Land use and Land cover Features	Area (in Sq.m)
Road	90592.13
Settlement	10895.26
Vegetation/Grass Land	1605141.05
Nali	7347.79
Agriculture land	17123.59

The area of each LULC features were analyzed and given in the Table 1. It is found that the 46042.87 sq.m agriculture land were completely disappeared in the area due to frequent minor and major flooding from 2004 to 2014. It is seen from most of the portion road and settlement is eroded away which are located at the adjacent of river course. Settlement and road were also decreased much 733.4 sq.m and 55632.33 sq.m respectively. Eroded land due to river activities and natural hazards such as landslides were increased to103465.79 sq.m.

The area of the river course in 2004 was 141916.38 sq.m, and in 2011 it was 151642.41 sq.m, and in 2014 it was 226055.70 sq.m (Figure 3). It was observed that, the area of the river was increased to 9726.03sq.m from 2004 to 2011, to 226055.70 sq.m from 2011 to 2014 Table 2. The 74413.29 sq.m. area of the river course has increased from 2011 to 2014. It was found the river bank got eroded almost two times when compared to the period from 2004 to 2011 (Figure 4). It is mainly due to climate change which is following by heavy rainfall. The major disaster occurred in 2013 was the worst disaster occurred and the area heavily affected by flooding and landslides. It also leads to increase the kinetic energy of the river. As a result of it the lower portion of bank is more eroded than upper parts. It leads to subsidence. It is also notable the land in the western part is more eroded than the eastern part. It is mainly because of sharp meandering. The area of the peak of bending landmass toward river course is more vulnerable to erosion. Most of the people of that area is mainly based on cultivation and tourism. Due to land erosion the livelihood of the people in this area is highly hampered.

Conclusion

The remote sensing and GIS technique was helpful to map the LULC of the area, determination of area and comparison. Through this study it was concluded that the river flow is increasing day by day. It erodes the river bank slow to rapid manner. The area is not only damaged but also under vulnerable of bank erosion. It is a big threat to the people living in this area. Now a day the intensity of rainfall is increased. As a result of it frequency of flashflood is also increased. But the human activities are still remaining in this area. Any developmental activities are a great challengeable issue in this hazard prone area.

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