Monitoring Yumuna River Course along Haryana-A Spatio Temporal Change Analysis Study through Geoinformatics

Ankur Sharma[1], Dr. V. S. Arya[2], Shashikant[3], Dr. R.S. Hooda[4], Sarvan Kumar[5]

Abstract— ***River course changes with respect to time and space play a significant role in stream flow dynamics as well as land resource planning. Topographical maps and Satellite images for a period spanning nearly 40 years (1992-2012) are used for this specific purpose. The course of Yumuna River along Haryana has been selected, which is the sub-basin of the Ganga river system. The prime objective of the study is to reveal the Spatio temporal change in river course and its impact in the study area. . Present paper has tried to find out the changes which have taken place in course of Yumuna River along Haryana from 1972 to 2012. Study has used satellite images of IRS-P6 LISS-III from (NRSC) and Survey of India, Toposheets. During this period the river course shifted in the both directions i.e. right and left and during the period 1972 to 1992 Haryana gain 12 sq. km area and during 1992 to 2012 it's gained 62 sq. km. area approximately.***

***Keywords*—Spatio-temporal change, River shifting, Changing river course and geo-informatics approach.**

I. INTRODUCTION

River is a general term applied to a natural stream of water flowing regularly or intermittently over a bed in a definite channel following the slop of the land. The American Geomorphologist, W.M. Davis (1899) first presented a general theory of landform development called "normal cycle of Erosion" which describes a genetic classification and systematic description of land forms developed by the fluvial process. According to this theory, there are three successive stages in the evolution of fluvial landforms like Youthful stage, Mature Stage and old Stage.

Yamuna is the sub-basin of the Ganga river system. Out of the total catchment's area of 861404 sq. km. of the Ganga basin, the Yamuna River and its catchment together contribute to a total of 345848 sq. km area which 40.14% of total Ganga River Basin (CPCB, 1980-81; CPCB, 1982-83). It is a large basin covering seven Indian states. The river water

is used for both abstractive and in stream uses like irrigation, domestic water supply, industrial etc.

***Ankur Sharma**, Haryana Space Applications Centre (HARSAC), CCS HAU Campus, Hisar, Haryana 9813166096.*

***Dr. V.S. Arya**, Soil and Land Use Survey of India, Govt. of India, New Delhi, India, 9718809155.*

***Shashikant**, Haryana Space Applications Centre (HARSAC), CCS HAU Campus, Hisar, Haryana 9416517166.*

II. OBJECTIVES:

The present study was carried out with the following objectives:

1) To scan and digitize the river course from Survey of India topographical maps for the year 1972.
2) To interpret and delineate river course from satellite images of 1992 and 2012.
3) To generate database of gain or loss of the area of Haryana due to migration of Yamuna river course.
4) To create data base in GIS format.

III. STUDY AREA

Yamuna River forms the eastern boundary of Haryana with Uttar Pradesh. Yamuna enters Haryana near the Kalesar forest in Yamunanagar district. It flows south along the districts of Yamunanagar, Karnal, Panipat, Sonipat, and exits Haryana near Hasanpur in district Faridabad. The study area is the Yamuna river course and located between $27^0$54'32" to $30^0$27'23" N latitudes and $77^0$31'04" to $77^0$39'26" E longitudes. The topography of the study area is the river itself with its geo-morphologic features including built up area and agricultural areas. Thus the landscape of the study area is both flat. The length of the study area is approximately 6-7 km and its width is approximately 2-3 km. The soil type of the study area mainly varies from Fine loamy to sandy loam. The location map of the study area is shown in Figure-1.

Segmentation of Yamuna River:

The water flow characteristics of Yamuna River changes significantly from monsoon to non-monsoon seasons. Thus, in dry season (almost nine months), the river becomes segmented in four distinguished independent segments. Haryana falls in the second segment.

Segment - I:

This segments (length 157 km) is identified from Yamunotri and terminate at Hathnikund / Tajewala barrage. The major source of water in this segment is the melting of glaciers. The water flow in this segment terminates into Western Yamuna canal (WJC) and Eastern Yamuna Canal (EJC) for irrigation and drinking water purposes in command areas.

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Segment- II:

This segment (about 224 km) lies between Hathnikund / Tajewala barrage and Wazirabad barrage. The actual river course along the state boarder during 1972, 1992 and 2012 is shown in Figure-2, 3 & 4, respectively. The main source of water in this segment is ground water accrual. Few small tributaries also contribute water in this segment. The water is diverted in this segment from WJC through drain No. 2 to fulfill the raw water demand for drinking water supply in Delhi. The water segment is terminated into Wazirabad reservoir formed due to stagnation of water at Wazirabad barrage. The reservoir water is pumped to the various water works as raw water for treatment to meet drinking water demand of the capital city. No or very little water is allowed to flow downstream Wazirabad barrage during lean seasons.

Segment III:

This 22 km segment of Yamuna River is located in between Wazirabad barrage and Okhla barrage. This segment receives water from seventeen sewage drains of Delhi and also from WJC and Upper Ganga Canal via Najafgarh drain and Hindon cut canal respectively. Little contribution of water is also made in this segment by Surghat, where Ganga and Yamuna water is provided for bathing purposes. This river segment terminates into Agra Canal, which is used to augment its flow for irrigation in the states of Haryana and Uttar Pradesh.

Segment IV:

This Segment of Yamuna River is about 973 km long initiate immediately downstream to Okhla barrage and extends upto confluence to Ganga River at Allahabad. The source of water in this segment are ground water accrual, its tributaries like Hindon, Chambal, Sindh, Ken, Betwa etc. and waste water carrying drains of Delhi, Mathura-Vrindavan, Agra and Etawah. The water of this segment is used for drinking and industrial uses at Mathura & Agra. At Mathura, recently Gokul barrage has been constructed to trap the Yamuna river water for drinking purposes. Due to low drinking water demand only part of water is pumped out and rest flows downstream. As the water demand will increase in future. It is likely that no water will be allowed to flow down stream like Wazirabad and Okhla barrage. This may create further segmentation of segment IV into two segments of 154 & 804 km.

Table-1 Specification of satellite data

Sr. No.	Satellite	Sensor	Toposheets/ Scene numbers	Date of acquisition
1	IRS-P6	LISS-III	94/50 and 95/50	October 1992 & 2012
2	Survey of India, Toposheets		53F/8,11,12 53G/2,3,4,5 , 53H/1,2,6,8 11,12 & 53E/5,9	September 2012

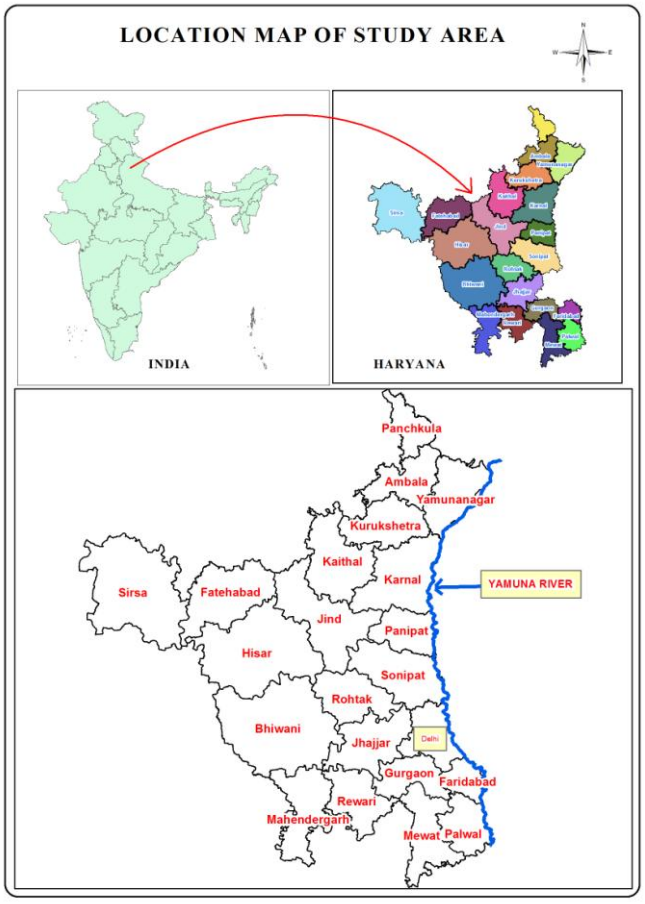

Figure-1

IV. Materials & Methodology

Satellite Data

Survey of India topographic maps on 1: 50,000 scale for the year 1976 were used to delineate the Yamuna River course along eastern boundary of Haryana state. Data from Indian Remote Sensing Satellite-P6 (IRS-P6), LISS-III was also used to interpret the river course for the years 1992 and 2012 for the present study. The satellite data was procured from National Remote Sensing Centre (NRSC), Hyderabad. The details of the data used during the analysis are given in the Table 1.

Scale: The present change mapping was prepared on 1:50,000 scale to monitor the change in Yumuna river course during the period 1972 to 2012.

Software used:

1. ERDAS IMAGINE 9.3
2. ARC Map 9.3
3. M.S. Office

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Methodology:

For systematic study, analysis and interpretation of the present problem varied specification of spatio-temporal data are used involving scanned photographs, images and SOI toposheets data of the respective river are used. The river course map of Yamuna River was collected and scanned. The scanned maps of the area are rectified with the already available geo-referenced images. The satellite images in digital format for the whole area between 1972 to 2012 from IRS P- 6 have been analyzed to compare changes in river course. After that, the boundary of river Yamuna was digitized from the rectified maps to create vector layer for change detection study. Image enhancement was adopted to increase the amount of information, which can be visually interpreted from the image data by improving the apparent contrast between features in the scene. Linear enhancement was used in the present study. Mosaicing was done to obtain one single image from two overlapping images covering the study area. The final maps were composed in Arc Map software to display the different layers of the extracted information and report writing is done.

V. Results & Discussion

The study has been carried out with the help of Survey of India Topsheets and Remote Sensing data for the years 1972, 1992 and 2012. All this data were individually processed and analyzed in a GIS environment. After overlapping those shape files, the changes of river course was identified and analyzed.

During the overlay of vector layers, it was found that the Yamuna River changes its course every time. Which has much impact to the settlers living around the River; this is because the river is a fast flowing river and erodes the banks at high rate and also deposits at high rate. Huge deposition increases the sand bars which can be a cause of river changing its course. The river channel pattern is meandering pattern at the top and in the low lying area, the river pattern is braided. Thus at the meandering area, the river does not spread out and it flows in only one direction at high speed that cuts and erodes the bank at a brisk rate. However at braided pattern area, the river spreads out in all directions and moves which leads to huge deposition and increasing of sand bars. It lowers the water holding capacity and once the flood occurs it can't hold much so the river can create a new channel by eroding the banks. Figure-2, 3 & 4 below show the meandering pattern of the river during 1972, 1992 and 2012 in order to identify river pattern of Yamuna River.

This study shows that Yamuna River shifted in the both directions i.e. right and left bank during the period of 1972, 1992 and 2012. However it was found that major impact of Yamuna river course change happened to be at the left side i.e. towards Uttar Pardesh during 1972 to 1992 and 1972 to 2012. The analysis of the data shows the net river course shifting between 1972 to 1992 was 12 sq.km towards Uttar Pardesh as shown in Figure-5 whereas, the net river course shifting between 1972 to 2012 was 66 sq. km towards Uttar Pardesh as shown in Figure-6.

It was found that Yamuna River shows both meandering and braided pattern in the study area. High flow velocity and flowing pattern is the main causes of bank erosion and river course shifting. Changing river morphology has also contributed to higher river bank erosion and its societal impact. Local people have faced severe problem from bank erosion as they have lost their farm land, loss of agricultural productivity and other valuable properties.

River course change and bank erosion has provided great negative impact on people's livelihood along the river, loss of properties, income, increased sediment in water which affects water consumption and river water quality. Some of the momentous impacts that occurs during the change in river course are:

(1) River bank erosion creates difficulties for the inhabitants as well as the native.
(2) Degradation of fertile soil which has higher capacity of productivity and efficiency.
(3) Change in river morphology and geometry.
(4) Some settlements shifted due to higher bank cutting.
(5) Impact upon human life as well as its various activities.
(6) Meandering of River due to changing the stream flow and geometry of river.
(7) Changing physical characteristic of river and surrounding environment.

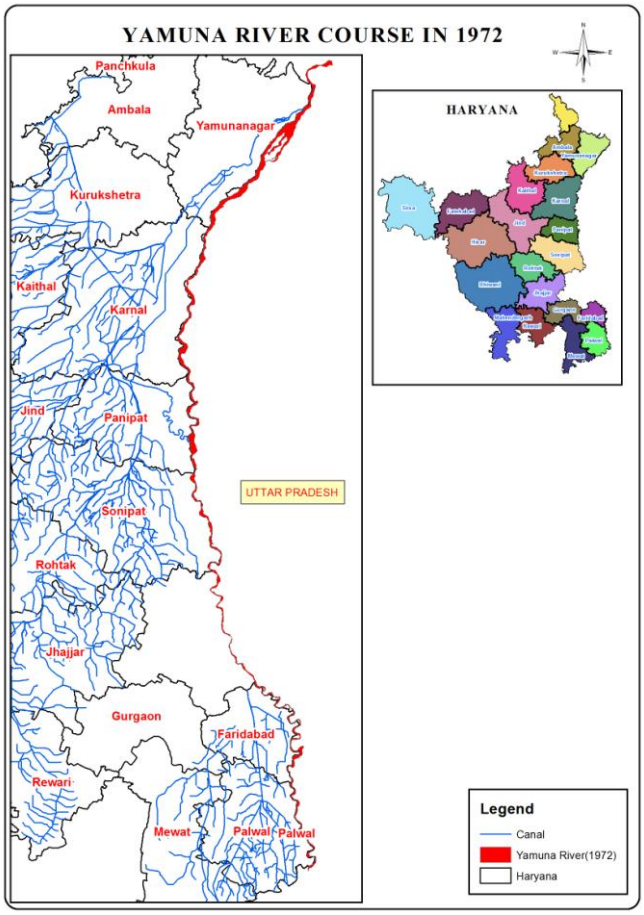

Figure-2 Yamuna River Course During 1972

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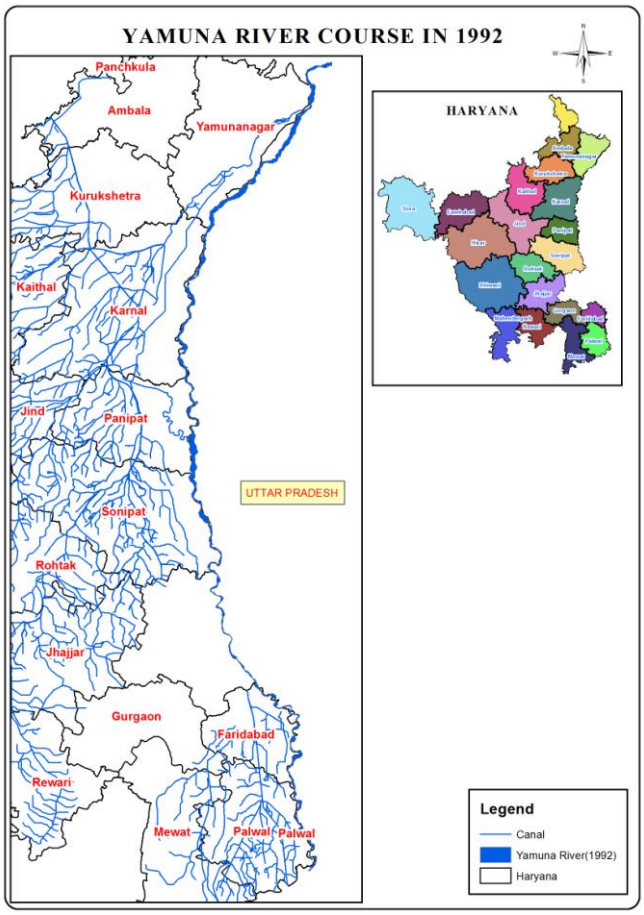

Figure-3 Yamuna River Course During 1992

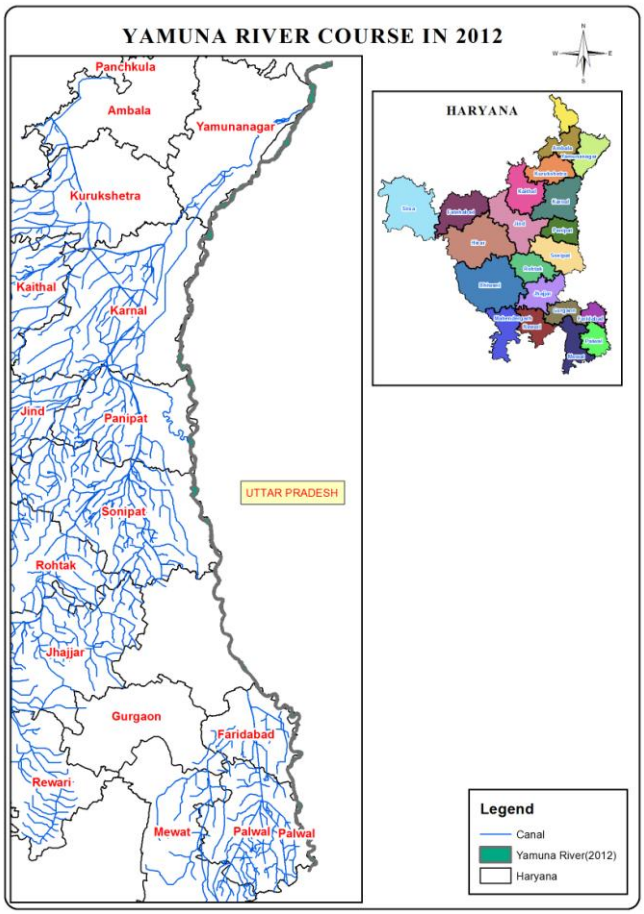

Figure-4 Yamuna River Course During 2012

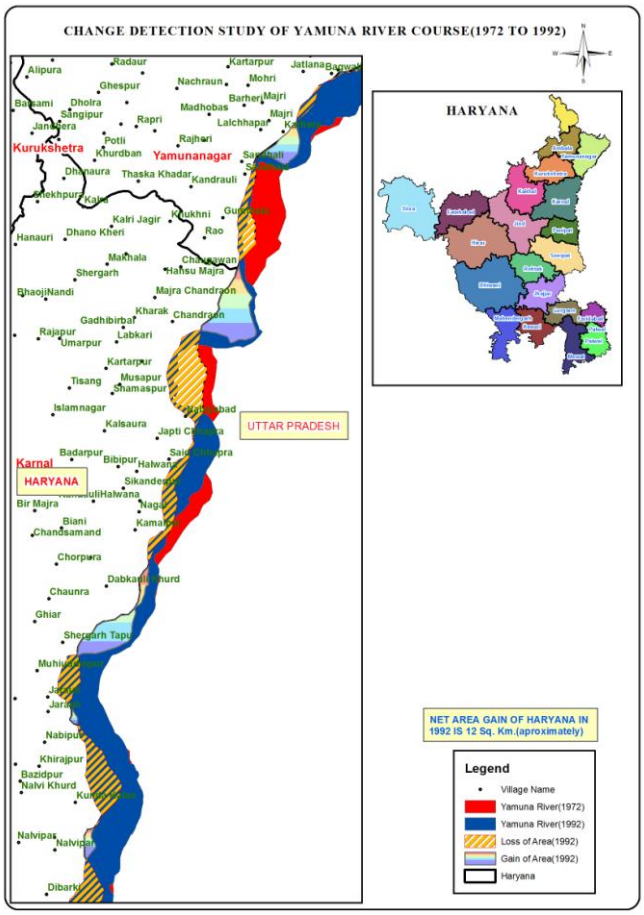

Figure-5 Change of Yamuna River Course during 1972-1992

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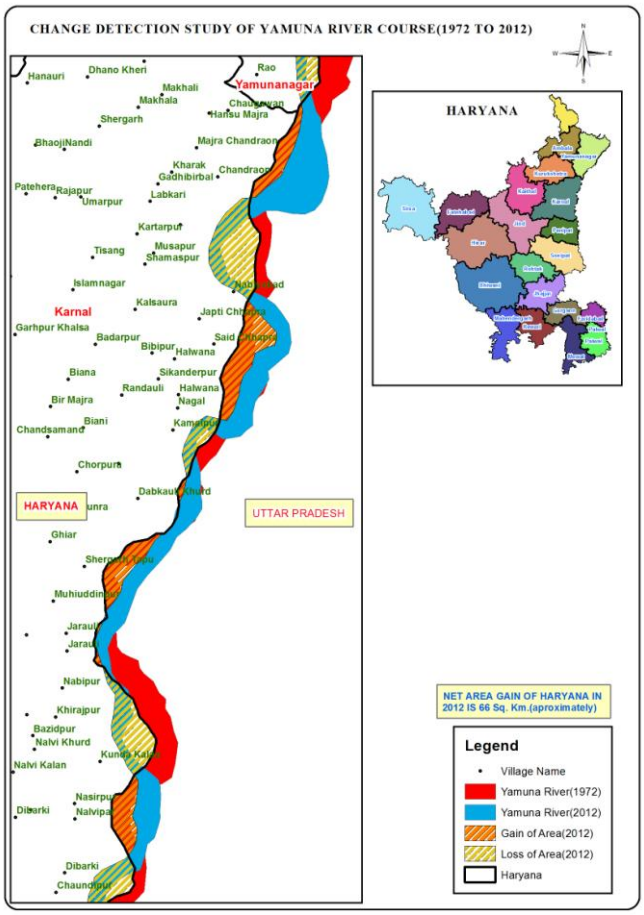

Figure-6 Change of Yamuna River Course during 1972-2012

VI. CONCLUSIONS

The present study was conducted to evaluate Yumuna river course change in context of Haryana and its impact on the study area IRS-P6, LISS-III satellite data of 1972 to 2012 and SOI toposheets. From the results and discussion, the study has proven that the changing pattern or course of Yamuna river change has caused much destruction to its associated land use / land cover.

Thus there must be some mitigation measures to reduce the impact of river course change. To prevent future damages, the embankment, revetment, the wire creating spur can be constructed which will be a useful measure to reduce the flow velocity and also protect the bank erosion and down cutting. Scientific River training management, awareness generations in local people to reduce the tendency of deforestation, agricultural practices in river bed etc. are also essential parts of mitigation. Bank revetment and or construction of embankment are considered to be the best available engineering response to the serious river course change and bank erosion occurring along the Yamuna River.

REFERENCES

[1] Nanson, G.C.; Croke, J.C. A genetic classification of flood-plains. Geomorphology 1992, 4, 459-486.
[2] Wolman, M.G; Leopold, L.B. River Flood Plains: Some Observations on Their Formation; U.S. Geological Survey Professional Paper 1957, 282c; United States Government Printing Office: Washington, DC, USA, 1957.
[3] Marcus, W.A.; Fonstad, M.A. Optical remote mapping of rivers at sub-meter resolutions and watershed extents. Earth Surf. Process. Landf. 2008, 33, 4-24.
[4] Raven, E.K.; Lane, S.N.; Bracken, L.J. Understanding sediment transfer and morphological change for managing upland gravel-bed rivers. Prog. Phys. Geog. 2010, 34, 23-45.
[5] Bryant, R.G.; Gilvear, D.J. Quantifying geomorphic and riparian land cover changes either side of a large flood event using airborn remote sensing: River Tay, Scotland. Geomorphology 1999, 29, 307-321.
[6] Dayal, P., (2007), Text Book of Geomorphology, published by Rajesh Publication.
[7] CPCB, 1980–81. The Ganga River—Part I—The Yamuna basin, ADSORBS/2, Central Pollution Control Board, Delhi, India.
[8] CPCB, 1982–83. Assimilation capacity of point pollution load, CUPS/12, Central Pollution Control Board, Delhi, India.

Author's Profile

Ankur Sharma Senior Scientist Assistant (SG), Haryana Space Applications Centre (HARSAC), CCS, HAU Campus Hisar (Haryana).

Dr. V. S. Arya Chief Soil Survey Officer in Soil *and Land Use Survey of India, Govt. of India, New Delhi***.**

Shashikant received the Master degree in Geography, from Agra University, (U. P.) in 2007 and P. G. Diploma in Remote Sensing & GIS from Rajasthan University, Jaipur (Rajasthan) in 2012. He is Junior Research Fellow at Haryana Space Applications Centre (HARSAC), CCSHAU Campus, Hisar (Haryana). He has Three years' experience in the field of remote sensing & GIS.

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