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LAND USE/LAND COVER CHANGE DETECTION USING GEOSPATIAL TECHNIQUE: A STUDY OF RISPANA RIVER CATCHMENT, DEHRADUN, UTTARAKHAND

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Abstract: Land Use/Land Cover (LULC) change plays an important role in urban growth management and urban planning. This study attempts to examine LULC change in the Rispana River Catchment over the period from 2008 to 2015. Satellite data of Cartosat1 from 2008 and 2015 with a resolution of 2.5 m were used to create LULC maps. The LULC change matrix used to determine the total change among classes from 2008 to 2015. Five major LULC classes were identified: built-up land, agriculture, open land, forest, and water body. The primary LULC class of the catchment is built-up land, which increased by 6.65 km² between 2008 and 2015. This study uses the Remote Sensing and Geographic Information System (GIS) approach, which is currently one of the predominant technologies for spatio-temporal analyses. This study would help to identify the critical areas that are highly susceptible to flooding, and to assist in urban planning.

Keywords: Land Use Land Cover, Remote Sensing, GIS, Rispana River Catchment.

Introduction: According to the *National Ocean Service*, land cover data document how much of a region is covered by forests, wetlands, impervious surfaces, agriculture, and other land and water types. Water types include wetlands and open water. Land use shows how people use the landscape - whether for improvement, conservation, or diverse use. Land cover areas can be determined by analysing satellite and aerial imagery. Land use area is difficult to determine from satellite imagery. Land cover maps provide information that helps managers to better understand the current landscape. Land cover maps for several years are needed to identify changes over time. With this information, managers can evaluate past management decisions and gain insight into the potential impacts of their current choices before they are implemented (NOAA, 2019). Land Use land Cover (LULC) change is probably the most important form of global environmental change because it occurs at spatial and temporal scales that are directly relevant

to our daily lives (CCSP, 2003). LULC is not only the product of the geological structure, elevation, and slope, but also of socioeconomic and institutional conditions (Rai, Sharma & Sundriyal, 1994).

Due to rapid industrialization and increasing demographic pressures in India, natural resources are being overexploited, leading to a critical resource management challenge as agricultural land shrinks, fallow land and water crises increase (Department of Agriculture, Ministry of Agriculture and Farmers Welfare, Government of India, 2016). LULC dynamics have changed significantly in recent decades. Thus, the LULC change patterns have been influenced by both humans and natural factors (Hassan et al., 2016). LULC changes on the Earth's surface are generally divided into land use and land cover, two concepts (Barnsley et al., 2001), that are often used interchangeably (Dimyati et al., 1996).

Remote sensing has enormous potential to provide a synoptic view of the landscape in at all phases, from the local to the global scale. Remote Sensing is an essential tool for land change research because it allows observations over larger areas of the Earth's surface than is possible with ground-based observations. Various algorithms have been introduced to distinguish land cover changes through the analysis of multi-temporal satellite data. Therefore, integration of geographic information systems and remote sensing data, change vector analysis, image differentiation, etc., have emerged as powerful techniques for change detection applications (Haque and Basak, 2017).

After the establishment of Uttarakhand, Dehradun has become a regional service center for the entire Garhwal region and has attracted a large number of people from the hill. Most of the built-up area is located on the banks of the Rispana River, which also means that the migrant people have greatly affected the riverbed. It has been found that most of the buildings have come up along the Rispana River. Since, Dehradun is the capital of Uttarakhand and the land prices in the capital areas are very high, so people have started encroaching on the riverbed. People are settling on the banks of Bindal and Rispana River. These areas cannot be ignored, as they represent a significant portion of the city's population. The proliferation of slums is one of the main side effects of urbanization, as the city is unable to absorb the additional population beyond its carrying capacity and provide the necessary infrastructure. Migration from rural areas to open spaces in cities is increasing day by day. As a result of this migration, open space and agricultural land are decreasing, leading to a loss of biodiversity. Therefore, the objective of this study is to use satellite imagery to determine the changes in land use in the Rispana River basin between 2008 and 2015 and to create a LULC map of the study area.

Study Area: The Rispana River Catchment is located between 30°15' and 30°27' north latitude and 78° 03' and 78°06' east longitude. The study area falls under the administrative control of Dehradun Municipality. The total area of the study area is 56.62 km² and falls under toposheet No. 53J/3 (Survey of India). As Dehradun Municipal Corporation has 60 wards, the study area of Rispana River Catchment covers 16 wards. The total population of the study area is 174490 people (Census of India, 2011). Rispana River is located in the central part of the study area. It originates from Mussorie hill near Rajpur, which is part of Shiwalik Himalaya. Rispana and Bindal are the two tributaries of Song River. Rispana flows

southwest of Dehradun and joins the Song River on the eastern outskirts of the city. Several small tributaries flow into the Rispana River.

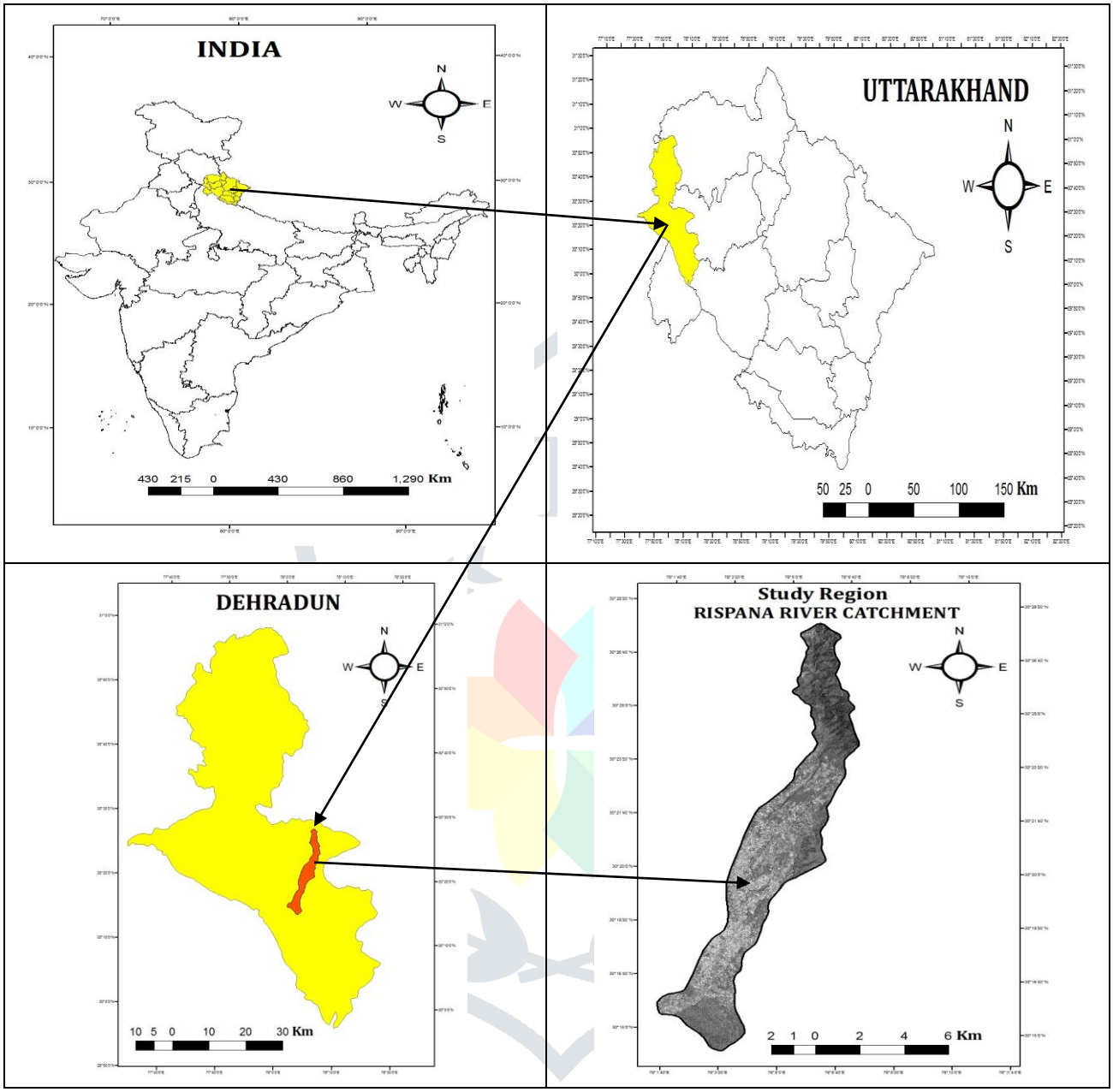

Figure: 1. Location Map of the Study Region

Data Used and Methodology:

Table: 1. Description of Satellite Image used in the Study

Satellite	Sensor	Date of Pass	Spatial Resolution	Spatial Reference
Cartosat-1	Panchromatic	24th, March 2008	2.5m	WGS_1984 UTM_Zone_44N
		17th, April 2015		

Data Acquisition and Preparation: Digital data for this study, Cartosat 1 (panchromatic orthorectified imagery) at 2.5-metre resolution for March 2008 and April 2015 were obtained from NRSC, Hyderabad, India. Topographic map 53J/3 (scale 1:50,000) was obtained from the Survey of India and used to cover

the entire area. The boundary of the catchment area was taken from Disaster Mitigation and Management Centre, Uttarakhand Secretariat, Dehradun. The topographic map was geo-referenced with longitude and latitude using ArcGIS 10.4 software. ArcGIS software was also used to generate the LULC classes and maps of the study area.

Method: The methodology used was on-screen visual interpretation using interpretive keys such as tone, shape, texture, size, and pattern, etc. The 2008 and 2015 image of Cartosat 1were classified and both the derived layers of LULC were superimposed to prepare the change matrix. The matrix provides information about the spatial distribution and changes in LULC classes (Shalaby and Tateishi, 2007). The 2008 and 2015 maps were overlaid with the matrix function in ArcGIS to detect the changes. The matrix was created between 2008 and 2015 to assess the overall changes in LULC in the study area.

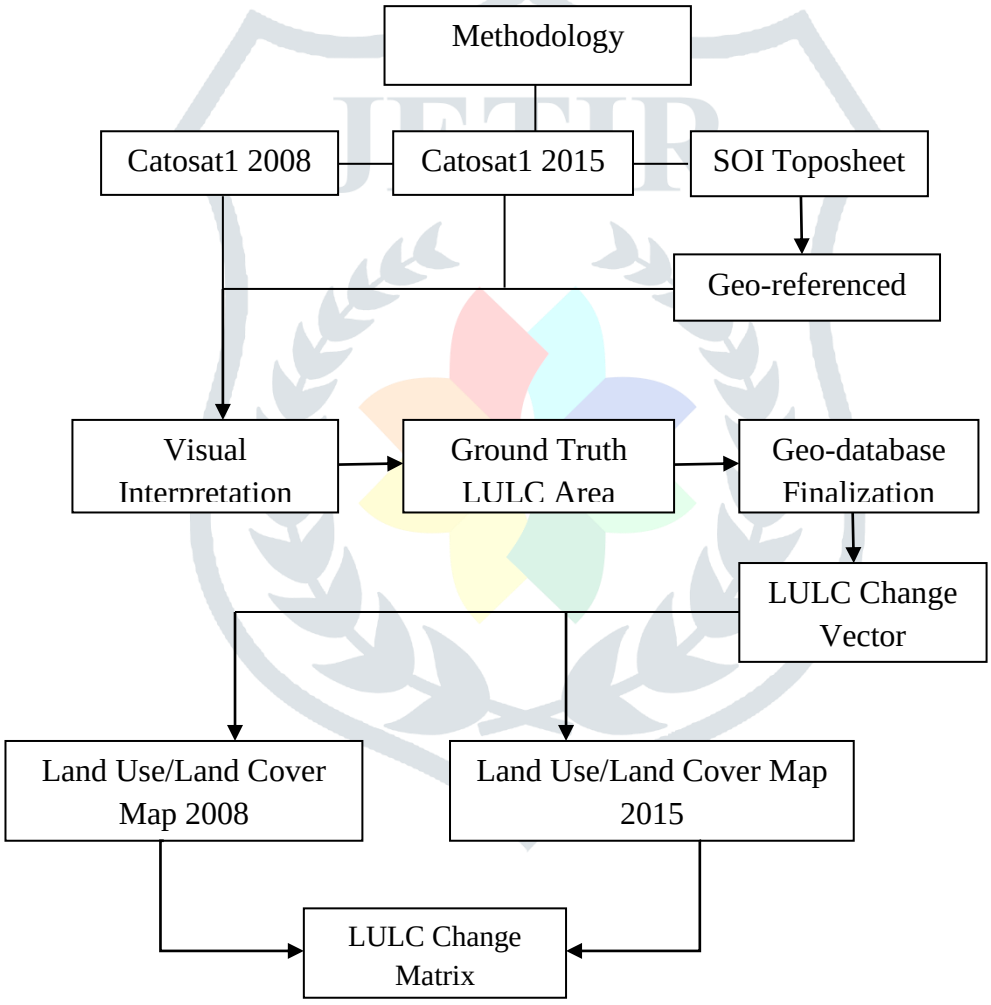

Figure: 2. Methodology Framework

Results and Discussion: Rural to urban migration has been gradually increased in recent decades, and is expected to increase further due to government policies and lack of opportunities in rural areas. The main reasons for the LULC changes are rapid population growth, rural-urban migration, poverty, and lack of basic facilities. The study area is a part of Dehradun, the capital of Uttarakhand, which is a rapidly developing city and well-known educational centre for the entire state. In recent years, the area has experienced significant population growth. Migration from rural to urban areas for education and search of employment is an essential factor determining the socioeconomic profile of the urban population. Urban

growth includes the expansion of residential, commercial, industrial, transportation, and communication activities, resulting in an increase in built-up areas (Jain et al., 2013). Encroachment into the riverbed is a continuous process that leads to the transformation of the riverbed into built-up areas and platforms for human activities. In developing countries, people migrate from rural to urban areas for occupational reasons. Due to their economic situation, they prefer to build their houses either in the riverbeds or in the peripheral areas.

Table: 2. LULC Distribution and Change (2008-2015)

S.N.	LULC Class	2008 (km^2)	2015 (km^2)	Change (km^2)
1	Agriculture	8.43	4.77	3.66
2	Forest	25.44	22.99	2.45
3	Open land	7.85	7.89	0.04
4	Built-up	13.78	20.43	6.65
5	Water body	1.13	0.61	0.52

Figure 2 shows the classified image of two time periods for the study area. Table 1 shows the total LU /LC change from 2008 to 2015. The built-up area was 13.78 km^2 in 2008; it increased to 20.43 km^2 in 2015. Agricultural land was 8.43 km^2 in 2008; it decreased to 4.77 km^2 in 2015. Barren land was 7.85 km^2 in 2008, and increased to 8.49 km^2 in 2015. It is also observed that the price of land is very high due to migration from other places to the newly established capital of Uttarakhand. The forest area was about 25.44 km^2 in 2008 and decreased to 22.99 km^2 in 2015.
As the study area is located on the bank of the Rispana River, the major change is observed in the riverbed. Most of the encroachments in the riverbed are unauthorised buildings with a low living standard of low-income people. The consequences are the destruction of the natural landscape, insufficient open spaces, environmental degradation, and lack of proper facilities.

Table: 3. LULC Change Matrix between 2008 and 2015

LULC Classes	Agriculture	Forest	Open Land	Built-up	Water Body	Area in 2008 (km^2)
Agriculture	**4.21**	**0.04**	**1.06**	**3.03**	**0.09**	**8.43**
Forest	**0.06**	**22.15**	**2.05**	**1.14**	**0.03**	**25.44**
Open Land	**0.50**	**0.73**	**4.51**	**2.01**	**0.10**	**7.85**
Built-up	**0.00**	**0.00**	**0.00**	**13.78**	**0.00**	**13.78**
Water Body	**0.00**	**0.00**	**0.27**	**0.47**	**0.39**	**1.13**
Area in 2015 (km^2)	**4.77**	**22.99**	**7.89**	**20.43**	**0.61**	**56.62**

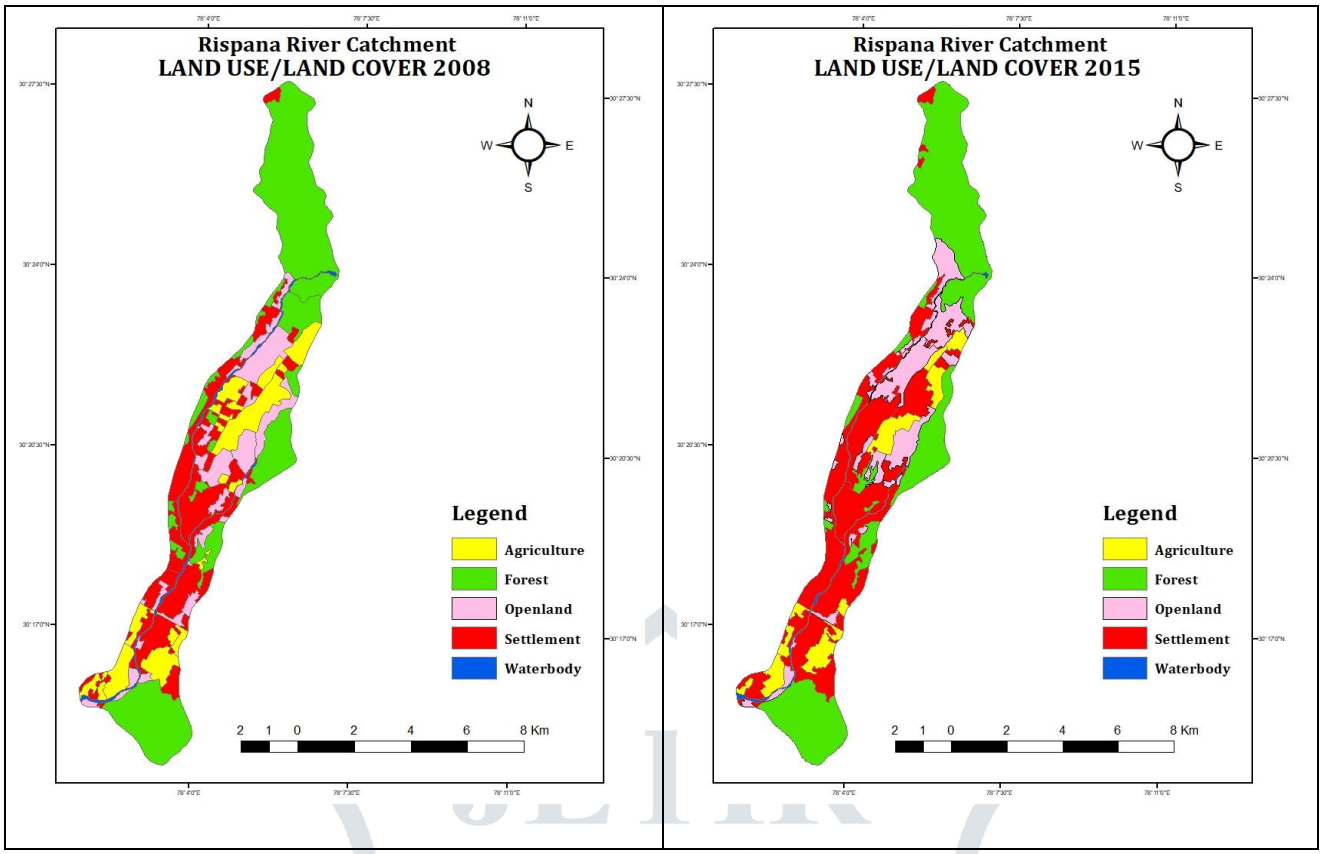

Figure: 3. LULC Change Map of Rispana River Catchment (2008-2015)

LULC Change Matrix: The LULC matrix presented in Table 3 shows the total changes from 2008 to 2015. Results show that 3.03 km² of land was converted from agriculture to built-up land, while 1.06 km² of land was converted to open land. Built-up area is one of the main land use classes in the area, which has increased significantly over the last seven years. A total of 6.65 km² of land was converted to built-up land from the other classes. Forest is another important land cover class; the northern part of the study area is completely covered with dense forest in 2008. The result shows that 2.05 km² and 1.14 km² of forest were converted to open land and built-up, respectively. The water body in the study area present in the form of small rivers, which used to be the lifeline of the city. It is observed that 0.52 km² of the waterbody was reduced by human intervention.

Conclusions: The study assessed and monitored changes in land use patterns in the Rispana River basin in Dehradun district of Uttarakhand state. The study shows that the primary land use of the catchment is built-up. The rising land prices are leading to the conversion of vegetation, agricultural land and open spaces into heavily built-up areas. The most important land use class in the basin is built-up area, which increased by 6.65 km² between 2008 and 2015. The largest changes in built-up area were observed in the central part of the study area, as the riverbed was heavily impacted. The area of the river has decreased by 0.52 km² from 2008 to 2015. This study uses the RS and GIS approach, which is currently one of the predominant technologies for spatio-temporal analyses. This study would help to identify the critical areas that are highly susceptible to flooding and to assist urban planning.

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