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Land Use and Land Cover Change Mapping: A Spatio Temporal and Correlational Analysis of Ramganjmandi Tehsil, Kota, Rajasthan, India

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ABSTRACT

Land use and Land cover signifies the human footprints on the surface of the earth. The current study depicts the Land use and Land cover change analysis of Ramganjmandi tehsil of Kota district in Rajasthan, for a period of 30 years, 1990 to 2020. Supervised classification in ERDAS imagine software, opting maximum likelihood classifier is used for the classification of the region into 7 classes. LANDSAT 1-5, 7, 8 Level 1 collection were used for the year 1990, 2000, 2011, 2018 and 2020. The region shows a rapid change in the classes of Mining, Agriculture, Vegetation, and waterbody. There is negative correlation between Mining area and Vegetation (-0.68), Mining Area and Water Body (-0.86), Mining area and Cropland (-0.11), Mining Area and Open Land (-0.68), Mining area and Built-up area (0.84). The vegetation cover of the region has also declined from the year 1990 to 2020.

Key words : *Land use, Land cover, Correlation, Supervised classification, Mining*

Introduction

The impact of any economic activity is directly visible on land. The way humans utilize the land lie under the land use category whereas the way land occurs naturally lie in the land cover category. The land cover documents the area under forest cover, open land, water body, wetlands. Land Use signifies the region how humans utilize it. It can be for conservation, exploitation, or mixed uses. The information about land assists planning and development of the region. The excess utilization of land leads to resource pressure which eventually portrays negative impact over the other factors of the concerned ecosystem. Land cover have been determined with the help of toposheets, open series maps, aerial photographs, satellite imageries, Master plans etc. Land use and land cover have been a current strategy to manage natural resources and monitoring environmental changes. Viewing earth from space has become an important way to monitor human activities on land. Over the years remotely sensed data have become vital in understanding the land utilization (Zubair, 2006).

Jonatthan *et al.* (2007), decided that maximum likelihood classifier is renowned and simple to classify Land into several categories. Hence supervised classification is executed in ERDAS imagine 2014. For the classification seven LU/LC classes have been created including Vegetation, Built-Up Area, Fallow Land, Cropland, Water Body, Mining Area, Open Land. Mining area is the most significant in this case. Due to which the other factors have been presumed to be impacted. The shift to easy money generating activity is natural to humans, as humans often act to the role of a satisfier which is both an

(Assistant Professor)

economic man and satisfaction seeking. The shift towards mining from agriculture often generates reduction in the agricultural land and increase in the mining area. The built-up area is also increased as the needs of housing, resource extraction, transportation also increases. Land use and land change are perhaps the most significant changes executed over the global environment change since they are occurring both on spatial and temporal scale (Liu *et al.*, 2009). This kind of mapping shows the extent to which humanity is using natural resources. When the demand for natural resources increases more than what nature could supply is termed as ecological overshoot. This ecological overshoot describes the irreversible change over the land or any other form of natural resources (Wakarangal *et al.*, 2002). Numerical Modelling of the land gives us the tools to understand and quantify the process involved in the alteration of land.

Land and Land cover apart from changing the physical dimension of the spatial extent of land use and land cover classes also alter the secondary processes which leads to the overall ecosystem degradation (Dregne and Chow, 1992). The changes in the land in the spatial and temporal domains give the environmental and human dynamics which mediate with the land availability (Lambin *et al.*, 2003).

When humanity's ecological resource demand exceeds what nature can continuously supply, we move into what is termed as ecological overshoot (Wakrangal *et al.*, 2002). It is the ecological overshoot which leads to land use and land cover change which reects irreversible change to ecosystems. This leads to changes in one form of land cover naturalized over time to a particular ecological formation.

Human activities on land are the prime basis of any land use and landcover survey. The land utilization involves a complexity of interacting variables like population, tenure system, technological level, development stage and various other propensities of the community (Ahlquist *et al.*, 2016).

A varied number of social cultural trends are expected to create land use and land cover changes in the country. The change in the consumption patterns affect the transport and the mode of production. The other factor is increased demand of leisure activities and need of access to the countryside. The change in the working pattern also creates locational changes. The changes in the family structure like fragmentation of families increases the demand for housing. Besides all this migration is also among the drivers of land use changes (Gautam, 2015).

Mining can affect the environment in numerous ways. Most conspicuous is disruption of land surface. The scars from the mining are long lasting and the resulting air and soil quality degradation can go beyond the limit of control (Miller,1999).

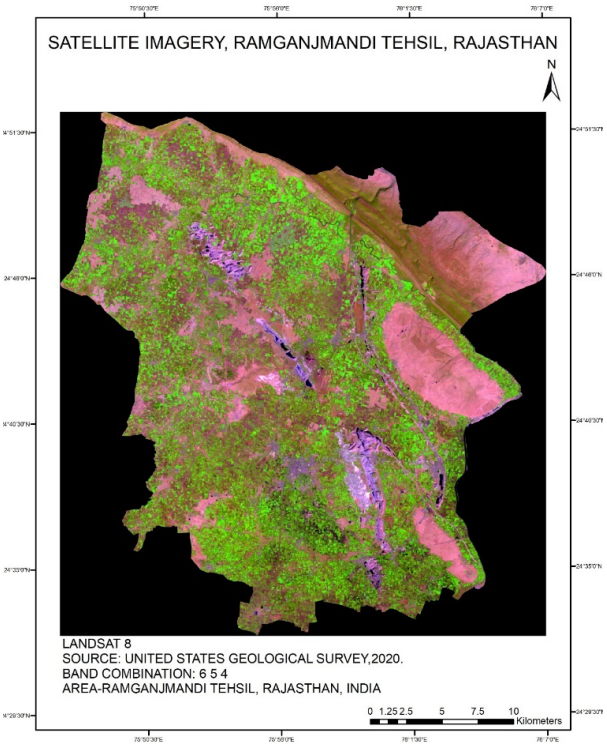

Fig. 1. A satellite portrayal of Ramganjmandi Tehsil

Ramganjmandi is a tehsil of the district of Kota in the state of Rajasthan, in which lies the Ramganjmandi city. It is known as a stone city and coriander city. It is 73 kms away towards south of Kota on the Delhi-Mumbai broad gauze railway line. The latitudinal extension is 24° 08´00´´N to 24° 11´ 10´´N and the longitudinal extension is 75° 13′ 04″ E to 76° 01′57″E. The area possesses semi-arid conditions. The average maximum temperature is 48°C and the average minimum temperature is 9°C. The average annual rainfall is 85.18 cms and average humidity is 42%. The winds move from west to east in summers and north-east to southwest in winters. The soil is black with deposits of limestone.

Ramganjmandi once famous for coriander cultivation is now famous for mines, extraction, mine mafias, poor air quality, water unfit for drinking, loss of agricultural land, deforestation, massive solid waste disposal. Although the region is herein demarcated based on administrative boundary, but

the economic activity of Kota stone mining mostly lies in the tehsil except for few areas of Jhalawar district. Either hills are covered with Kota stone scrap or mounds of scraps have been created. This not only diminishes the aesthetic value of the place but also create environmental degradation (Rana and Sharma, 2020).

Materials and Methods

The LANDSAT series of images are procured from Earth explorer of United States Geological Survey. LANDSAT 1-5 MSS, LANDAT 7 ETM, LANDSAT 8 OLI/TIRS Level 1 collection were used for the year 1990, 2000, 2011, 2018 and 2020. The images belonged to 147/43 & 146/43. The images were layer stacked and mosaiced. Supervised classification was executed using ERDAS imagine 2014. For the classification seven LU/LC classes have been created including Vegetation, Built-Up Area, Fallow Land, Cropland, Water Body, Mining Area, Open Land. Mining area is the most significant in this case. Due to which the other factors have been presumed to be impacted. Further, to develop a correlational picture of the classes, a Correlation Matrix is created using Data analysis tool in Microsoft excel.

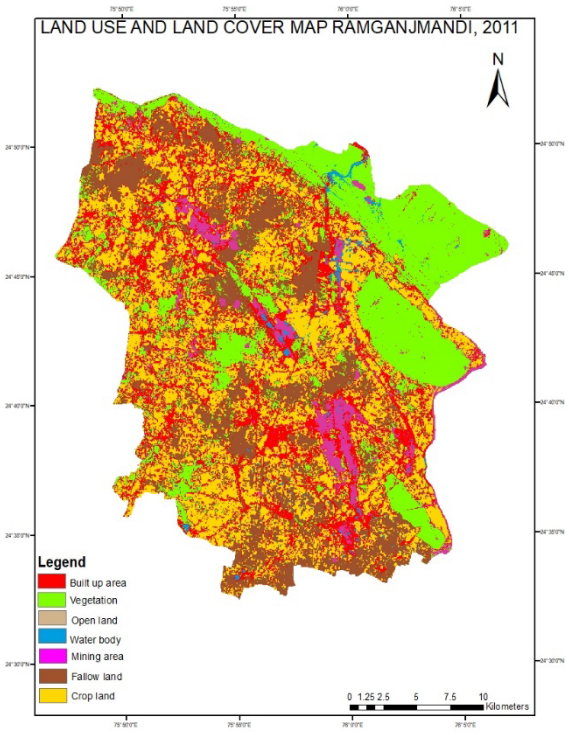

Fig. 1. Land use and Land Cover map,1990

Results and Discussion

Land Use and Land Cover Analysis, 1990

For the year 2000, the supervised classification depicts a massive change in the mining area and the built-up area. The area under vegetation is 200.59 km^2, the area under water bodies is 41,44 km^2, cropland occupies 111.37 km^2, built- up area occupies 120.49 km^2, Open land occupies 81.79 km^2, fallow land occupies 180.34 km^2 and mining area occupies 32.52 km^2. The mining belt in this year extended to Kumbhkot and Chechat. The built-up area sparsely started increasing to the northwestern and southwestern region as well. The built-up area in Ramganjmandi city expanses. As per the pie distribution of the land, cropland occupies 34 % of the tehsil's land, vegetation occupies 22%, mining area occupies 1 %, 16% is occupied by fallow land, 2 % by built-up area, open land occupies 18% and waterbody occupies 7 % of the total region of the tehsil.

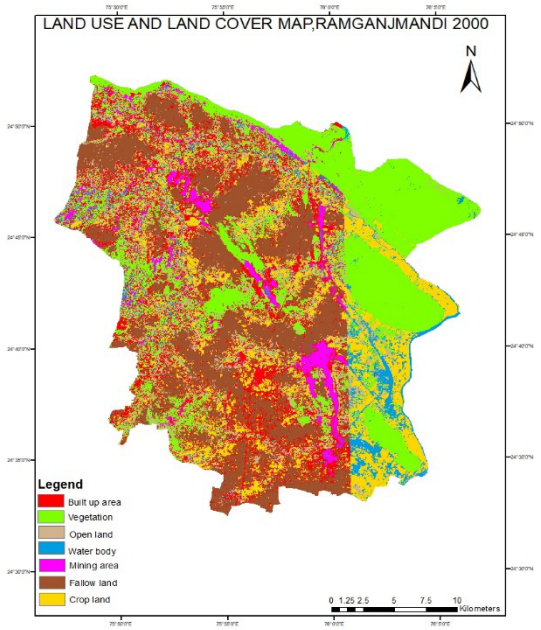

Fig. 2. Land Use and Land Cover map,2001

Land Use and Land Cover Analysis, 2000.

For the year 2000, the supervised classification depicts a massive change in the mining area and the built-up area. The area under vegetation is 200.59 km^2, the area under water bodies is 41,44 km^2, cropland occupies 111.37 km^2, built- up area occupies

120.49 km², Open land occupies 81.79 km², fallow land occupies 180.34 km² and mining area occupies 32.52 km². The mining belt in this year extended to Kumbhkot and Chechat. The built-up area sparsely started increasing to the northwestern and southwestern region as well. The built-up area in Ramganjmandi city expanses. The area under vegetation is 26%, waterbody is 5%, cropland is 15%, Built up area is 16%, Open land is 16%, Fallow land is 23%, and the mining area is 4%.

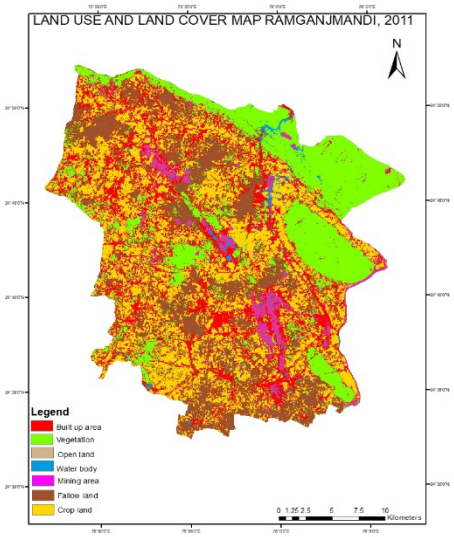

Fig. 3. Land Use and Land Cover map, 2011

Land Use and Land Cover Analysis, 2011

For the year 2011 the area under vegetation is 186.10 km², waterbody is 9.84 km², cropland is 220.37 km², Built up area is 177.28 km², open land is 31.21 km² , fallow land is 109.66 km² and the area under mining is 34.08 km². The area under vegetation is 24%, waterbody is 1%, cropland is 29%, built up area is 23%, open land is 4%, Fallow land is 14% and mining area is 5%.

Land use and Land Cover analysis 2018

For the year 2018 the area under vegetation us 125.02 km², waterbody 14.10 km², cropland 135.38 km², built up area 114.06 km², open land is 108.09 km², fallow land is 220.38 km² and the area under mining is 51.50 km². The mining area intensifies in the southern part of the tehsil mainly in the Kumbhkot region. The water body shows a marked increase due the seasonal change. The built-up region aggravates in their original clusters in the census towns and villages. The city Ramganjmandi extends more towards Kumbhkot.

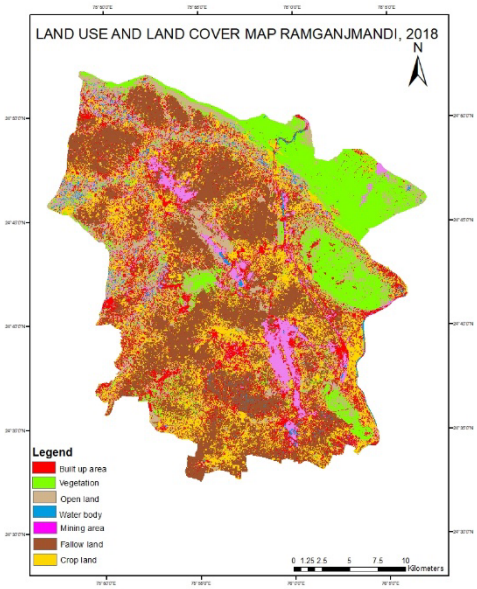

Fig. 4. Land Use and Land Cover map,2018

Land use and Land Cover analysis 2020

For the year 2020 the area under vegetation is 110.639 km². The area under water body is 7.666 km². The area under cropland is 287.835 km². The built-up area is 117.396 km². The open land is 16.957 km². The fallow land is 175.01 km². The mining area

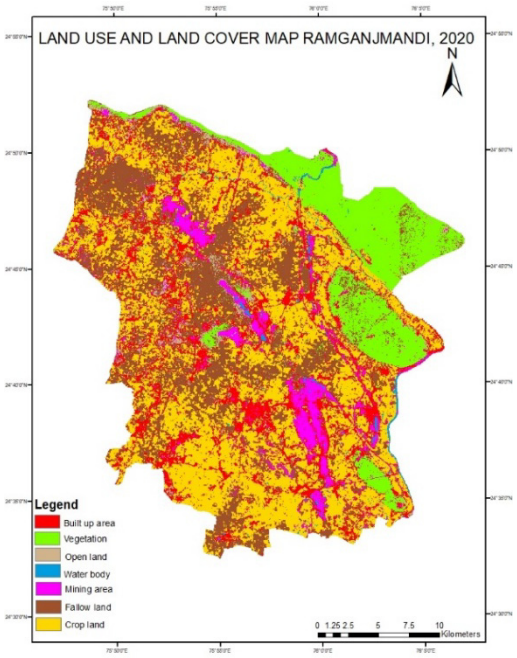

Fig. 5. Land Use and Land Cover map,2020

Table 1. Correlational Matrix of Land Use and Land Cover Classes, Ramganjmandi

	Vegetation	Water Body	Crop Land	Built-up area	Open Land	Fallow land	Mining area
Vegetation	1.00						
Waterbody	0.54	1.00					
Cropland	-0.53	0.06	1.00				
Built-up area	-0.17	-0.73	-0.49	1.00			
Open land	0.50	0.54	-0.36	-0.61	1.00		
Fallow land	-0.33	-0.69	-0.60	0.84	-0.25	1.00	
Mining area	-0.68	-0.86	-0.11	0.84	-0.68	0.84	1.00

Correlational aspect between land use and land cover classes

is 53.037 km^2. There is a negative change in the land under vegetation, water body, open land, fallow land. There is positive change in cropland area, built up area and mining area.

The correlational matrix suggests a negative correlation between Mining area and Vegetation (-0.68), Mining Area and Water Body (-0.86), Mining area and Cropland (-0.11), Mining Area and Open Land (-0.68), Built up Area and Water Body (-0.73), Cropland and Vegetation (-0.53), Fallow Land and Cropland (-0.60), Open land and Built-up area (-0.61). the positive correlation lies between Water Body and Vegetation (0.54), Mining area and Built-up area (0.84)(Table 1).

Change Detection

The change in the land use and land cover from the year 1990-2000 is seen in almost all the classes. There is a positive change under the classes of vegetation, Built-up area, Fallow land, and mining area. There is a negative change under the classes of Water body, Cropland, and open land.

The change in Land use and Land cover is seen from the year 2000 to 2011. There is a negative change under the classes of Vegetation, Water body, Built up area and fallow land. There is a positive change under the classes of cropland, open land, and mining area(Table 2).

Table 2. Land Use and Land Cover Change (1990-2000), Ramganjmandi

Type of land use/land cover	Area in km^2 (1990)	Area in km^2 (2000)	1990-2000
Vegetation	169.33	200.59	31.26
Waterbody	56.69	41.44	-15.25
Cropland	260.05	111.37	-148.68
Built-up area	17.96	120.49	102.53
Open land	133.78	81.79	-51.99
Fallow land	120.07	180.34	60.27
Mining area	10.66	32.52	21.86
Total	768.54	768.54	0

The change in Land use and Land cover is seen from the year 2000 to 2018. There is a negative change under the classes of Vegetation and Cropland. There is a positive change under the classes of Water body, Built-up area, open land, fallow land, and mining area (Table 3).

Table 3. Land Use and Land Cover Change (2000- 2011), Ramganjmandi

Type of land use/land cover	Area in km^2 (2000)	Area in km^2 (2011)	2000-2011
Vegetation	200.59	185.22	-15.37
Waterbody	41.44	9.84	-31.6
Cropland	111.37	150.37	39
Built-up area	120.49	107.28	-13.21
Open land	81.79	105.09	23.3
Fallow land	180.34	176.66	-3.68
Mining area	32.52	34.08	1.56
Total	768.54	768.54	0

The change in Land use and Land cover is seen from the year 2018 to 2020. There is a negative change under the classes of Vegetation, Water body, Open land, and fallow land. There is a positive change under the classes of Cropland, Built-up area, and mining area (Table 4).

Loss of Vegetation Cover

As far as the vegetation cover in concerned in the study area, we see an increasing trend from the year 1990 to 2000. The area under vegetation was 169.32 km^2 in the year 1990. It increased to 200.58 km^2 in the year 2000. In the year 2011, it declined to 186.09 km^2 and in the year 2018 it further declined to 125.02 km^2. In the year 2020, area under vegetation further declined to 110.63 km^2.

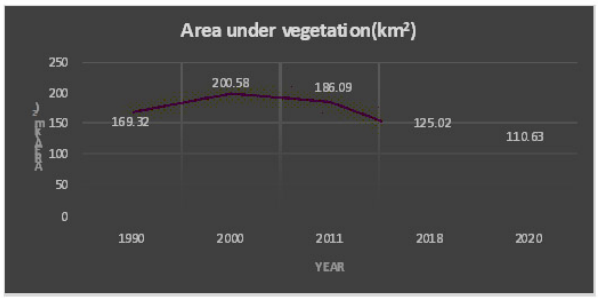

Fig. 7. Area Under Vegetation (1990-2020), Ramganjmandi

Table 4. Land Use and Land Cover Change (2011- 2018), Ramganjmandi

Type of land use/land cover	Area in km² (2011)	Area in km² (2018)	2011-2018
Vegetation	185.22	125.02	-60.2
Waterbody	9.84	14.1	4.26
Cropland	150.37	135.38	-14.99
Built-up area	107.28	114.06	6.78
Open land	105.09	108.09	3
Fallow land	176.66	220.38	43.72
Mining area	34.08	51.5	17.42
Total	768.54	768.54	0

Table 5. Land Use and Land Cover Change (2018- 2020), Ramganjmandi

Type of land use/land cover	Area in km² (2018)	Area in km² (2020)	2018-2020
Vegetation	125.02	110.639	-14.38
Waterbody	14.1	7.666	-6.43
Cropland	135.38	287.835	152.46
Built-Up Area	114.06	117.396	3.34
Open Land	108.09	16.957	-91.13
Fallow Land	220.38	175.01	-45.37
Mining Area	51.5	53.037	1.54
Total	768.54	768.54	0

Conclusion

The landscape of the region has faced several changes spatially and temporally. The mining region has drastically increased reflecting the changes in the other classes including vegetation, waterbody, agricultural land. The un-reclaimed large mining pits have completely altered the landscape. The correlation matrix does not signify the cause-and-effect relationship between the classes, but it does portray that the classes are correlated to each other. The region has faced loss of vegetation cover from the year 1990 to 2020 which can be attributed to the undergoing major economic activity, the limestone mining.

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