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Land use / Land Cover Change analysis using Matrix Union Method

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Abstract
This paper has been attempted the Land use Land cover Change analysis of Jaunpur district U.P. Land is becoming a scarce resource due to immense agricultural and demographic pressure. Hence, information on land use/land cover change is essential for the selection, planning and implementation of land use schemes to meet the increasing demands for basic human needs and welfare. The study area has been situated in Eastern Uttar Pradesh of the Middle Ganga Plain. The main objective of this study is to analyses the land use pattern in Jaunpur district in 2001 and 2021 and trace the change in land use pattern. The land use / land cover (LULC) change analysis in present investigation has been largely based on secondary data like Landsat 7 (ETM +) dated 24 October 2001 and Landsat 8 (OLI& TIRS) dated 24 October 2001 data of path and row 142/43 for the years 2001 and 2021 have been downloaded from the USGS website, survey of India topographical sheets and google earth image. Five major class change analysishas been done by using Matrix Union Method. The result shown that 711 km2 area of Natural vegetation was notified in 2001, while in 2021, it reduced and 156 km2 noted, which is 13 per cent negative change in the wetland. The water body accrues the total 246 km2 area in 2001 while it has been negatively changing in 2021 and shrink within 166 km2.

Keywords: *Land use, Land cover, Matrix Union and Landsat 8*

INTRODUCTION

Change is the rule of nature, and land is also part of nature, so land use also changes time to time. (Murthy and Rao 1997), Land use and land cover change is a consequence of human interference, which aimed at satisfying human needs, either material or spiritual (Shetty et al., 2005, Srivastava, R.N. and Narayana, L.R.A. 1974) or both form the complex of natural and artificial resources (Vink, 1975,Raghavaswamy, 1982, Shah, A. I. et al., 2017). During the past two centuries, the impact of human activities on land grew enormously because of technological development (Verma 2017), population pressure, and changing landscape: consequently, its negative impact is noticed on biodiversity, nutrients, and hydrological cycles as well as climate (Kolhan, 2015). Stockholm International conference, 1972 on human and

environment, UNCED for Environment and Development in Rio, 1992 and world submit for sustainable development in Johannesburg 2002, etc. have called for sustainable studies on changes in land use and land cover, and since then it has become a global issue (Nayak, 2014, Rimal, 2011). Application of remotely sensed data made it possible to study the changes in land cover in lesser time, at a low cost, and with better accuracy (Kachhwala, 1985) in association with Geographical Information System (GIS) that provides a platform for data analysis, update and retrieved (Foody, 2002, Shetty 2005).

Study area

Jaunpur district (25˚ 26′ N to 26˚ 11′N and 82˚ 8′ E to 83˚ 5′ E) is situated in Eastern Uttar Pradesh of the Middle Ganga Plain. Total area of the district is 4038 km^2 having population of 44,94,204 persons (Census 2011). There are ten rivers which flow in district namely Gomati, Sai, Varuna, Basuhi, Pili, Tambura, Mongar, Besu, Nand, and Gangi. The Gomati and Sai Rivers flow in middle part of the district. Physiographically Jaunpur is divided in five part such as Gomati new alluvium, Sai new alluvium, northern tract, central tract (between Gomati and Sai River) and southern tract (between Sai and Varuna River). The surface of district is about flat and some undulation is seen in the part of riverine areas. The slope of the district is towards the south east and relief varies from 77 metres to 89 metres from mean sea level. The district is covered by mainly two type of soils like loam (*Domat*) and clay (*Matiyar*). The loamy soil is found in Jaunpur, Kerakat and some parts of Shahganj Tahsil. Clay soil is found in Shahganj, Machhalishahar and Kerakat Tahsil (Figure 1).

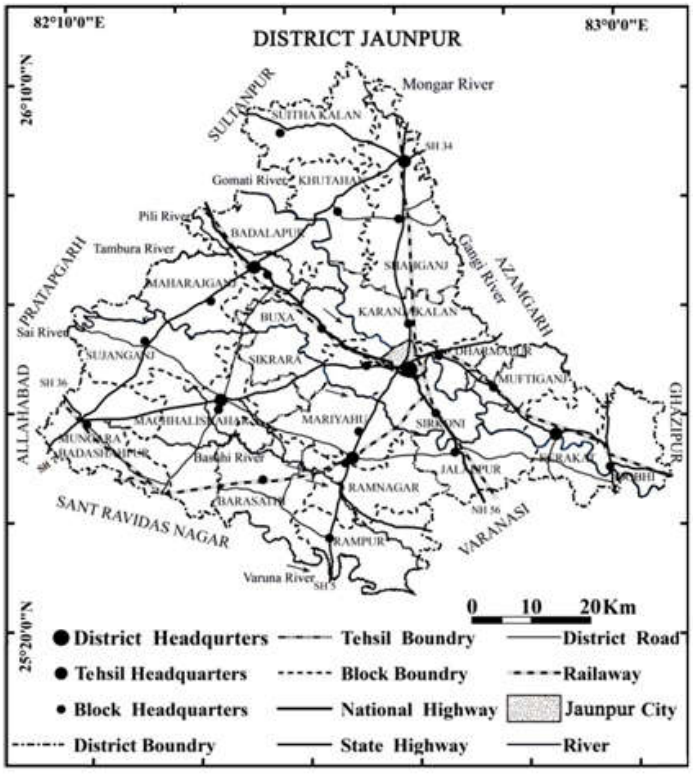

Figure 1: Study area

OBJECTIVE OF THE STUDY

The main objective of this study is to analyses the land use pattern in Jaunpur district in 2001 and 2021 and trace the change in land use pattern.

DATABASE AND METHODOLOGY

In order to fulfil the above objective freely available Landsat 7 (ETM +)dated 24 October 2001 and Landsat 8 (TM and OLI- TIRS) dated 24 October 2001 data of path and row 142/43 for the years 2001 and 2021 have been downloaded from the USGS website (http://earthexplorar.com). The dataset are projected in UTM projection system (Datum WGS 1984, 44N Zone) (Figure 3).After the downloading the images, the layer stacking, mosaicking and masking for both season image have been done by Erdas imagine 2014. Supervised classification with maximum likely hood classifier has been performed to classification of land use land cover classes in the study area. There are five major class classified in study are alike cropland, fallow land, settlement, water body, and wetland. The Matrix union model method has been used for change detection between classified images. This method has been detected the conversion of pixel form one type to another type from pixel to pixel using following model (Figure 2).

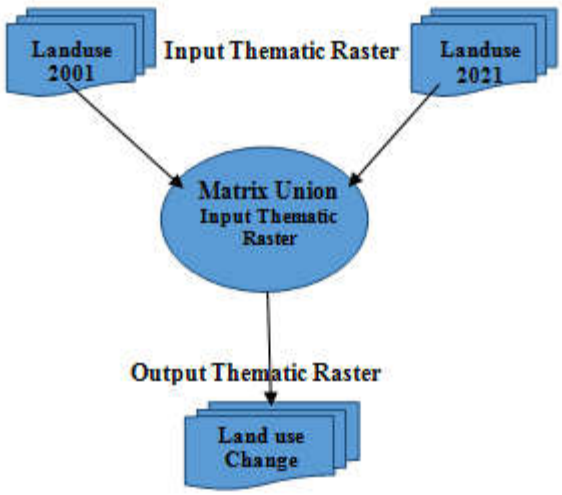

Figure 2: Methodology

RESULT AND DISCUSSION

Land-Use Change

This topic discusses the changing pattern of land use/ land cover from 2001 to 2021. Landsat 7 (ETM+) satellite imagery has used for classification of land use/land cover 2001, and Landsat 8 (OLI & TIRS) imagery has used for the 2021 classification (Figure 3). Analysis by the unsupervised classification method. (Figure 4) Total five major class classifies in class that is cropland, fallow land, settlement, water body, and wetland. Detail classification describes as below.

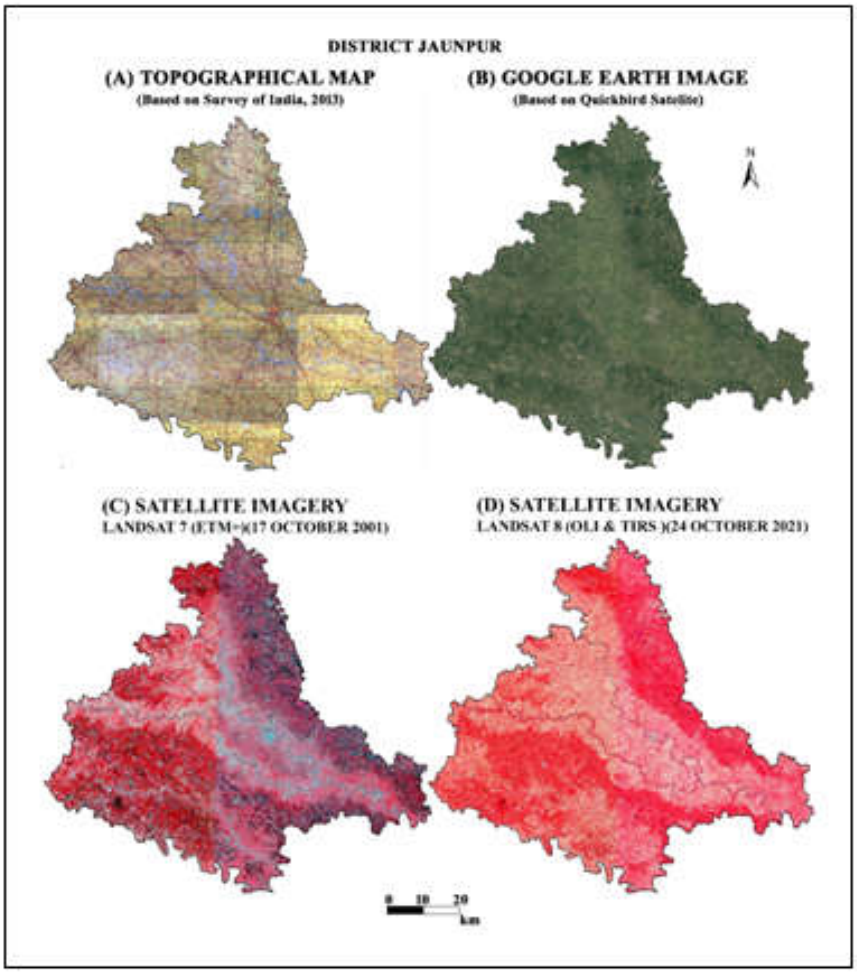

Figure 3: Different Satellite Data used in the study area

Land Use / Land Cover Change

The changing patterns of land use/ land cover have been analysed from 2001 to 2021. Landsat 7 (ETM+) satellite imagery has used for classification of land use/land cover 2001, and Landsat 8 (OLI and TIRS) imagery has used for the 2021 classification. Analysis by the unsupervised classification method (Figure 4). Total five major class classifies in class that is cropland, fallow land, built-up, water body, and wetland. Detail classification describes as fallows. Total 711 km^2 area of Natural vegetation was notified in 2001, while in 2021, it reduced and 156 km^2 noted, which is 13 per cent negative change in the wetland. The water body accrues the total 246 km^2 area in 2001 while it has been negatively changing in 2021 and shrink within 166 km^2 (Table 1). The leading causes of reducing the water body are less rainfall and change in agricultural land. There are high positive change reflected in cropland in the study area, which has 2449 km^2 in 2001 while it's noted in 2021 has 3158 km^2 means 17.60% positive changes (Table 1 and Figure 5).

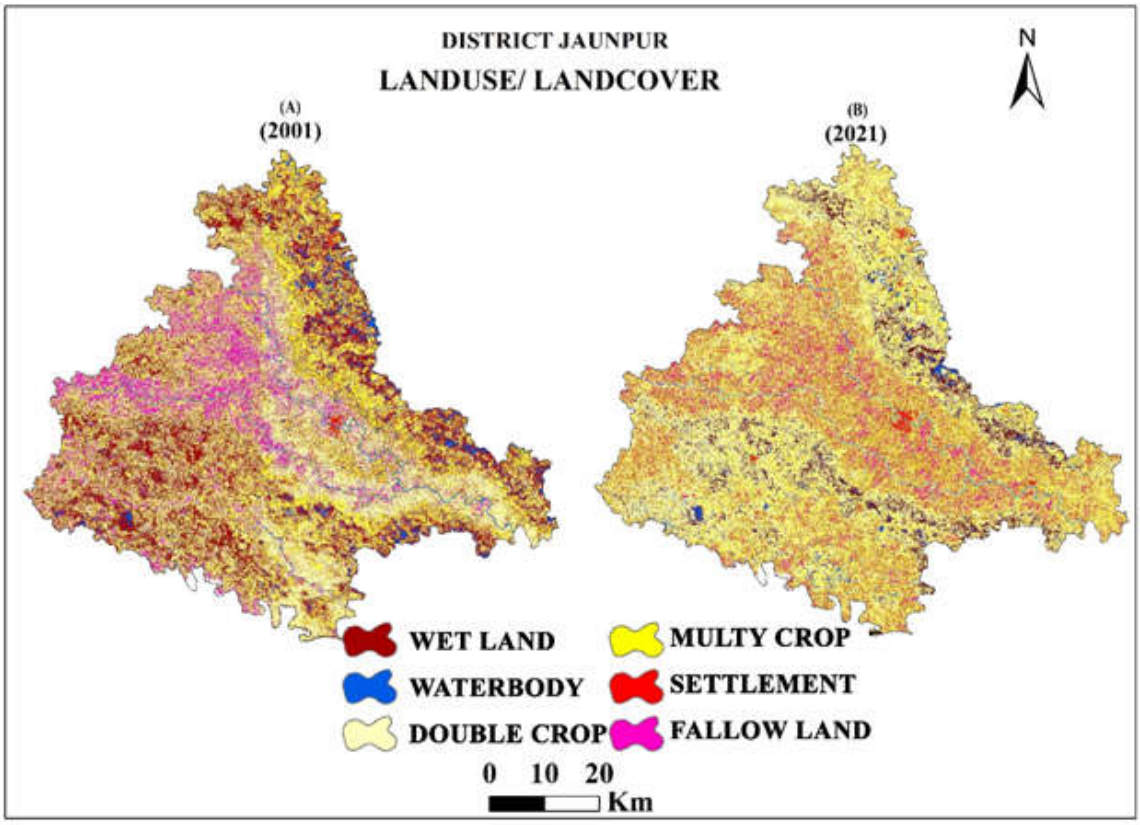

Figure 4: Unsupervised Classification Map

Table 1: Land use / land Cover Change (2001-2021)

	Land use Type	Area (Km^2)		Change (Km^2)	Area (Per cent)		Change (%)
		2021	2001		2021	2001	
1	**Wetland**	156.80	711.90	-555.10	3.89	17.64	-77.94
2	**Water Bodies**	166.21	246.66	-80.44	4.12	6.11	-32.61
3	**Crop Land**	3158.84	2449.36	709.48	78.31	60.71	28.97
4	**Built-up Land**	430.19	266.45	163.74	10.66	6.61	61.45
5	**Fallow / Waste Land**	121.80	360.40	-238.60	3.02	8.93	-66.20

Source: Landsat 7 (ETM +) October 2001 and Landsat 8 (OLI and TIRS) October 2021

The causes of LULC change are noticed due to increase in population and demand for grain and modernisation of agricultural work. Wetland, pond, and fallow lands are changing into agricultural land. Most of the built-up change from agricultural land and fallow land. There 260 km^2 area noted as a built-up in 2001 while it increased to 430 km^2 in 2021 due to the increasing demand of population and modern mechanisation. There are Fallow land covered

360 km² area in 2001 in satellite imagery while it's reduced in 2021 only 121 km² (Table 1). Wetland and pond change into fallow land and fallow land change into agricultural land and built-up because of modern techniques and less rainfall.

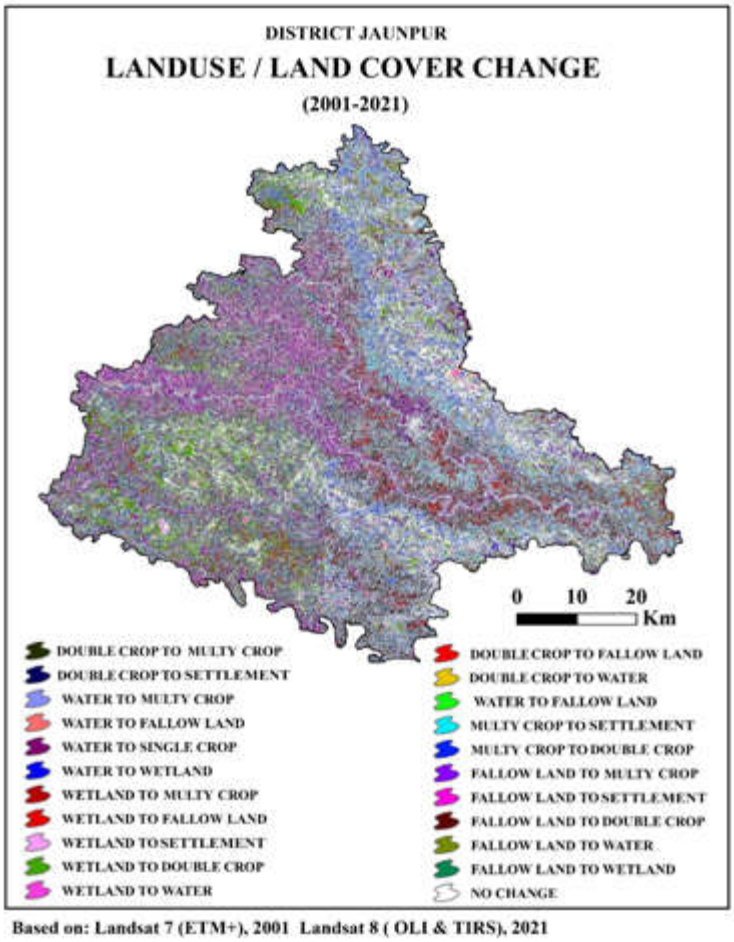

Figure 5: Landuse /Landcover Change Analysis (2001-2021)

Cropland

There are high positive change reflected in cropland in the study area, which has 2449 km² in 2001 while it's noted in 2021 has 3158 km² means 17.60% positive changes. (Table 1). The cause of this change due to increases in population demand for grain and modernisation in agricultural work. Wetland, pond, and fallow lands are changing into agricultural land. Wetland, water bodies and fallow land have been change in cropland. All the blocks belong to positive change, but some block less positive change, and some block have high positive change due to spatial location. Like Shahganj, Sujanganj, MungraBadshahpur, Machhalishahar have high positive change while Dharmapur, Ramnagar, Jalalpur, and Sirkoni have in low positive changes. (Table 2 & Figure 5).

Water

The water body accrues the total 246 km² area in 2001 while it has been negatively changing in 2021 and shrink within 166 km² (Table 1). The leading causes of reducing the water body are less rainfall and change in agricultural land. Most of the negative change show in Dobhi block while Baksha has low area wise negative change and Badlapur, Mahrajganj, Baksha,

Sujanganj, Mungra Badshahpur, Machhalishahar, Mariyahu, Barsathi, and Sikrara have positive changes in the water body due to human awareness, Environment conservation program. (Table 2 & Figure 5).

Natural Vegetation

Total 711 km² area of natural vegetation was notified in 2001, while in 2021, it reduced and 156 km² noted, which is 13 percent negative change in the wetland (Table 1). Most of the natural vegetation change in single cropland and the causes of reduction in wetland are less rainfall human interaction to wetland change into agricultural land. Maximum negative change (- 30.49 %) accrue in Machhalishahar block (85 km2) while low change (0.27 %) in Sirkoni block (0.44 km2) because Sirkoni is less have wetland and environmental awareness program implemented surrounding the Jaunpur city. (Table 2 & Figure 5).

Table 2: Blockwise deference in Percent of different Land use / land Cover between 2001 and 2021

Sr. No.	Block	Change (%)				
		Vegetation	Water	Crop	Settlement	Fallow
1	Suithakala	-25.03	-2.14	22.87	4.78	-0.48
2	Shahganj	-16.99	-7.92	25.15	1.90	-2.14
3	Khuthan	-4.22	-1.80	8.09	4.21	-6.28
4	Karanjakala	-3.84	-2.72	8.54	1.96	-3.95
5	Badlapur	-5.78	0.95	23.16	2.97	-21.30
6	Mahrajganj	-15.11	1.00	28.97	2.31	-17.17
7	Baksha	-2.16	-0.12	23.28	4.13	-25.14
8	Sujanganj	-21.80	1.69	28.65	3.72	-12.27
9	M. Badshahpur	-26.29	1.44	31.72	1.15	-8.03
10	Machhalishahar	-30.49	2.68	30.46	2.47	-5.12
11	Mariyahu	-13.14	1.53	13.40	2.68	-4.48
12	Barsathi	-26.26	2.01	19.68	8.89	-4.32
13	Sikrara	-8.08	0.77	15.19	4.88	-12.76
14	Dharmapur	-4.90	-6.34	1.82	6.77	2.65
15	Ramnagar	-8.68	-0.40	2.27	5.33	1.47
16	Rampur	-12.51	-0.15	6.91	4.19	1.56
17	Muftiganj	-11.05	-9.15	13.42	3.00	3.78
18	Jalalpur	-8.92	-5.30	5.22	5.94	3.06
19	Kerakat	-8.57	-5.56	6.81	4.05	3.27
20	Dobhi	-1.78	-21.47	13.60	5.24	4.41
21	Sirkoni	0.27	-2.40	4.53	9.55	-11.95
	District	**-13.76**	**-1.99**	**17.60**	**4.06**	**-5.91**

Source: Calculated with the help of Landsat 7 and Landsat 8

Settlement

The settlement is also a basic need of the human body, and the development process originates from settlements. There is also a positive changes in the area of settlement due to population pressure and single-family type. Most of the settlement changes from agricultural land and fallow land. There 260 km² area noted as a settlement in 2001 while it increased to 430 km²in 2021 due to the increasing demand of population and modern mechanisation. (Table 1). Some blocks have a high positive changes like Barsathi, Dharmapur, Jalalpur, Ramnagar, Dobhi and Sirkoni have changed more than 5 %, and other blocks have less than 5% changing. Sirkoni high positive change as a settlement due to urbanisation process while Mugara Badshahpur noted as a low positive change in settlement. (Table 2 & Figure 5).

Fallow Land

In this modern era, due to Technological and Sustainable Development, most of the fallow land changed. Like in the study area there are Fallow land covered 360 km² area in 2001 in satellite imagery while it's reduced in 2021 only 121 km² (Table 1). Wetland and pond change into fallow land and fallow land change into agricultural land and settlement because of modern techniques and less rainfall. Badlapur, Mahrajganj, and Baksha noted as a high negative change while Dharmapur, Ramnagar, Rampur, Muftiganj, Jalalpur, Kerakat, and Dobhi noted as a low positive change. (Table 2 & Figure 5).

CONCLUSION

In conclusion we can says that change analysis has been important for find the change detection of area and planning for future developmental process. In this study total five major class classifies in class that is cropland, fallow land, built-up, water body, and wetland. The high positive change shown in cropland while high negative change marked in natural vegetation due to increase the population demand. Many fallow land and cropland also change in settlement while single some cropland change in fallow land due to less rainfall. Total 711 km² area of Natural vegetation was notified in 2001, while in 2021, it reduced and 156 km² noted, which is 13 per cent negative change in the wetland. The water body accrues the total 246 km² area in 2001 while it has been negatively changing in 2021 and shrink within 166 km² (Table 1). The leading causes of reducing the water body are less rainfall and change in agricultural land. There are high positive change reflected in cropland in the study area, which has 2449 km² in 2001 while it's noted in 2021 has 3158 km² means 17.60% positive changes. Various plans should be made and implement to prevent the high negative change of vegetation. Change in land use should take place at relevant place because of less environment degradation and implement the concept of sustainable development.

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