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ORIGINAL RESEARCH ARTICLE

Land use/land cover change assessment of Mohana watershed (Far-Western Nepal) using GIS and remote sensing

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ABSTRACT

The present study was conducted in the Mohana watershed of Far-western Nepal to assess land use land cover change. The study has used ArcGIS and three Landsat images - Landsat TM (1999), Landsat ETM+ (2009), and Landsat OLI (2019) – to analyze land use the land cover change of the watershed. The change matrix technique was used for change detection analysis. The study area was classified into five classes; forest, agriculture, built-up, water bodies, and barren lands. The study has found that among the five identified classes forest and build-up increased positively from 45.40 % to 51.51 % - forest cover and 11.26 % to 19. 85 % - build-up respectively. Similarly, agricultural land and water bodies initially increased but after 2009 both land cover areas decreased to 23.79 % and 0.73 % from 31.38 % and 0.97 % in 2009 respectively. Barren land decreased from 15.37% to 4.12% over the last 20 years. This study might support land-use planners and policymakers to adopt the best suitable land use management option for the Mohana watershed.

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INTRODUCTION

Land use land cover change is the most important form of a biophysical process of global environment change (Turner *et al.*, 1995). Changes in land use land cover directly impacts sustainable livelihood in most parts of the region (Maitima *et al.*, 2010). The land is an area on which all human activities are being conducted and Land use generally refers to how the land has been used by human activities. The use of land varies with the purposes of human need either they are being used for the provision of shelter, recreation, extraction, or processing of materials for the sake of economic purpose. In Nepal, Ecological and environmental impacts are the main causes of land-use change. Land cover refers to the earth's physical material at the surface including forest, barren land, water, etc. Those physical materials of the earth's land surface have been changing for the past few years and are likely to continue to change in the future (Dinka and Chaka, 2019). These changes are taking place at local and global levels. Both natural and anthropogenic forces are responsible for the change. Natural effects are only over a long period whereas, anthropogenic effects are immediate and often direct. Out of the anthropogenic factors, the most common effect in a developing country is population growth. People need land for the construction of buildings and it is common practice to encroach forest and agricultural land for housing purposes. Therefore, the result of these activities is the main cause of land use land cover change due to human factors. Hence, understanding how the land cover change affects the surrounding environment will enable land-use planners to formulate land-use policies to minimize the undesirable effect of future land cover change. A watershed is a topographically delineated area drained by a river system and differentiated from various river networks. Increasing degradation of watersheds due to Human activities like agriculture, solid waste disposal, and land-use patterns like forest area, croplands, and settlement area has changed the surface structure (Turner *et al.*, 1995). The detection of change on the surface structure by identifying the difference at different times should be studied for changing, adjusting, and planning of water resources as well as land resources.

The application of remote sensing and GIS has made it possible for the management and improvement of the watershed by integrating and analyzing temporal and spatial data to study land use land cover change at a different level (Attri *et al.*, 2015). Several studies (Awasthi *et al.*, 2002; Gautam *et al.*, 2002; Paudyal *et al.*, 2019) have been carried out on land use and land cover changes in Nepalese watersheds using GIS and remote sensing approaches (Shalaby and Tateishi, 2007). Where they have analyzed there has been experiencing a rapid increase in urbanization with a similar trend of increasing forest cover and urban areas on the one hand and the decreasing trend of agriculture on the other hand. The rate of urban land expansion over the past 30 years has increased quadruple, with urban land covering a total of 469 km² in 2010 (Uddin *et al.*, 2015). Above mentioned studies demonstrated that urbanization is growing rapidly and is a potent form of LULC changes. Therefore, to study major conversion in the Mohana watershed, this study will provide baseline information on the LULC detection and its change over the past two decades. Mohana watershed covers nearly 96% area of Kailali district which is densely populated of about 7 lakh 75 thousand (CBS, 2014). This causes degradation in river water quality by increasing population and demand for water (Shrestha and Shah, 2019). A very little watershed research has been done in Kailali and no such studies have been carried out to detect land use and land cover change scenarios for this watershed. Therefore, the study area was selected to detect and document LULC change in the Mohana watershed by using RS and GIS techniques. The main objective of the present research was to utilize GIS and Remote Sensing applications to examine the present land use pattern and its change in different periods between 1999 and 2019 in the Mohana watershed. The outcome of this study is expected to be highly useful to land-use planners and policymakers for the better land-use planning of the watershed.

MATERIALS AND METHODS

Study area

The present study was conducted in the Mohana watershed located in the Kailali district of Sudurpashchim (Far west) province, Nepal. This watershed covers nearly 96% area of the district (Neupane *et al.*, 2019). It lies between 28˚22'- 29˚05' north and 80˚30' - 81˚18'east. The elevation of the watershed varies from 119m in the Terai belt to 1,944m in the hilly region. The area of Mohana watershed taken for the study is 3098.74 Km^2 and occupies 13 local levels, of which one is the sub-metropolitan city (Dhangadi) six are municipalities (Tikapur, Ghodaghodi, Lamkichuha, Bhajani, Godawari, Gauriganga), and six are rural municipalities (Janaki, Bardagoriya, Mohanyal, Kailari, Joshipur, Chure) respectively. According to the 2011 census (CBS, 2014) the district has a population of about 775,709 with a population growth rate of 2.29% and a population density of 240 people per sq. Km.

The 40% of the upper part lies within the Churia range while the remaining 60% of the watershed is in Terai (Chaulagain and Rimai, 2019). The climate ranges from lower tropical to subtropical with a marked rainy monsoon season lasting from June to August. The annual average rainfall is about 1840mm with a minimum temperature at 5°C during winter and a maximum at 43°C in summer (Chaulagain and Rimal, 2019). The soil and climate are favorable for the cultivation of crops (Shrestha *et al.*, 2019), and the flat terrain of the Terai belt is suitable for urbanization and industrialization (Poertner *et al.*, 2011). The map of the study area is shown in Figure 1.

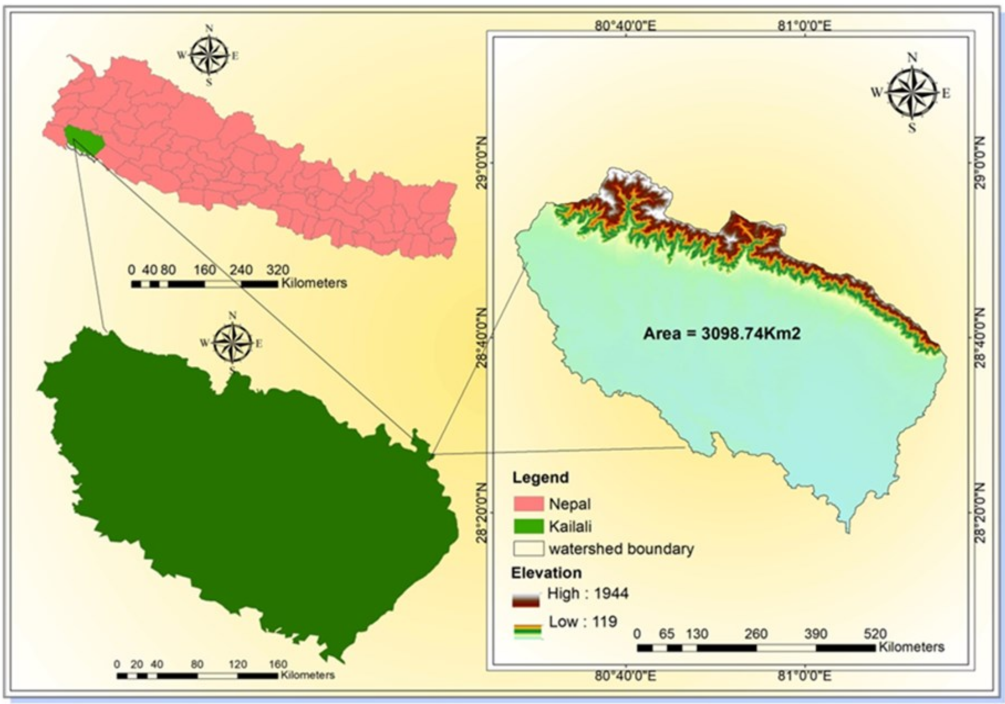

Figure 1. *Location map of study area.*

Table 1. Details of the remotely sensed data used in the study.

Landsat Image	Sensor	Date	Path/ Row	Spectral Band	Resolution
Landsat 5	TM	18/02/1999	144/040	1, 2, 3, 4, 5, 6, 7	30m
Landsat 7	ETM+	11/10/2009	144/040	1,2,3,4,5,6,7,8,9,10,11	30m
Landsat 8	OLI	23/10/2019	144/040	1,2,3,4,5,6,7	30m

Table 2. Land use Land cover classification scheme.

Class	Description
Forest	Mixed and uncultivated forest area.
Agriculture	Organized or unorganized agricultural practices, crops fields and fallow lands, etc.
Built-up	Residential industrial, commercial or mixed up areas including network of roads, transportation.
Water body	River, open/ surface water, lakes, ponds, streams, reservoirs.
Barren land	Sand exposed rock and gravel pits.

Data collection

For this study, two major data sources were used i.e., primary data and secondary data. Primary data were collected from reconnaissance visits to the study area. During reconnaissance visits, ground information was taken, to define the major ground covers such as forest, agriculture, built-up, water body, and barren land. Ground control points from each land cover type were collected with the help of GPS. Whereas, secondary data such as; Shutter Radar Topography (SRTM) Global Digital Elevation Model (GDEM) of 30m resolution data was downloaded from SRTM data, (https://srtm.csi.cgiar.org/srtmdata/) on January 8, 2020, and was used for extracting boundary of Mohana Watershed. Landsat images for three years (Table 1) consisting of multi-spectral data is acquired by Landsat satellite provided from the United States Geological Survey (USGS) Earth Explorer (https://earthexplorer.usgs.gov/). In order to get geometric and radiometric calibrated images, the Landsat collection 1 level 1 with cloud cover less than 10% were selected and used for visual interpretation and detecting LULCC. Five major LULC types were identified by using field data and satellite images of Landsat TM, 1999, ETM+, 2009, and OLI, 2019. The definition of each land use land cover is described in Table 2.

Data preparation

Watershed delineation: Watershed delineation is simply a creation of a boundary that represents the drainage area of a point or set of points or outlets (Bajjali, 2018). There are several software applications available that provide automated watershed delineation tools. Most of these tools require a DEM as an input tool moreover a river shape-file can also be used for watershed delineation. In this research, SRTM GDEM of the study area with the 30-meter spatial resolution was used for the extraction of the Mohana watershed boundary.

Image processing and LULC class detection: For image processing and performing supervised image classification of the Landsat imageries, ArcGIS 10.3 was used to composite the bands into a single layer using the image analyst tool. Then the resultant shape-file of Mohana watershed produced through watershed delineation process was used to clip these imageries using clip raster tool in ArcGIS. These clipped images were then re-projected to Universal Transverse Mercator (UTM) 44N zone. Then Landsat imageries were studied by assigning per-pixel signatures in ArcGIS. For each of the predetermined classes, an average of 100 signature files was drawn around representative sites, which describes minimal confusion among the LULC to be mapped (Chowdhury *et al.*, 2020). Thus, signatures were drawn in the Landsat images using Google Earth. The maximum likelihood algorithm was used for image classification.

Field survey and accuracy assessment: Accuracy assessment is the comparison of classification with the ground-truth data to evaluate how accurate the classification represents the true geographical reference data. In this study, random points were used to validate the classification accuracy. A total of 500, 608, and 708 stratified random points were created from 1999, 2009, and 2019 classified images, respectively. Field verification was conducted in March 2020 with the help of GPS (GARMIN eTrex 10) at different places of the study area covering all the LULC classes. A total of 250 verification points were collected covering all the LULC classes and also focused on the verification of doubtful areas. After that, created random points were superimposed on the LULC map, and the value was extracted. The confusion matrix was generated and placed such that class determined by ground-truth value is along X-axis and class determined by supervised image classification is along Y-axis. The comparison of reference data and classification results were statistically analyzed using error matrices. In addition, Producer's, User's, and Kappa value was also calculated to measure the extent of classification accuracy.

Change detection: Post classification is considered the broadest method of change detection techniques (Haque and Basak, 2017). Several change detection methods have been developed viz., image differencing, post-classification change matrix, comparison technique, and key component analysis (Lu *et al.*, 2004). The change matrix technique is simple and easy to use which shows vital information about the spatial distribution of the LULC changes (Usman *et al.*, 2015). Change matrix showing the LULC change in each decade was generated from classified images of 1999 to 2009 and 2009 to 2019 and a change matrix table was generated from 1999 to 2019 to access the overall change in the watershed between 1999 and 2019.

LULC Data analysis method: The analysis and interpretation of numeric data of land use land cover changes were done on Microsoft excel 2010 and presented in the form of maps, tables, and graphs.

LULC Classification accuracy analysis: The overall classification accuracy of the study was calculated by dividing the correctly classified pixels by the total number of pixels (Bharatkar and Patel, 2013).

$$\text{Overall accuracy} = \frac{\text{Number of correct pixels}}{\text{Total number of pixels}} \times 100$$

$$\text{User's accuracy(\%)} = \frac{\text{Correctly classified pixels}}{\text{Classified total pixels}} \times 100$$

$$\text{Producer's accuracy(\%)} = \frac{\text{Correctly classified pixels}}{\text{Reference total pixels}} \times 100$$

Besides the overall classification accuracy, the accuracy of the individual class was also calculated from the user's accuracy and producer's accuracy (Bharatkar and Patel, 2013). The kappa coefficient (K) was calculated as follows,

$$K = \frac{P_0 - P_e}{1 - P_e}$$

Where,

P_0 Proportion of correctly classified pixels; *Pe* Proportion of correctly classified pixels expected by chance.

LULC change detection analysis: LULC change detection analysis was computed as follows:

$$\text{Total LULC} = \text{Area of the Final year} - \text{Area of initial year}$$

Where '+' values suggest an increase in the LULC whereas, '-' values suggest a decrease in LULC.

Percentage LULC changes calculated using the following equation:

$$\text{Percentage of LULC} = \frac{\text{Area of final Year} - \text{Area of initial Year}}{\text{Area of nitial Year}} \times 100$$

RESULTS AND DISCUSSION

Land use land cover status analysis

The classified land use land cover maps of Mohana watershed from the year 1999 to 2019 are presented in Figure 2. The figure presents the land use land cover classes for the years under consideration, in 10 years of interval. A total of five classes were produced for each of the images (forest, agriculture, built-up, water body, and barren land). The outputs for the classification of images were compared in terms of the total area for each land use land cover class. As presented in Table 3 and Figure 2, the land use land cover classes that have consistently increased are forest and built-up. The outputs of this study can be presented into several clear outcomes as follows;

Forest cover: The forest cover has increased within the watershed over the years. Forest cover has increased from 45.40% to 51.51% over the last 20 years (Figure 2 and Table 3).

Agricultural land and water body: Agricultural land and water bodies have increased first from 27.51%, 0.47% in 1990 to 31.38%, 0.97% in 2009, and then decreased to 23.79%, 0.73% in 2019 respectively (Figure 2 and Table 3).

Built-up area: Built-up areas have grown rapidly throughout each decade from 1999 to 2019, increased about to double from 11.26% to 19.85% over the last 20 years.

Barren land: Barren land decreased over the years. Decreased from 15.37% to 4.12% over the last 20 years (Figure 2 and Table 3).

Land use land cover change assessment of Mohana watershed from 1999-2009

From 1999 – 2009, a major decline concerning area coverage was observed in the barren land class whereas areas of agriculture, built-up, forest, and water body have increased. (Table 5) barren land shrank by 48.36%. Out of 476.35Km^2 in 1999, barren land lost area mainly to agriculture, built-up, then forest and retained 101.73 Km^2 of the total 3098.74Km^2 in 2009. Besides, the water class retained only 3.87Km^2 of the total 14.41Km^2 in 1999. It was mainly replaced by barren land and then followed by agriculture, built-up, and forest in 2009. The area of other land cover classes replaced by water was small. Out of 852.34Km^2 that was agriculture in 1999, 614.05Km^2 was still an agricultural area in 2009 but 128.60Km^2 was converted to built-up and rest to barren land, forest, and water body. At the same time, built-up increased from 348.96Km^2 in 1999 to 353.37Km^2 in 2009. It retained only 80.57Km^2 of it in 2009 and was mainly replaced by agriculture and forest. The class which was continuously increased from 1406.68Km^2 in 1999 to 1497Km^2 in 2009 was a forest. It retained 1289.02Km^2 of the total area in 2009. The results for the study duration (1999 – 2019) on different classes of LULC indicate that most of the agricultural and barren land was intensively converted to the built-up area. Previously the river Mohana was used for drinking purposes but now this river faces multiple pressures from different human activities such as migration, deforestation, pollution, etc. as a result the amount of sand in the watershed increased (Neupane *et al.*, 2019). The increasing trend of LULC change in the watershed indicates the influence of economic development and population growth (Attri *et al.*, 2015). However, there is a variation in the trend of LULC change of different LULC types. The increasing trend of LULC alteration in the watershed highlights a marked impact of an increase in population. Kailali is a terai region of Sudurpaschim province (Far-west), where in terai, internal migration is the major contributor to urban growth and, as a result of which, the reduction of agricultural lands (Rimal, 2018). Consequently, our study shows a similar result, from the LULC change matrix overall comparison of each LULC class of 1999 and 2019 demonstrate that there has been a marked LULC change around the last 20 years.

Table 3. Results of the LULC classification for 1999, 2009, and 2019 images showing the area of each category and category percentages.

LULC type	1999		2009		2019	
	Area (Km2)	Proportion (%)	Area(Km2)	Proportion (%)	Area (Km2)	Proportion (%)
Forest	1406.68	45.40	1497.00	48.31	1596.24	51.51
Agriculture	852.34	27.51	972.27	31.38	737.06	23.79
Built-up	348.96	11.26	353.37	11.4	615.24	19.85
Water body	14.41	0.47	30.12	0.97	22.68	0.73
Barren land	476.35	15.37	245.98	7.94	127.52	4.12
Total	3098.74	100	3098.74	100	3098.74	100

Table 4. LULC change assessment of Mohana watershed.

LULC type	LULC change from 1999 to 2009		LULC change from 2009 to 2019		LULC change from 1999 to 2019	
	Change in area (Km^2)	% change	Change in area (Km^2)	% change	Change in area(Km^2)	% change
Forest	90.32	6.42	99.24	6.63	189.6	13.48
Agriculture	119.93	14.07	-235.21	-24.19	-115.3	-13.53
Built-up	4.41	1.26	261.87	74.11	266.3	76.31
Water body	15.71	109.02	-7.44	-24.7	8.3	57.39
Barren land	-230.37	-48.36	-118.46	-48.16	-348.8	-73.23

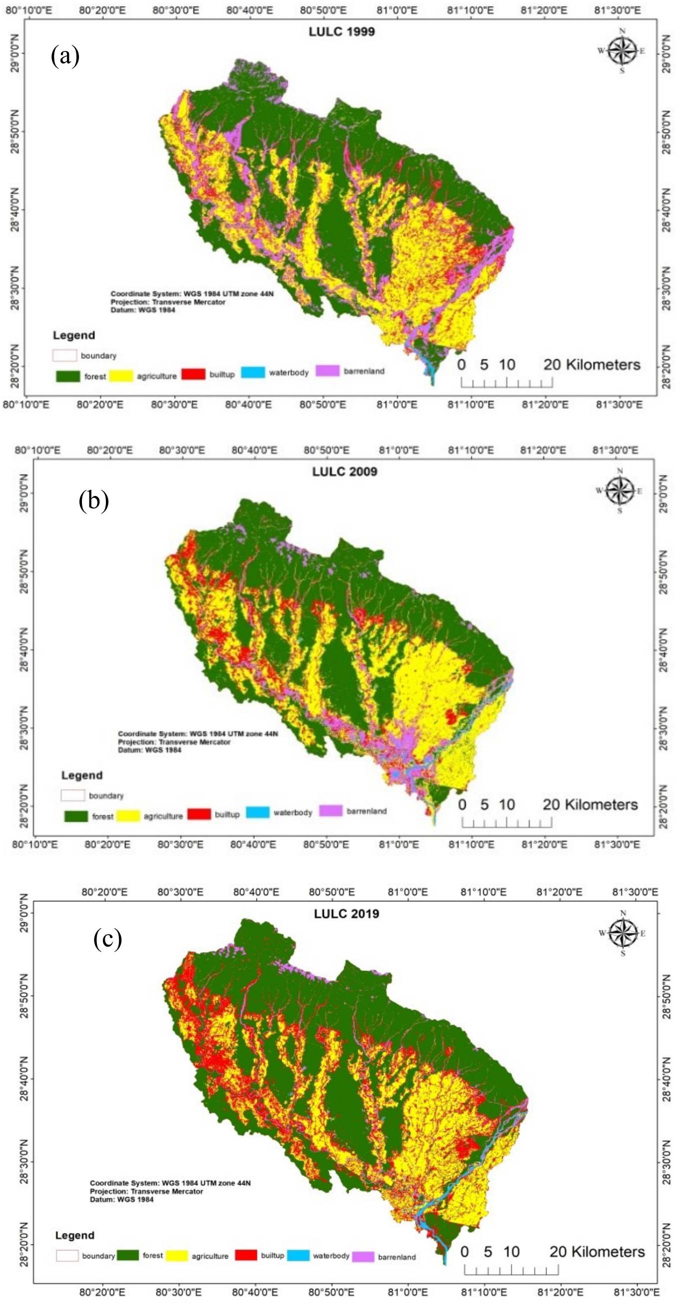

Figure 2. *LULC map for 1999 (a), 2009 (b), and 2019 (c) at Mohana Watershed.*

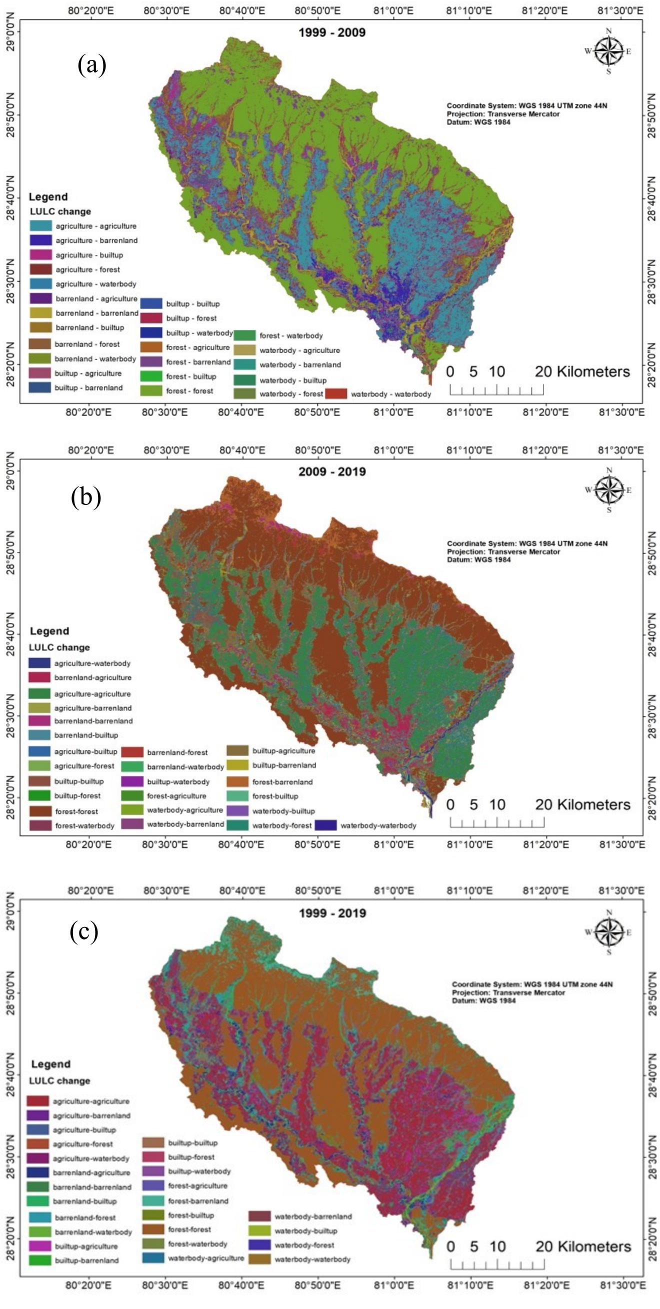

Figure 3. *LULC change map in Mohana watershed from (a) 1999 – 2009, (b) 2009 – 2019 and (c) 1999 – 2019.*

Table 5. Change matrix of LULC class between 1999 and 2009 (area in Km^2).

1999	2009				
	Agriculture	Barren land	Built-up	Forest	Water body
Agriculture	614.05	78.10	128.60	38.02	5.59
Barren land	127.13	101.73	119.22	112.03	16.03
Built-up	163.93	27.84	80.57	58.23	3.19
Forest	71.08	33.26	19.32	1289.02	1.15
Water body	2.84	5.30	1.27	0.56	3.87

Table 6. Change matrix of LULC class between 2009 and 2019 (area in Km^2).

2009	2019				
	Agriculture	Barren land	Built-up	Forest	Waterbody
Agriculture	662.04	48.74	192.78	59.96	13.43
Barren land	103.48	44.20	45.67	18.48	33.39
Built-up	143.17	26.07	155.03	16.91	7.71
Forest	19.07	127.72	60.71	1286.24	4.12
Waterbody	8.08	4.31	4.29	0.22	12.92

Table 7. Overall change matrix of LULC class between 1999 and 2019 (area in Km^2).

2009			2019		
Agriculture	539.53	25.30	244.95	45.77	2.83
Barren land	75.22	58.60	170.69	159.86	11.86
Built-up	105.13	17.16	136.49	72.80	2.24
forest	17.77	20.99	57.20	1317.09	1.41
Waterbody	1.37	2.71	2.44	3.26	4.07

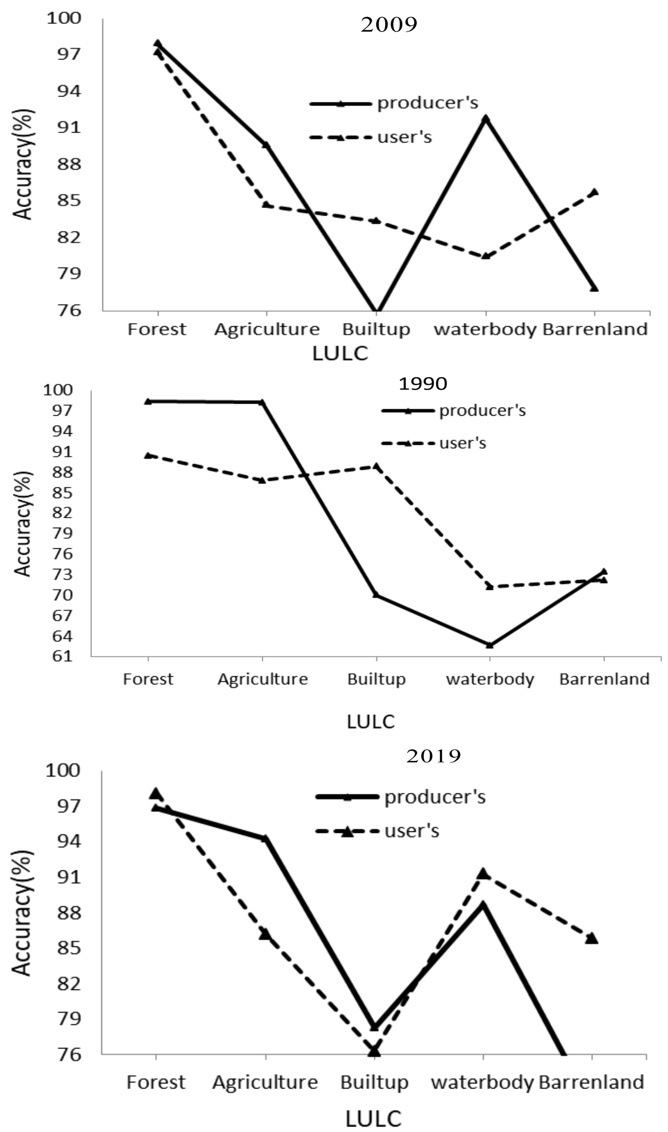

Figure 4. *Producer's and User's Accuracy.*

Land use land cover change assessment of Mohana watershed from 2009-2019

From 2009 to 2019, a significant decline is again observed in a barren land with a rate of 48.16%. Besides, agriculture and waterbody lost their area by 235.21 Km^2 and 7.44 in 2019. Table 6 depicts that agricultural land retained 662.04Km^2 in 2019, it was mainly replaced by built-up. Forest, increased from 1497 Km^2 in 2009 to 1596.24 Km^2 in 2019, a lost area mainly to the barren land and retained 1286.24 Km^2 of the total in 2019. Within this time frame, built-up also increased by 74.11%. Out of 615.24Km^2 area, built-up in 2009 was mainly converted to agricultural land.

Land use land cover change assessment of Mohana watershed from 1999-2019

This study examined land use land cover change between 1999 and 2019, which can be seen in Table 4. The primary change was that the agricultural land was converted into built-up areas during 1999 – 2019. The barren land decreased gradually as they were converted to built-up and forest areas. Historically, the land use land cover has been changing at different rates within a watershed. The forest cover showed an increasing trend over the past 20 years. A similar trend was also found in built-up areas, which has increased from 11.26% to 19.85% between 1999 and 2019. Similarly, the annual growth rate observed per year within the watershed for agriculture and barren land was decreased. However, the decreasing trend of barren land can be observed from 15.37% to 4.12% respectively (Figure 3 and Table 3). During 1999 – 2019, agriculture and barren land decreased by 13.53% and 73.23% respectively whereas built-up area and forest cover increased by 76.31% and 13.48% in 2019. Overall, this research found an increase in a forest area with the increase of altitude. In contrast, a gradual

Table 8. Confusion error matrix of LULC classification for 1999, 2009, and 2019.

	LULC type	Reference data (1999)					Total	User's accuracy (%)
		Forest	Agriculture	Built-up	Waterbody	Barren land		
Classified data	Forest	123	0	0	8	5	136	90.44
	Agriculture	0	112	17	0	0	129	86.82
	Built-up	0	2	56	5	0	63	88.89
	Waterbody	0	0	0	52	21	73	71.23
	Barren land	2	0	7	18	72	99	72.73
	Total	125	114	80	83	98		
	Producer's accuracy (%)	98.40	98.25	70.00	62.65	73.47		
Overall accuracy = 83.00%								
Kappa coefficient = 0.77								

	LULC type	Reference data (2009)					Total	User's accuracy (%)
		Forest	Agriculture	Built-up	Waterbody	Barren land		
Classified data	Forest	137	0	0	1	3	141	97.16
	Agriculture	2	154	24	0	2	182	84.62
	Built-up	1	14	75	0	0	90	83.33
	Waterbody	0	0	0	78	19	97	80.41
	Barren land	4	4	0	6	84	98	85.71
	Total	140	172	99	85	108		
	Producer's accuracy (%)	97.86	89.53	75.76	91.76	77.78		
Overall accuracy = 86.84%								
Kappa coefficient = 0.83								

	LULC type	Reference data (2019)					Total	User's accuracy (%)
		Forest	Agriculture	Built-up	Waterbody	Barren land		
Classified data	Forest	155	0	0	0	3	158	98.10
	Agriculture	0	181	28	0	1	210	86.19
	Built-up	0	11	116	7	18	152	76.32
	Waterbody	0	0	2	94	7	103	91.26
	Barren land	5	0	2	5	73	85	85.88
	Total	160	192	148	106	102		
	Producer's accuracy (%)	96.88	94.27	78.38	88.68	71.57		
Overall accuracy = 87.42%								
Kappa coefficient = 0.84								

increase in the agricultural area in the lower altitude. Even though built-up increased at lower altitudes, other land covers such as waterbody and agriculture increased over the same time. Paudyal *et al.* (2019) also found a similar trend as reported in other studies conducted in Nepal where forest area increased with built-up. Similar trends have been observed in other places, including (Ishtiaque, 2017; Bhawana *et al.*, 2017 and Rai *et al.*, 2017).

Overall accuracy and Kappa statistics

For the supervised image classification of 1999 to 2019 images, the overall accuracies were 83.00% (1999), 86.84% (2009), and 87.42% (2019) respectively while the kappa statistics were 0.77 (1999), 0.83 (2009), and 0.84 (2019) respectively (Table 8). Kappa statistics are used here to check the accuracy of the classification measured. The user's and producer's accuracy were also calculated. The value for the user's and producer's accuracy of the LULC maps for each year and each LULC class are presented in Figure 4. The increasing trend of built-up land at a rapid rate is mainly due to the population increase in recent years; national census results (Table 9) show that the total population of the district was recorded as 417891 (2.26%) in 1991 which increased to 775709 (4.63%) in 2011 (Pathak and Lamichhane, 2014). The main cause of an increase in population is population growth and internal migration. Kailali district is classified as highly urbanized with about 4.63% of the total population of the far-west region. Such rapidly increased population within the region has mainly been due to rural to urban migration. Population density is continuously increased from 129 (Person/sq. Km) in 1991 to 224 (Person/sq. Km) in 2011 (CBS, 2014). Among all of these changes, a positive change was that the area of forest cover within this watershed was increased by 13.48% (Table 4). The increase of forest cover within the watershed was due to the initiation for Rastrapati Chure conservation program where, the tenth plan of the Chure conservation program was the implementation of massive forest and conservation of soil in the Chure watershed to reduce the natural calamities of landslide, flooding and increase the forest soil fertility and forest cover. The Ministry of Forests and Soil Conservation of Government of Nepal also implemented the biodiversity sector program for the Siwalik and Terai region of the country that has the aim of producing an equitable distribution of forest products and revenues by maintaining ecological balance through biodiversity conservation.

Table 9. Population and average annual growth rates between 1991 and 2011.

Year	Population	Percent	Average annual growth rate (%)
1991	417891	2.26	
2001	616697	2.66	3.89
2011	775709	2.93	2.29

Conclusion

This study assessed LULC change analysis in the Mohana watershed based on remote sensing imagery using Landsat-5 (TM), Landsat-7(ETM$^+$), and Landsat-8 (OLI) data from 1999 to 2019. The result of this study reveals the detection of different types of changes with the time series of maps. Based on LULC mapping and analyzing the trends of changes within watersheds it was observed that LULC change trends varied significantly during the periods mentioned above. The results showed that from the period 1999 – 2019, most of the agriculture and barren land were converted into the built-up area. This indicates that expansion of the built-up area was due to the rapid migration of people from the Mountains and Hill regions and the construction of building materials into the low-lying Terai region that accelerates the pressure in the cultivation area of the watershed. So, the prepared map for this study might support local as well as national reporting, and the analyzed land use land cover dynamics may support land-use planners during decision-making process to reduce this drastic land cover change in this watershed of Kailali district.

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Conflicts of interest

The authors have no conflicts of interest to declare that are relevant to the content of this article.

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