Original Research Article

Land Use and ~~Land~~ Cover Change Detection Using Satellite Data RS & GIS, A case study of Sawangi watershed of Yavatmal district, Maharashtra

ABSTRACT

Land cover is a physical appearance of land and represents its ecological status. It is dynamically changed due to human intervention, natural disturbance and succession. This research extent of such changes needs to be known for better land use planning decisions.Land use/land cover changes during the period of 2008 to 2017. Geographical Information System (GIS) and remote sensing were used to determine the changes based on date series of Landsat satellite imagery in Sawangi watershed of Yavatmal district, Maharashtra. The comparison of each class of study over these years showed a significant change in land use and land cover. The result showed that there was a high increase of 5 (five) land cover types, namely: current fallows(12.5 %), wasteland (2.34 %), habitation (0.07 %), industrial area(0.23 %) and water bodies (0.36 %). While, there was a decrease of 3 (three) land cover types, namely: agriculture (12.7 %), shrub land (2.77 %), and forest (09 %). These findings will help in deciding land use policy for future in the watershed.

Key words: Land use ~~land~~ andcover, geospatial techniques, remote sensing, GIS, Change Detection

1. INTRODUCTION

Information on land use/land cover (LULC) in the form of maps and statistical data is very vital for spatial planning, management and utilization of land for agriculture, forestry, pasture, industrial, environmental studies, economic production etc. (Roy and Giriraj, 2008). LULC changes refer to (quantitative) changes in the areal extent (increases or decreases) of a given type of land use and land cover respectively. Land use/land cover change (LUCC) is the major underlying cause of global environmental change (Sala, 2000). Present land use practices are more focused on satisfying short-term supply needs for a growing population without considering the long-term loss in ecosystem services and environmental damage. A change in land use is one of the nine planetary boundaries, and humanity may soon approach the boundary that jeopardizes the safe operating space for humanity with respect to the earth system process (Rockstrom *et al.* 2009). The Bhuman-dominationmodel (land transformation, biotic addition, and losses) alters the earth's bio-geochemistry and influences climate change, resulting in a loss of biological diversity (Ojima *et al.* 1994; Vitousek*et al.* 1997).

Rapid development and population increase of an area require more land and space. Thus, land cover change is unavoidable. Land cover is a combination of various factors created by natural and human beings, includingvarious vegetative zones, ecosystems, soil (soil types and uses), glaciers, bodies of water, wetlands and anthropogenic activities~~vegetation, soil, glaciers, lakes, wetlands and a variety of buildings~~. Land cover indicates an ecological status and physical appearance of the land surface, which may change due to human interventions, natural disasters and plant succession. In many cases, land use change may not significantly change the land cover condition. For example, allocation of degraded area as protection forest will not automatically change the land cover into forest area. Land cover change can be classified into two categories, namely a) conversion into different category b) modification within the same category for example from primary forest into secondary forest. Estimation of land cover change at local scale from a global study is challenging, in fact a local study of a country often yields a different result due to different method and land classification. Human activities have been the major cause of land cover change that will halt at a certain point when no possible change can be made in the landscape (CITE).

Remotely sensed imagery has been widely used for detecting LULC changes. Among others, Weng (2002) and Berlanga-Robles and Ruiz-Luna(2011) investigated land use change dynamics in the Zhujiang Delta south China and the Northern Coastal Region of Nayarit, Mexico, respectively using satellite imagery, GIS and stochastic modelling technologies;~~ and~~ they concluded that the integration of satellite data and GIS is an

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Perhaps the following could be better:
Land cover is created by the combination of various natural and human factors.

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Naturally, it is true, the change would not be significant, but the use of soil and vegetation depends a lot on anthropogenic activity.

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effective approach for ~~analysing~~analyzing the direction, rate and spatial pattern of land use change.

Chauhan and Nayak (YEAR), adopted multi-temporal satellite data to monitor LULC changes in the Hazira Area, India and they found that remote sensing and GIS can provide a better understanding of LULC change patterns. Dewan and Yamaguchi (YEAR), used multi-temporal satellite data and topographic maps to detect LULC changes in Dhaka Metropolitan, Bangladesh from 1960 to 2005 and they argued that multi-temporal satellite data is useful tool for sustainable land management and policy makings. Vitte*ket al.* (YEAR)~~k, Brink~~ examined land cover changes occurring between 1975 and 1990 in West Africa using systematic sample of satellite imagery and they concluded that satellite images can provide valuable information regarding to land cover change.

2. MATERIAL AND METHODS

Study area

The Sawangi watershed area is located between ~~20o~~ 20°15' 47" to 20o 20' 42" N latitude and ~~77o~~ 77°35' 27" to 77o 42' 54" E longitude, The elevation ranges from 161 to 356 m (WGS 84 datum) above mean sea level (AMSL)~~.~~ which covers an area of 11777.62 ha in Yavatmal district, Maharashtra. The average annual rainfall of 917.36 mm (decennial average of 2008-2017), out of which maximum rainfall (85.95 per cent) is received during rainy season (late June to October) and 3.14 per cent during winter (December to February). The climate is mainly hot moist to semiarid type with annual mean maximum and minimum temperatures of 33.8 °C~~oC~~and 23.31°C~~oC~~respectively. Soil moisture regime is ustic and hyperthermic soil temperature regime (Soil Survey Staff 2014). The geology of the study area is covered by Deccan trap formation known as basalt flows, which belongs to Sahyadri group of Ajanta and Chikhli formations. (District Resource Map, Yavatmal District, Maharashtra of Geological survey of India, 2001). In ~~T~~these areas crops~~growing are mostly under~~ such as cotton, soybean, pigeon pea, sorghum, gram, wheat, and vegetables.The basalt flows are generally dark grey, massive, fine to medium grained and non to moderately porphyritic with few flows of highly porphyritic nature (District

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Resource Map, Yavatmal District, Maharashtra of Geological survey of India, 2001). The recent alluvium occurs in the river valley. The basalt of the area is mainly of two types,*viz*., ~~massive~~massive, and vesicular basalt. The vesicular basalts are filled up with secondary minerals like silica, zeolite and calcite.

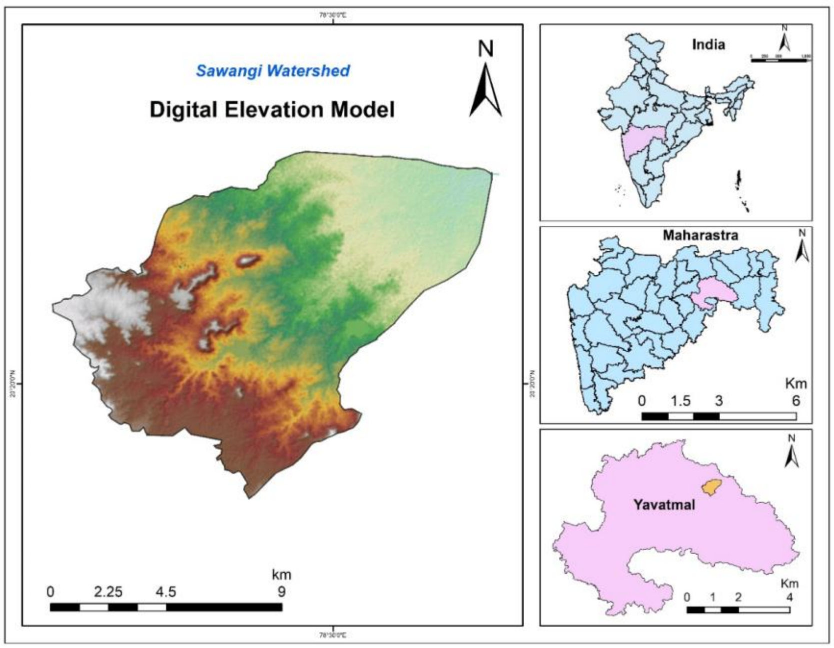

Fig.1 Location map of Sawangi watershed. Source: …..

Data collection

Satellite data, physical data and ancillary data were used in the present study. Physical data included cadastral map of each village in the watershed and revenue records of land holdings, crops grown during the preceding year (2016-17), population details etc. Survey of India (SOI) toposheet on 1:50,000 scale (55 H/13) was used to collect topographical information. This toposheet was used as base map for location of sample areas, ground truth sites and planning for traverse routes in the field and other details.

Ancillary data included ground truthing for the land cover/use classes and topographic maps. The ground truth data were in the form of reference data points collected using Geographical Positioning System (GPS). Satellite data for the three different years on the other hand consisted of multi-spectral data acquired by Landsat satellite for the month of February - April provided by USGS glovis. Specifications of the satellite data acquired for change analysis are given in Table 1.

Table 1 Details of remote sensing data used in the present study.

S. NO.	Satellite Sensors	Resolution (m)	Month of acquisition	Image Type
1.	LANDSAT- 5 (TM)	30m	March 2008	Level-1 GeoTIFF
2.	LANDSAT-5 (TM)	30m	February 2012	Level-1 GeoTIFF
3.	LANDSAT-8 (OLI)	30m	February 2017	Level-1 GeoTIFF

Table 2. Data source used for the study.

Data	Source
• Digital Elevation Model (30 m resolution)	United States Geological Survey
• Satellite Sentinel – 2 (10 m resolution)	European Space Agency
• Soil data on 1:50000K	National Bureau Soil Survey and Land Use Planning
• Geomorphology on 1:50000 K	Maharashtra Remote Sensing Application Centre
• Satellite image	Google Earth

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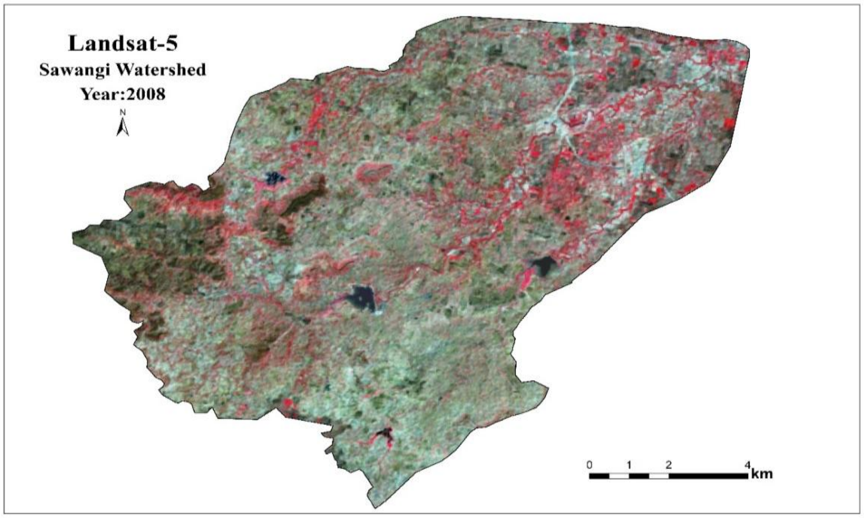

Fig. 2 Satellite data of Sawangi watershed (2008)

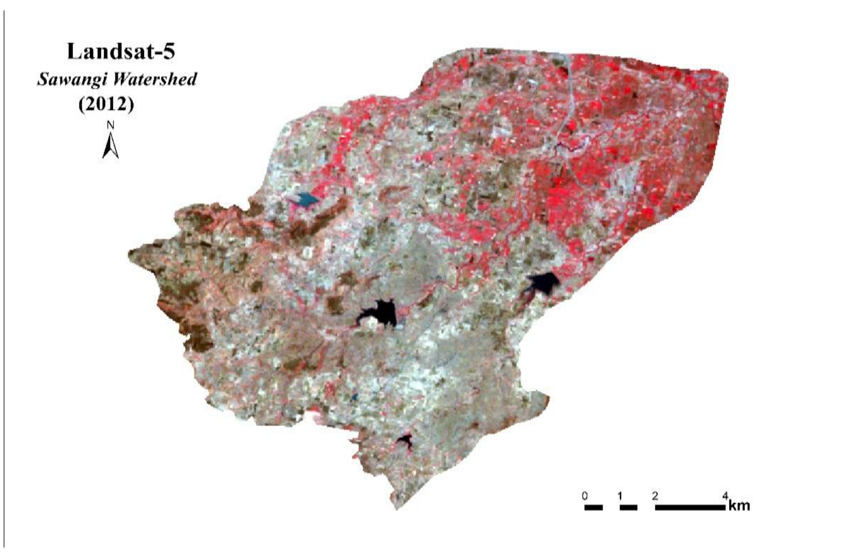

Fig. 3 Satellite data of Sawangi watershed (2012)

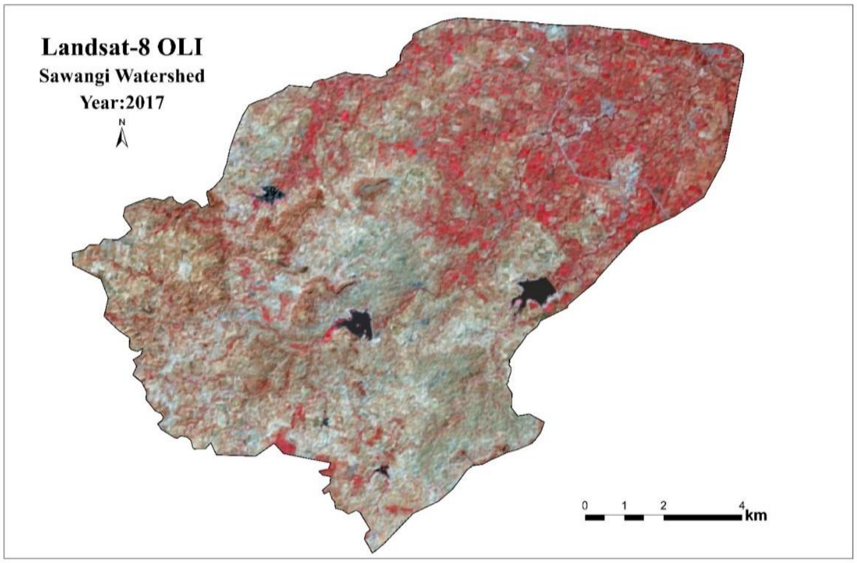

Fig. 4 Satellite data of Sawangi watershed (2017)

Data used in this research comprised three cloud-free Landsat (TM-5 and OLI-8) images, which were collected on March 2008, February-2012 andMarch2017. All three images were obtained from the USGS Earth Explorer Landsat archive and geometrically corrected and rectified to UTM zone 49. Were used for visual interpretation ~~in order to~~to assess the classification process. The standard false colour composite (FCC) was generated by bands 2,3 and 4 using arc GIS software (version). Satellite images of the area are shown in ~~fig~~Figure ~~.~~2, ~~fig.~~ 3, ~~& Fig~~and~~.~~4. The details of the imagery used in investigation are given in the Table 2.

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The soil data at 1:10000 scale collected through detailed survey were used for hydrological grouping and overlaid. The effect of LULC changes based on ground truth data and visual interpretation.

Accuracy Assessment

In general, the accuracy assessment determines the quality level of information extracted from remotely sensed data. Classification accuracy refers to the rate of correspondence between the remotely sensed data and reference information. A common method for accuracy assessment is through the use of an error matrix which provides detailed information of the agreement between the classification results and reference information. Additionally, accuracy assessments such as overall accuracy, producer's accuracy, user's accuracy and overall kappa coefficient were carried out using the error matrices. Equation was used to compute the kappa coefficient:

Table 3. Land use land cover classes description

Sr. No.	Class name	Description
1	Agriculture	Crop fields
2	F~~f~~allow lands	Current fallow lands
3	Forest cover	Mixed forest lands
4	Wasteland Land	Land areas of exposed soil and barren area due to anthropogenic influence
5	Habitation	Residential, commercial, industrial
6	Water body	River, open water, lakes, ponds and reservoirs

3. RESULTS AND DISCUSSION

Land use / land cover distribution

LULC classes were identified and delineated by visual interpretation, ~~Landset~~Landsat-5 and ~~Landset~~Landsat-8 satellite images. The delineated classes were agriculture, current fallow, habitation, forest cover, shrubland, wasteland, industrial area and waterbody. The area under different land use/land cover classes with image characteristics are presented in (Table 4). The Sawangi watershed is classified in which LULC maps were generated for different years 2008, 2012, and 2017 using satellite data at 1:50,000 scale andshowed Figure~~.~~5, 6, 7, 8, 9&10.The distribution of various LULC classes and their area statistics was calculated using maps which are showed Table 5.

Table 4 Land use / land cover distribution (2008, 2012 & 2017)

LULC class	2008		2012		2017	
	Area (ha.)	**Area (%)**	**Area (ha.)**	**Area (%)**	**Area (ha.)**	**Area (%)**
Agriculture land	5926.46	50.32	5347.59	45.40	4436.5	37.67
Current fallows	1510.40	12.82	2144.88	18.21	2983.0	25.33
Wasteland	2292.12	19.46	2390.72	20.30	2567.1	20.80
Shrub land	1272.90	10.81	1002.01	8.51	946.3	8.03
Forest cover	329.45	2.80	320.11	2.72	319.0	2.71
Industrial Area	1.17	0.01	22.27	0.19	28.8	0.25
Habitation	73.37	0.62	75.69	0.64	82.1	0.70
Waterbody	371.75	3.16	474.36	4.03	414.7	3.52
TGA	11777.62	100	11777.62	100	11777.6	100

The LULC of Sawangi watershed is dominated by agriculture, wasteland, and current fallows landsof the total geographical area of the watershed. The investigated results showed that wasteland, ~~habitation~~habitation, and industrial area increased continuously between 2008 to 2017, while forest land and shrubland which is a forest degradation class has been decreased continuously between 2008 to 2017. The current fallows land has continuously increased between 2008 to 2017. The agriculture land has been decreased continuously between 2008 to 2017.

The land use and land cover change comparison of each class over different years was presented in Table 5. During the year of 2008 to 2017 area under agriculture, class decreased by 1489.93 ha (12.65%). The decline of agriculture class in the watershed area was due to construction mainly by an industrial area and habitation and the area around the water bodies in the watershed has shifted from a wasteland into an agricultural area. During the 2008 to 2017 area under fallow land class increased by 1472.63 ha (12.50%).

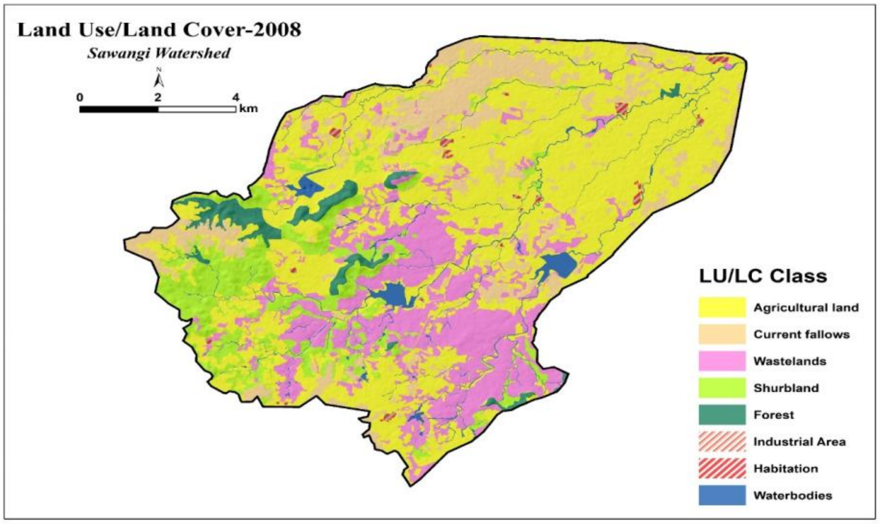

Fig 5 LULC of Sawangi watershed in year 2008

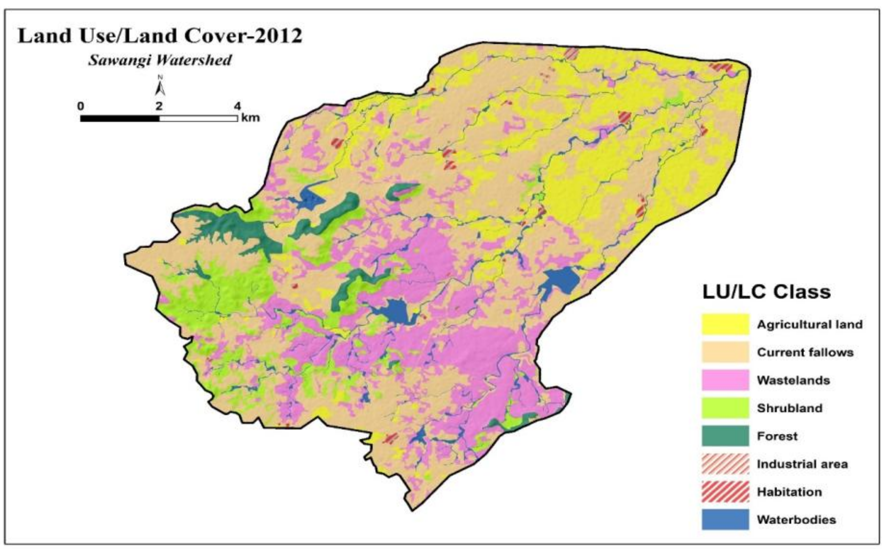

Fig 6 LULC of Sawangi watershed in year 2012

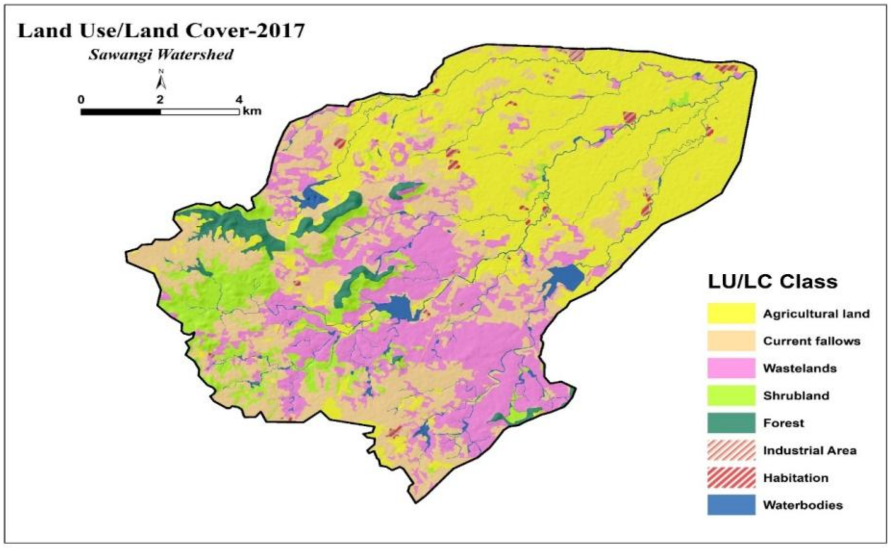

Fig 7 LULC of Sawangi watershed in year 2017

Table 5 LULC change detection

LULC class	2008-2012		2012-2017		2008-2017	
	Area (ha)	(%) Change	Area (ha)	(%) Change	Area (ha)	(%) Change
Agriculture	-578.88	-4.9	-911.06	-7.7	-1489.93	-12.7
Current fallows	634.48	5.4	838.15	7.1	1472.63	12.5
Wasteland	98.60	0.84	176.42	1.50	275.02	2.34
Shrub land	-270.89	-2.30	-55.70	-0.47	-326.58	-2.77
Forest	-9.34	-0.08	-1.08	-0.01	-10.42	-0.09
Industrial Area	21.10	0.18	6.56	0.06	27.66	0.23
Habitation	2.31	0.02	6.39	0.05	8.70	0.07
Waterbody	102.61	0.87	-59.68	-0.51	42.93	0.36

The decline of fallow land class in the watershed area was due to converted of fallow land into industrial areas and wasteland. It has also been seen in the study area that the industrial or habitation areas are mostly surrounded by agricultural areas, especially in the catchment area. it means that the area near the residential area has been cleared for the production of crops in order to fulfill the necessities of life. During the field survey, it was observed by the investigation that wastelands around the villages have also been utilized under cultivation land.

It was observed by ground truthing from 2008 to 2017 that some of the forest and shrubland areas were decreased by 10.42 ha and 326.58 ha, which was shifted into cultivated lands due to encroachment by the farmers and habitation. while during 2008 to 2017 that some of the habitation and industrial areas increased by 8.70 ha and 27.66 ha. This was attributed to population growth and increased housing requirements by the people of the study area. The classification results revealed that the wasteland area increased by 275.02 ha from 2008 to 2017. The increase of wasteland in the watershed area was due to converted of fallow land and shrubland into the wasteland. Water bodies area 42.93 ha increased from 2008 to 2017 and decreasing by 59.68 ha from 2012 to 2017.

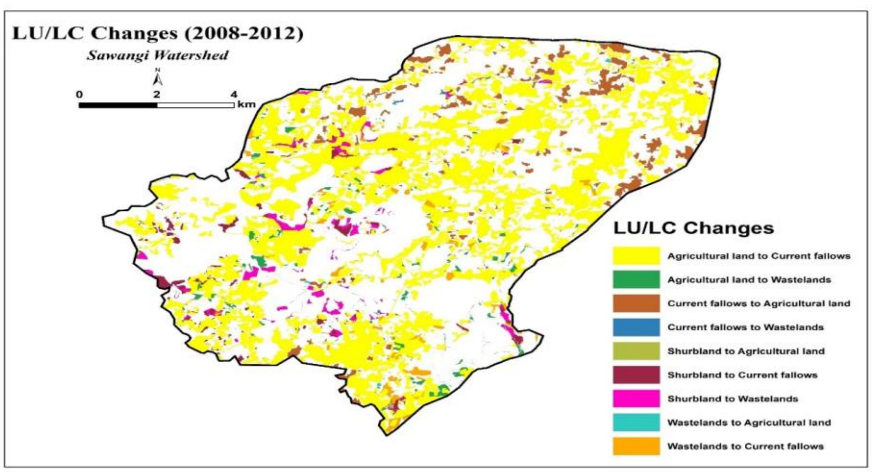

Fig. 8 LULC changes in Sawangi watershed (2008-12)

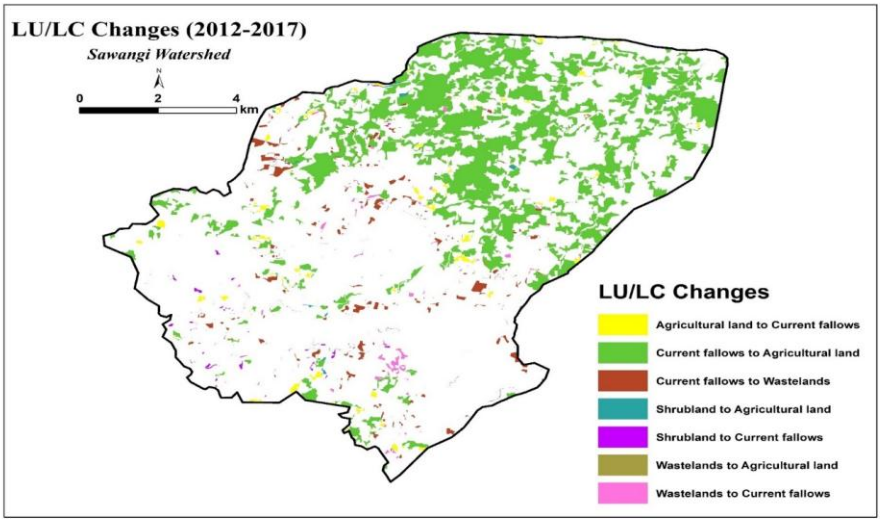

Fig. 9 LULC changes in the Sawangi watershed (2012-17)

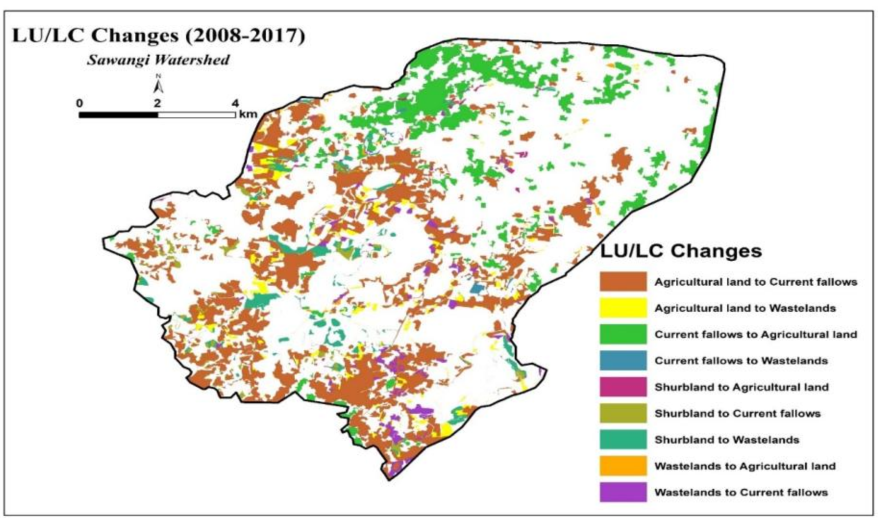

Fig. 10 LULC changes in the Sawangi watershed (2008-17)

4. CONCLUSIONS

This study assessed LULC changes and the dynamics based on the results obtained by employment of GIS and RS tools for LULC change detection, The results can be summarized were found to have experienced rapid changes in LULC from 2008 to 2017. that the land use /land and cover practices in the study area have altered significantly in 10 years. The agriculture areas decreased by approximately 1489.93 ha (12.7%) in watershed.The expansion of the agriculture landover the study area exhibited clear spatiotemporal differences due to increasing fallow land areas.

In summary, information provided by satellite remote sensing data, along with ancillary data such as population data, can play a significant role in quantifying and understanding the relationship between population density and LULC changes. Furthermore, researching the nature of land use land cover changes can be aided and developed by analyzing the satellite data, such as, Landsat images can provide the rate, patterns and trend of changes using the benefit of repetitive satellite coverage on a particular locality. Such information is essential for further land use planning in the future.

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