

1 *Original Research Article*

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

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Comment [NS1]: -The title needs to be modified or revised to read as "Land Use and Land Cover Change Detection in Sawangi watershed of Yavatmal district, Maharashtra"

6 **ABSTRACT**

Comment [NS2]: Abstract:
-The main objective/aim is quite unclear. Authors give a hint or attempts to highlight the main aim in the second sentence or lines (8-9).

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

Comment [NS3]: -Kindly connect the highlighted line to another sentence as it looks quite ambiguous and seems to be left alone.

20 **Key words:** Land use land cover, ~~geospatial techniques,~~ remote sensing, GIS, Change
21 Detection, ...

Comment [NS4]: -Kindly rewrite or rephrase this line or the concluding sentence to highlight the contribution or relevance of study findings to the international scientific community and industrial players.

Comment [NS5]: **Keywords:** You can preferably add the country or region to give the paper more audience.

22 **1. INTRODUCTION**

23 Information on land use/land cover (LULC) in the form of maps and statistical
24 data is very vital for spatial planning, management and utilization of land for agriculture,
25 forestry, pasture, industrial, environmental studies, economic production etc. (Roy and
26 Giriraj, 2008). LULC changes refer to (quantitative) changes in the areal extent (increases
27 or decreases) of a given type of land use and land cover respectively, ~~source???~~. Land

Comment [NS6]: **Introduction:**
-Authors are advised to revise or use more current literature that spans 5-10 years back. Old studies can be used where necessary.

Comment [NS7]: Kindly indicate the source

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28 use/land cover change (LUCC) is the major underlying cause of global environmental
29 change (Sala 2000). Present land use practices are more focused on satisfying short-term
30 supply needs for a growing population without considering the long-term loss in ecosystem
31 services and environmental damage. A change in land use is one of the nine planetary
32 boundaries^Δ, and humanity may soon approach the boundary that jeopardizes the safe
33 operating space for humanity with respect to the earth system process (Rockstrom *et al.*
34 2009). The Bhuman-dominationmodel (land transformation, biotic addition, and losses)
35 alters the earth's bio-geochemistry and influences climate change, resulting in a loss of
36 biological diversity (Ojima *et al.* 1994; Vitousek *et al.* 1997).

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

51 Remotely sensed imagery has been widely used for detecting LULC changes.
52 Among others, Weng and Berlanga-Robles and Ruiz-Luna investigated land use change
53 dynamics in the Zhujiang Delta south China and the Northern Coastal Region of Nayarit,
54 Mexico respectively using satellite imagery, GIS and stochastic modelling technologies and
55 they concluded that the integration of satellite data and GIS is an effective approach for
56 analysing the direction, rate and spatial pattern of land use change. Chauhan and

Comment [NS8]: -Authors can integrate some guiding concepts or standardized theories to improve the introduction. Kindly refer to Sarfo *et al.* studies on such concepts and driving mechanisms of land use cover change.

Comment [NS9]: Kindly consider enriching the literature or introductory section with these current literatures/studies by Sarfo *et al.*:

-Sarfo, I., Shuoben, B., Beibei, L. *et al.* (2022). Spatiotemporal development of land use systems, influences and climate variability in Southwestern Ghana (1970–2020). *Environ Dev Sustain* **24**, 9851–9883 (2022). <https://doi.org/10.1007/s10668-021-01848-5>

-Sarfo, I., Shuoben, B., Otchwemah, H.B. *et al.* (2022). Validating local drivers influencing land use cover change in Southwestern Ghana: a mixed-method approach. *Environ Earth Sci* **81**, 367 (2022). <https://doi.org/10.1007/s12665-022-10481-y>

-Sarfo, I., Bi, S., Kwang, C. *et al.* (2023). Class dynamics and relationship between land-use systems and surface temperature in south-eastern Ghana. *Environ Earth Sci* **82**, 104 (2023). <https://doi.org/10.1007/s12665-023-10755-z>

Comment [NS10]: -Lines 52-56 need to be cited appropriately.

-The research progress or what's known about the topic is too shallow. Authors need to expand it to appreciate what's known and what's unknown, but important to be studied.

57 Nayak, adopted multi-temporal satellite data to monitor LULC changes in the Hazira Area,
58 India and they found that remote sensing and GIS can provide a better understanding of
59 LULC change patterns. Dewan and Yamaguchi, used multi-temporal satellite data and
60 topographic maps to detect LULC changes in Dhaka Metropolitan, Bangladesh from 1960
61 to 2005 and they argued that multi-temporal satellite data is useful tool for sustainable land
62 management and policy makings. Vittek, Brink examined land cover changes occurring
63 between 1975 and 1990 in West Africa using systematic sample of satellite imagery and
64 they concluded that satellite images can provide valuable information regarding to land
65 cover change.

66 2. MATERIAL AND METHODS

67 Study area

68 The Sawangi watershed area is located between 20° 15' 47" to 20° 20' 42" N
69 latitude and 77° 35' 27" to 77° 42' 54" E longitude. The elevation ranges from 161 to 356
70 m (WGS 84 datum) above mean sea level (MSL). which covers an area of 11777.62 ha in
71 Yavatmal district, Maharashtra. The average annual rainfall of 917.36 mm (decennial
72 average of 2008-2017), out of which maximum rainfall (85.95 per cent) is received during
73 rainy season (late June to October) and 3.14 per cent during winter (December to
74 February). The climate is mainly hot moist to semiarid type with annual mean maximum
75 and minimum temperatures of 33.8 °C and 23.31 °C respectively. Soil moisture regime is
76 ustic and hyperthermic soil temperature regime (Soil Survey Staff 2014). The geology of
77 the study area is covered by Deccan trap formation known as basalt flows, which belongs
78 to Sahyadri group of Ajanta and Chikhli formations. (District Resource Map, Yavatmal
79 District, Maharashtra of Geological survey of India, 2001). These areas crops growing are
80 mostly under cotton, soybean, pigeon pea, sorghum, gram, wheat, and vegetables. The
81 basalt flows are generally dark grey, massive, fine to medium grained and non to
82 moderately porphyritic with few flows of highly porphyritic nature (District Resource Map,
83 Yavatmal District, Maharashtra of Geological survey of India, 2001). The recent alluvium
84 occurs in the river valley. The basalt of the area is mainly of two types viz., massive and

Comment [NS11]: -In-text citations are needed for this paragraph.

-Authors need to add one additional paragraph that briefly highlights the contribution or relevance of this study to key players, policy makers, land use strategists and the scientific community, followed by the specific objectives or main aim of the study. These will enhance flow and consistency.

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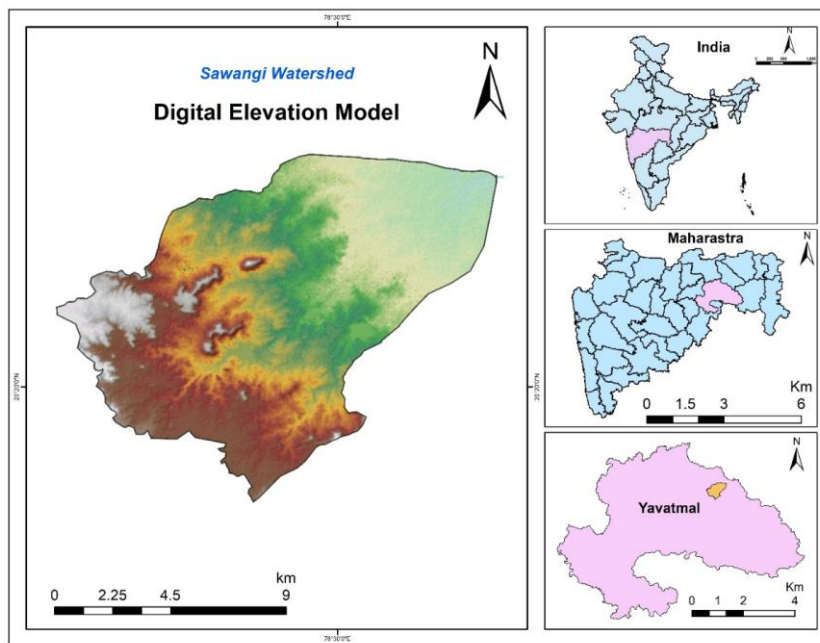
Comment [NS12]: Methodology:
-Authors should check the use of superscripts for the appropriate units/coordinates, and ensure uniformity throughout the manuscript.

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85 vesicular basalt. The vesicular basalts are filled up with secondary minerals like silica,
86 zeolite and calcite.



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88 **Fig.1 Location map of Sawangi watershed**

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90 **Data collection**

91 Satellite data, physical data and ancillary data were used in the present study.
92 Physical data included cadastral map of each village in the watershed and revenue records
93 of land holdings, crops grown during the preceding year (2016-17), population details etc.
94 Survey of India (SOI) toposheet on 1:50,000 scale (55 H/13) was used to collect
95 topographical information. This toposheet was used as base map for location of sample
96 areas, ground truth sites and planning for traverse routes in the field and other details.
97 Ancillary data included ground truthing for the land cover/use classes and topographic
98 maps. The ground truth data were in the form of reference data points collected using

Comment [NS13]: Figure 1:
-Authors are advised to provide a key or legend for this figure which captures DEM and its range for the high and low areas (i.e., elevation range).
-Kindly remove the title "Digital Elevation Model" from the top and place it in the caption under the legend.
-authors could use linking arrows to connect the selected region from the main area

99 Geographical Positioning System (GPS). Satellite data for the three different years on the
 100 other hand consisted of multi-spectral data acquired by Landsat satellite for the month of
 101 February - April provided by USGS glovis. Specifications of the satellite data acquired for
 102 change analysis are given in Table 1.

103 **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

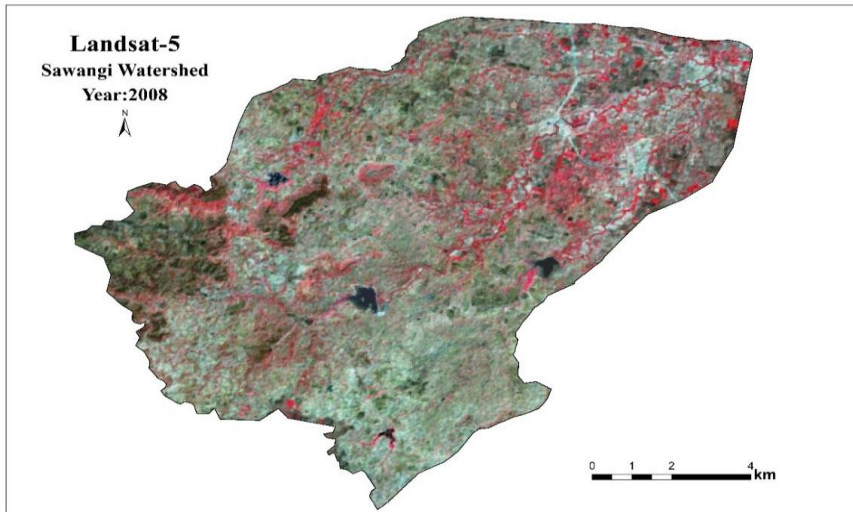
Comment [NS14]: Table 1: Kindly consider adding the path/row details where necessary.

104

105 **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 1:50 K	National Bureau Soil Survey and Land Use Planning
• Geomorphology on 1:50 K	Maharashtra Remote Sensing Application Centre
• Satellite image	Google Earth

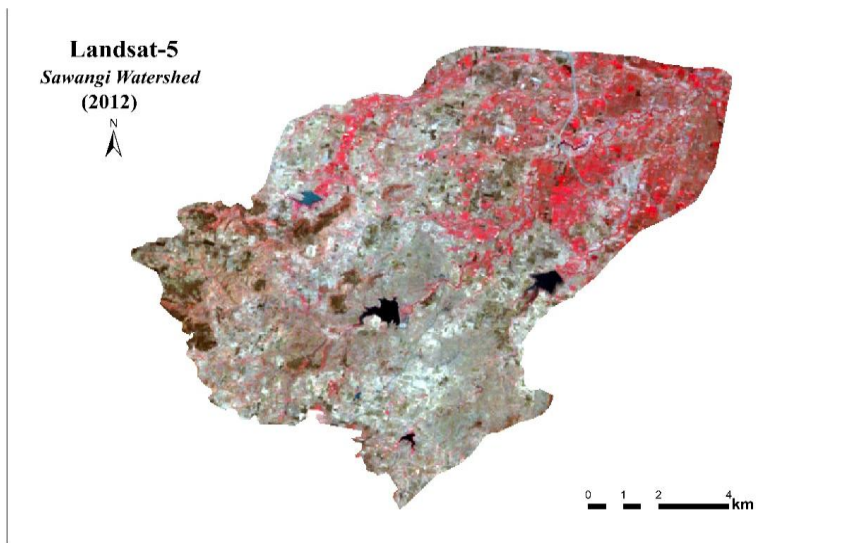
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Fig. 2 Satellite data of Sawangi watershed (2008)



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Fig. 3 Satellite data of Sawangi watershed (2012)

Comment [NS15]: -Figures 2, 3 and 4 using ArcMap layout tab can be merged as one image that presents all these three images/figures with the given years.

-Again, these figures could have one legend to depict or describe the classes or symbology used for each class. Such legend for the classifications is missing and must be included.

-Studies of this nature require a flowchart or workflow that visualizes or maps data acquisition/source of inputs or reference maps, image pre-processing and enhancement, classifications/post-class., accuracy assessments and other forms of analysis performed to help readers navigate easily. Kindly consider designing a flow in that regard to improve the robustness and scientific outlook.

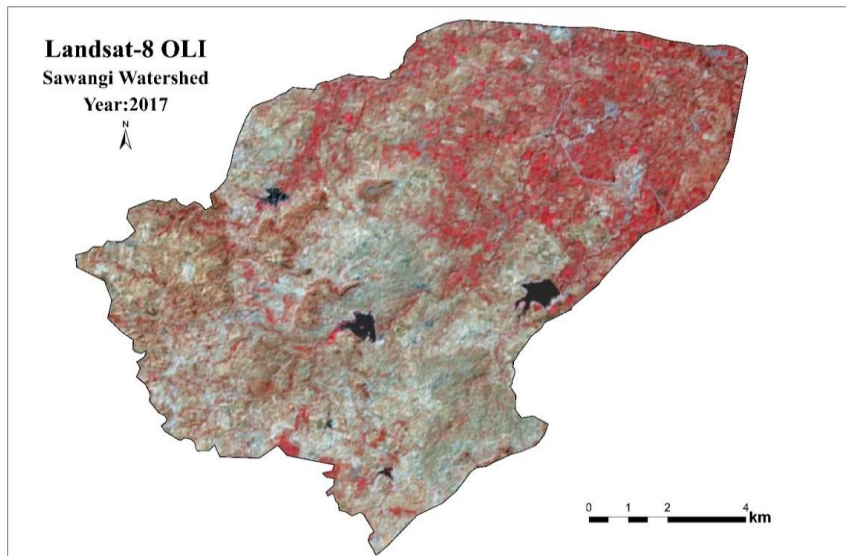


Fig. 4 Satellite data of Sawangi watershed (2017)

Data used in this research comprised three cloud-free Landsat (TM-5 and OLI-8) images, which were collected on March 2008, February-2012 and March 2017. 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 assess the classification process. The standard false colour composite (FCC) was generated by bands 2,3 and 4 using arc GIS software. Satellite images of the area are shown in fig. 2, fig. 3, & Fig. 4. The details of the imagery used in investigation are given in the Table 2.

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.

Data Analysis

Accuracy Assessment

Comment [NS16]: Data analysis

-Since change detection is a key component of this work, it is mandatory or important for authors to integrate expressions used for estimating or quantifying land use changes or rate of change in the area, along with their interpretations.
-Other analysis conducted and the type or version of software used must be given under this section.

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

Comment [NS17]: -The equation or expression used have not been given. Kindly check and ensure the expression, along with the variables and their interpretations are given clearly.

134 **Table 3. Land use land cover classes description**

Sr. No.	Class name	Description
1	Agriculture	Crop fields
2	fallow 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

Comment [NS18]: -Table 3 must be moved upwards or placed close to the imagery descriptions or section where classifications are discussed in the methodology section.

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136 3. RESULTS AND DISCUSSION

137 Land use / land cover distribution

138 LULC classes were identified and delineated by visual interpretation, Landsat-5 and
 139 Landsat-8 satellite images. The delineated classes were agriculture, current fallow,
 140 habitation, forest cover, shrubland, wasteland, industrial area and waterbody. The area
 141 under different land use/land cover classes with image characteristics are presented in
 142 (Table 4). The Sawangi watershed is classified in which LULC maps were generated for
 143 different years 2008, 2012, and 2017 using satellite data at 1:50,000 scale and showed Fig.
 144 5, 6, 7, 8, 9&10. The distribution of various LULC classes and their area statistics was
 145 calculated using maps which are showed presented in Table 5.

Comment [NS19]: -Please ensure all tables or figures are mentioned close to where the figures/tables are first mentioned.

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148 **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

Comment [NS20]: Kindly write this in full before using the abbreviated format.

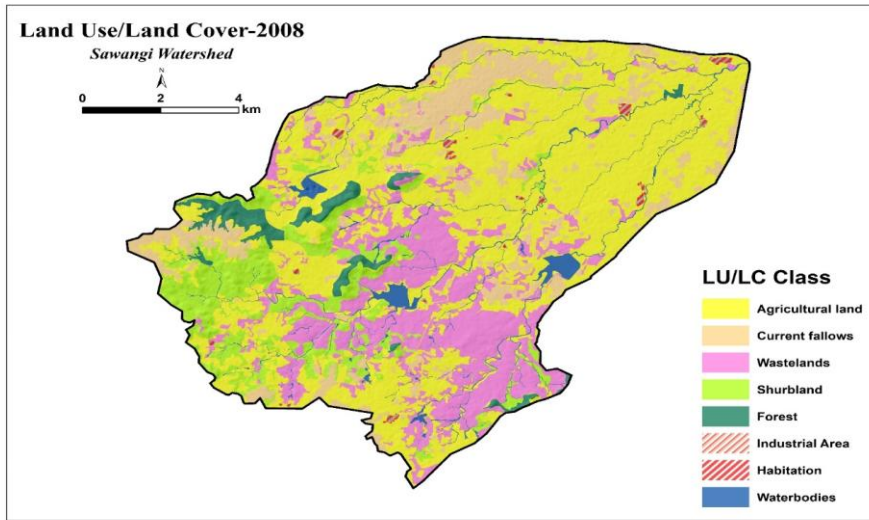
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151 The LULC of Sawangi watershed is dominated by agriculture, wasteland, and
 152 current fallows lands of the total geographical area of the watershed. The investigated
 153 results showed that wasteland, habitation and industrial area increased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

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

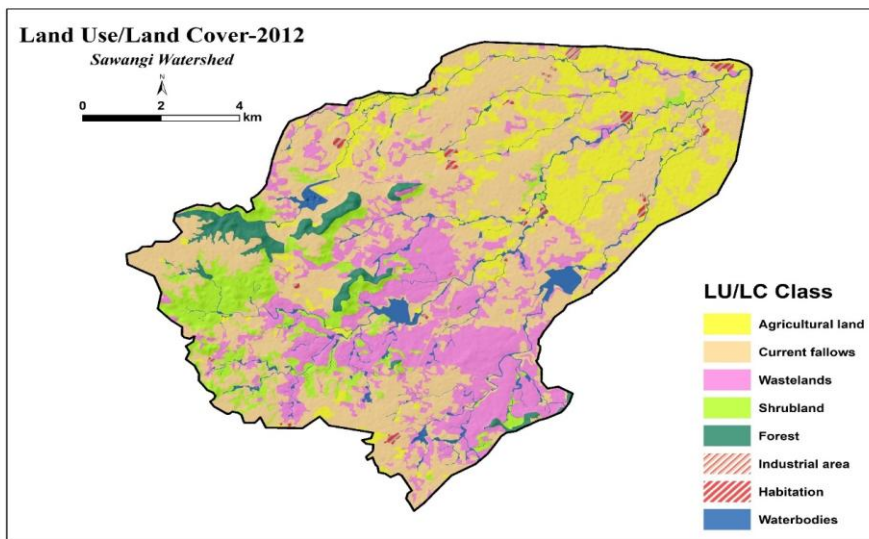
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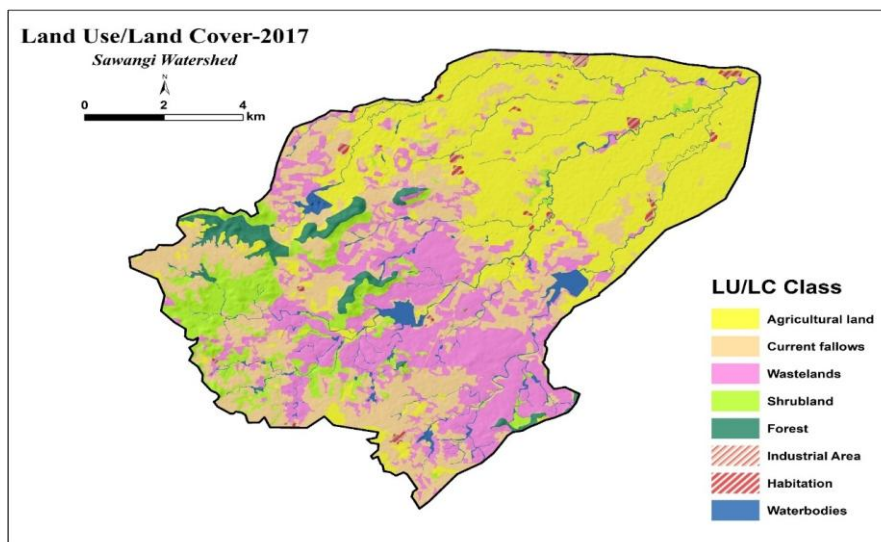
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Fig 5 LULC of Sawangi watershed in year 2008



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Fig 6 LULC of Sawangi watershed in year 2012



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Fig 7 LULC of Sawangi watershed in year 2017

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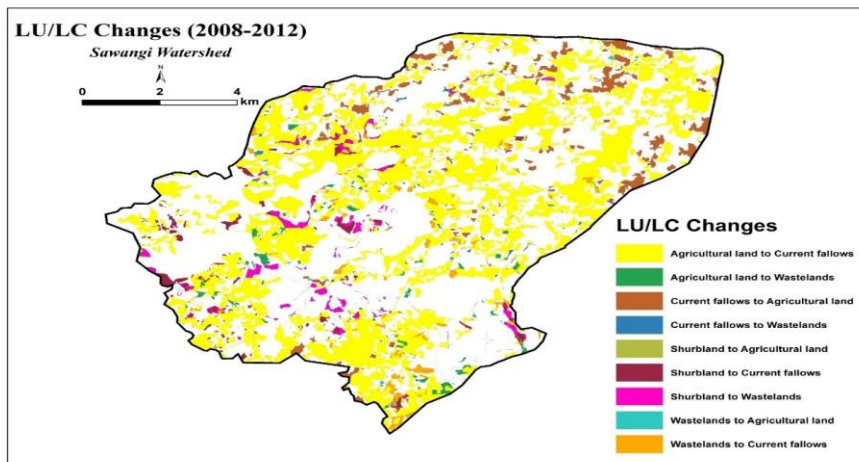
172 Table 5 LULC change detection

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

173

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

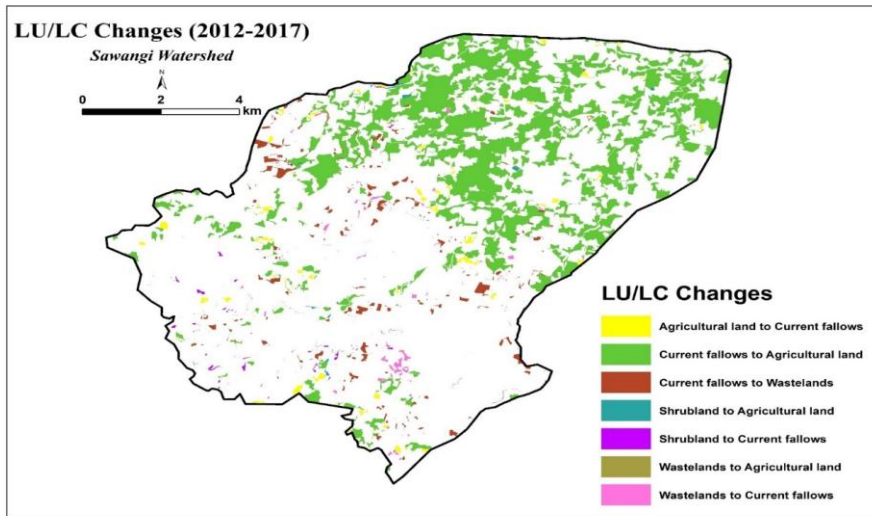
181 It was observed by ground truthing from 2008 to 2017 that some of the forest and
182 shrubland areas were decreased by 10.42 ha and 326.58 ha, which was shifted into
183 cultivated lands due to encroachment by the farmers and habitation. while during 2008 to
184 2017 that some of the habitation and industrial areas increased by 8.70 ha and 27.66 ha.
185 This was attributed to population growth and increased housing requirements by the people
186 of the study area. The classification results revealed that the wasteland area increased by
187 275.02 ha from 2008 to 2017. The increase of wasteland in the watershed area was due to
188 converted of fallow land and shrubland into the wasteland. Water bodies area 42.93 ha
189 increased from 2008 to 2017 and decreasing by 59.68 ha from 2012 to 2017.



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

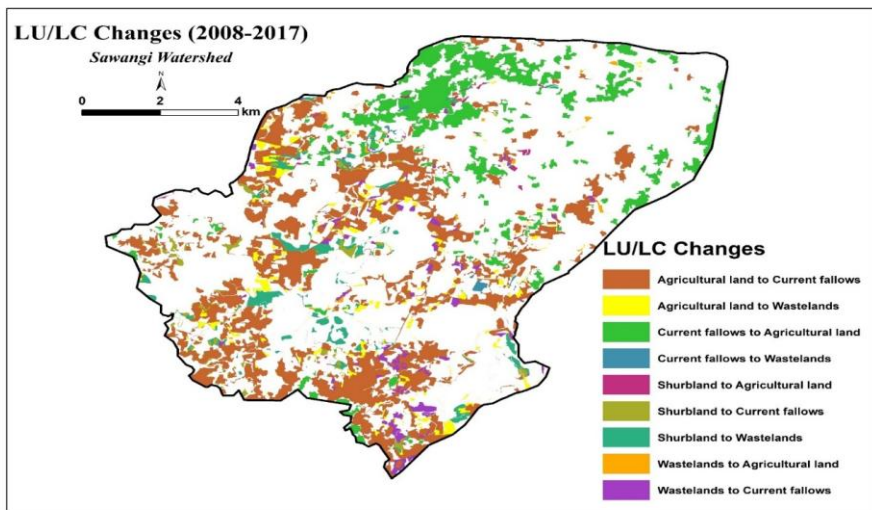


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Fig. 9 LULC changes in the Sawangi watershed (2012-17)

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

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DISCUSSIONS

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4. CONCLUSIONS

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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 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.

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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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5. REFERENCES

219

220

221

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222

223

Anonymous (year??). Annual Report, Cotton Advisory Board & Directorate of Cotton Development, Nagpur, 2018.

Comment [NS21]: Discussions:

-The results of this study need to be discussed in 2-3 pages. Authors need to compare the results of the current study to other studies conducted elsewhere.
-Does the current study agree with other studies conducted elsewhere or highlighted in the research progress given in the introduction? If findings do not agree with other studies, what could be the reasons?

-What are the drivers both domestic and external pressures? Do biophysical factors play a role in land use transitions?

-This section is very important and can be designed or organized in sub-sections with sub-headers to capture the drivers, implications and so on. Sarfo et al. among other similar studies could be helpful.

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Comment [NS22]: Other comments:

-Major grammatical defects and syntax errors were identified throughout the manuscript. Few were corrected/revised. It is suggested that authors check and revise the manuscript thoroughly before resubmission.

Comment [NS23]: References:

-Needs to be revised as some references look out of proportion or incorrect.

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224 Berlanga-Robles, C.A. and Ruiz-Luna, A. 2011. Integrating Remote Sensing
225 Techniques, Geographical Information Systems (GIS), and Stochastic Models for
226 Monitoring Land Use and Land Cover (LULC) Changes in the Northern Coastal Region of
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247 remote sensing and GIS techniques: Solapur district of Maharashtra, India. IJARSG
248 3(1):499-505.

Comment [NS24]: ??

Comment [NS25]: -Provide the appropriate reference for web-based references.

249 Pradeep, C., Bharadwaj, A.K. and Thirumalaivasan, D. 2014. Land use/land cover
250 change detection: a case study of Usilampatti Block, Madurai District, Tamil Nadu.
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