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Monitoring of Landuse /Landcover Changes for the Sub-Basin of Godavari Basin

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Abstract: Land use/land cover mapping and change detection using remote sensing and geographic information system (GIS) technique helps in assessing the land surface information on course scale as well as finer scale. This paper attempts the assessment of land use / land cover changes for the Wainganga Sub-basin which is a part of the Godavari basin. The change detection was done for the last 34 years (1985-2019) and found significant changes during 2005-2019; before that, the changes were not very noticeable. In the last 34 years, the agricultural land was shrunk by 3.20%, while waste cum barren land reduced by 0.20% of the study area. The shrunk part of agricultural land converted into forest, built-up and urban, and water bodies. The built-up expanded and variation in that period was 106% with respect to the base period.

Keywords: Land use/land cover, Remote sensing, GIS, Classification, Change detection, Wainganga Sub-basin

Land use and land cover (LULC) is a significant component to understand the connections of human activities with the environment, therefore, it is necessary to simulate changes (Prakasam 2010). In developing countries, the increasing impact of climate change and LULC changes are likely to be severe due to poor adaptability. The LULC also plays a vital role in meteorology and hydrology, and this is a crucial factor in the environmental alteration process taking place over the globe these days (Agaton et al 2016). Historical and pinpoint details of LULC are a supporting tool for the sustainable development program; it provides a better understanding plus solutions to overcome social, economic and environmental problems. LULC and hydrology have a complex association, incorporating an extensive range of surface-vegetation-atmosphere interactions at varying spatial and temporal scales. Hydrological processes like evapotranspiration (ET), groundwater recharge, base flow, and overland flow, consider the LULC as a driver (Garg et al 2017). For watershed planning and management, profound knowledge of the study area, magnitude and the factors which affect the LULC of a watershed is required. Yirsaw et al (2017) observed LULC changes and employed many remote sensing, GIS tools and used imagery to detect and monitor the changes. NDVI was also used to identify land cover mainly determine the vegetation cover (Lunetta et al 2006). McGinn et al (2021) interlinked the changes in LULC with the water resources of Myanmar. Panandiker et al (2020) analyzed the LULC change for Sal watershed Goa and linked it with the future climate change projection to assess the future streamflow. There are two ways to obtain data for LULC classification viz. satellite or aerial images. Satellite imagery is the most popular data source to analyze the alteration in LULC and their quantification because of its higher temporal resolution, a compatible data format for computer processing, and a precise geo-coding system. Remote sensing offers an economical and time-saving way to assess the Earth's information on a large spatial and finer temporal scale. These remote sensing imageries can be accessed any time for the past and existing time (McGinn et al 2021). Chen et al (2003) used Improved Change-Vector Analysis for land cover detection and observed good potential in LULC monitoring over the other methods. Since, real-time studies on LULC changes using remote sensing and GIS have not been done extensively for Wainganga sub-basin (Fig. 1), the present study focuses on identifying the changes in LULC during the last three decades (1985-2019) over the sub-basin.

MATERIAL AND METHODS

The present study classified decadal LULC from 1985 to 2019 in the GIS environment (Fig. 2). For 1985, 1995 and 2005, open-source decadal LULC (Roy et al 2016) was used, while for the LULC map of 2019, Landsat8 satellite imageries were used. The decadal LULC map, as well as LULC of 2019, has a 30m x 30m spatial resolution. The Wainganga sub-basin covers the seven tiles of the above satellite imagery. LULC was classified into five major classes viz. built-up, agricultural land, waste cum barren land, forest and waterbody.

Image pre-processing: LULC change detection essentially requires the pre-processing of a satellite image (El-Kawyet al 2011). In the present study, layer stacking image processing operations were considered to merge all seven satellite imageries.

Supervised classification: The ENVI software was used to process the set of Landsat imageries. Training samples were designated for each of the predetermined LULC classes by demarcating ROI (region of interest) around characteristic sites. The spectral signatures for the respective land cover types recorded by the satellite images were derived by the pixels encircled by this ROI, a spectral signature is considered to be acceptable when misperception among the land covers to be mapped [is]minimal' (Gao and Liu 2010). When obtained spectral signature was acceptable and go for the classification process. In the present study, the supervised maximum likelihood method was used for the classification. Supervised classification generates a thematic raster layer (the classified image) and a distance file. Both the thematic layer and the distance file were used for post-classification thresholding.

Accuracy assessment: Accuracy assessment necessitates that a sufficient quantity of samples per map class be gathered when the classified outcomes are compared with actual ground conditions (Kafi et al 2014). It was obtained by dividing the total number of correctly classified pixels by the total number of reference pixels.

Change detection: The identification of differences in the state of an object or phenomenon by observing it at different times is known as Change detection (Saini et al 2019). It describes the changes in the same image of different times. This type of analysis is helpful to recognize various variations appearing in different classes of land use land cover i.e. increase in land-use area or decrease in land cover.

RESULTS AND DISCUSSION

Land use land cover change detection for Wainganga sub-basin: The five LULC classes were produced, including agricultural land, forest, built-up and urban, waste cum barren land, and waterbodies. Inside the Wainganga basin, major part of the area is used for agricultural activities followed by forest having highest physical appearance. To investigate the changes in the study area, LULC map of 1985, 1995 and 2005 was taken from earth data, while Landsat-8 imageries were used to prepare the LULC of 2019. The Accuracy assessment was done in the ENVI software and the report of LULC 2019 (Table 1). The spatial distribution of different classes over the earth surface in the particular year 1985, 1995, 2005 and 2019 are depicted in Figure 3 to 6.

Decadal Changes in LULC

Changes during 1985-1995: Decadal changes in land cover were detected for the decade 1985-1995 and agricultural land, built-up and Urban, and water bodies are increased in 1995 by 0.53, 0.03 and 0.14%, respectively, of the total study area, while land covered by Forest and Waste cum barren land was decreased (Table 2).

Changes during 1995-2005: Decadal changes in land cover were detected for the decade 1995-2005 and found the maximum changes in agricultural land and the forest area (Table 3). The highest portion of agricultural land was converted into forest land.

Changes during 2005-2019: During 2005-2019 significant changes were observed in the study area. The area covered by built-up and urban, forest and water bodies were

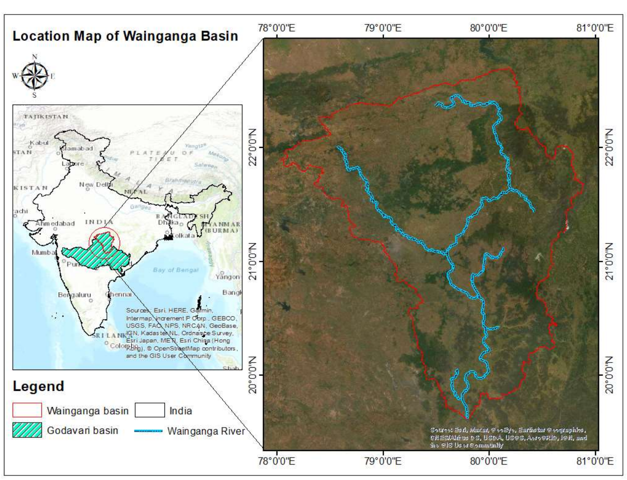

Fig. 1. Location of study area

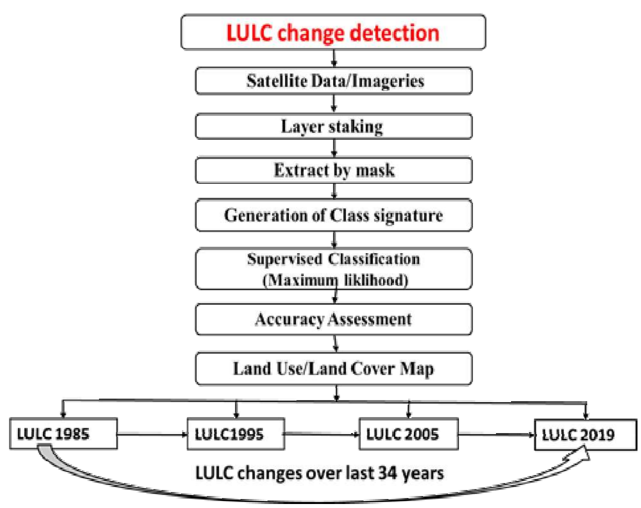

Fig. 2. Flowchart for the LULC change detection methodology

expanded while agricultural land and waste cum barren land were contracted. The agricultural area and waste cum barren land were shrunk by 3.53 and 0.14% of the total area of the basin and in that area, Forest, Water bodies, and built-up and Urban expanded by 2.32, 0.7 and 0.65 % of the total basin area (Table 4).

Variation in LULC during the last 34 years (1985-2019) : The changes in the physical appearance of land that comes under the Wainganga sub-basin in the last three decades (1985-2019), shows the increase in built-up and Urban,

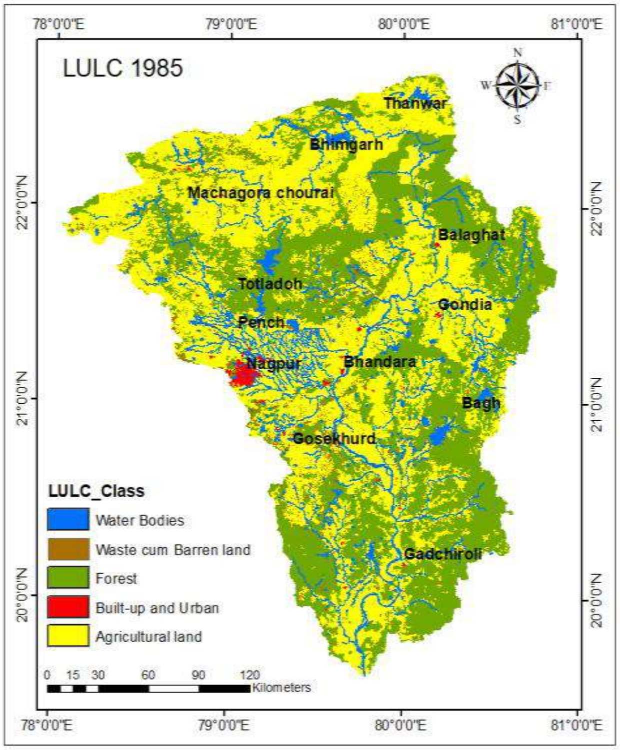

Fig. 3. LULC of the year 1985

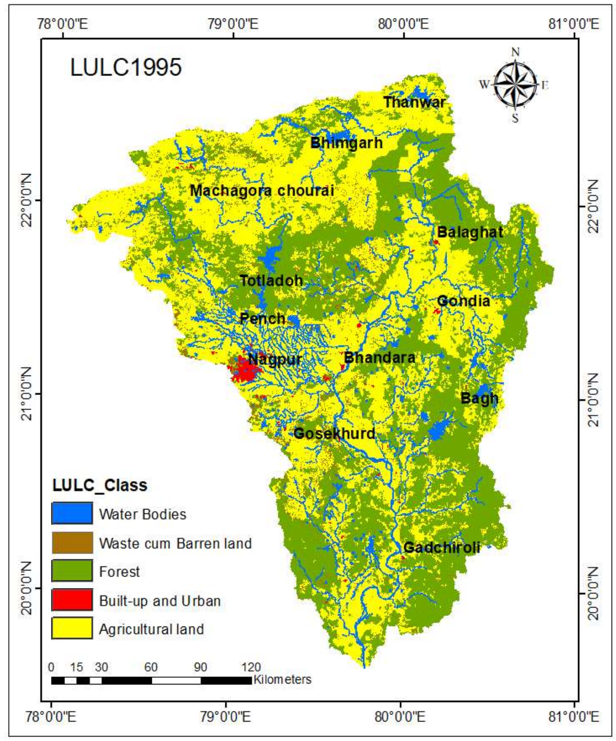

Fig. 4. LULC of the year 1995

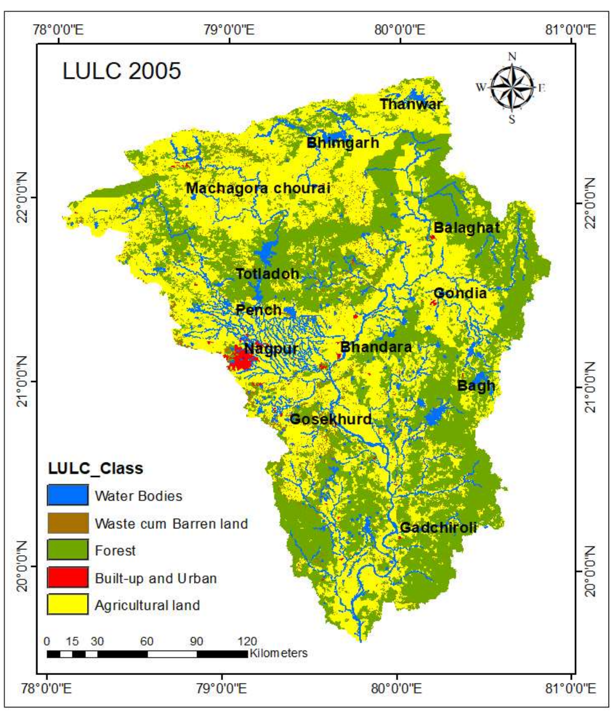

Fig. 5. LULC of year 2005

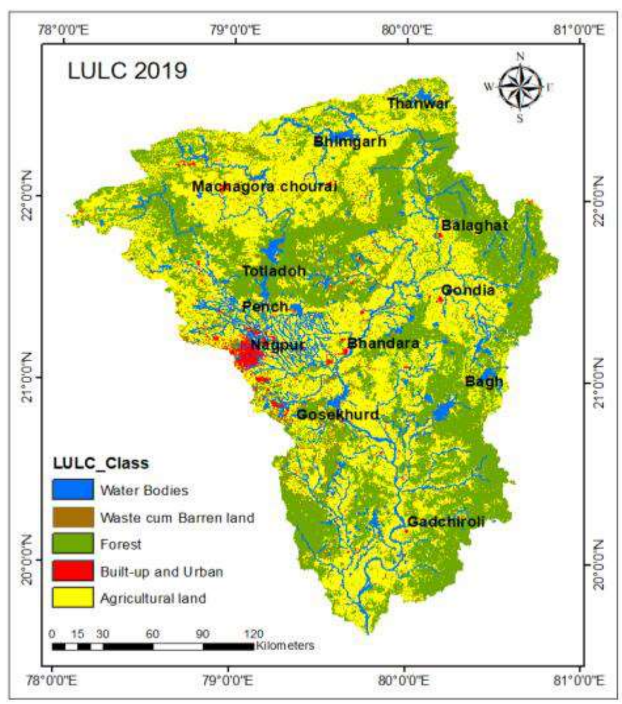

Fig. 6. LULC of the year 2019

Table 1. Accuracy assessment report of LULC 2019

Class	Reference totals	Classified totals	Number correct	Producers accuracy	Users accuracy	Kappa
Agricultural land	58	46	46	79.31%	100.00%	1
Built-up and Urban	4	6	4	100.00%	66.67%	0.66
Forest	54	66	54	100.00%	81.82%	0.67
Waste cum Barren land	2	2	2	100.00%	100.00%	1
Water bodies	4	2	2	50.00%	100.00%	1
	122	122	108	88.52%	89.70%	

Overall Classification Accuracy = 88.52%, Overall Kappa Statistics = 0.81

Table 2. Statistics of LULC changes during 1985-1995

LULC class	Area covered (%)		Changes during 1985-1995	Remark
	1985	1995		
Agricultural land	51.94	52.47	0.53	Increased
Built-up and Urban	0.65	0.68	0.03	Increased
Forest	41.54	40.88	-0.66	Decreased
Waste cum Barren land	3.25	3.21	-0.04	Decreased
Water bodies	2.62	2.76	0.14	Increased

Table 3. LULC changes during 1995-2005

LULC class	Area covered (%)		Changes during 1995-2005	Remark
	1995	2005		
Agricultural land	52.47	52.27	-0.2	Decreased
Built-up and urban	0.68	0.69	0.01	Increased
Forest	40.88	41.04	0.16	Increased
Waste cum barren land	3.21	3.19	-0.02	Decreased
Water bodies	2.76	2.81	0.05	Increased

Table 4. LULC changes during 2005-2019

LULC class	Area covered (%)		Changes during 2005-2019	Remark
	2005	2019		
Agricultural land	52.27	48.74	-3.53	Decreased
Built-up and urban	0.69	1.34	0.65	Increased
Forest	41.04	43.36	2.32	Increased
Waste cum barren land	3.19	3.05	-0.14	Decreased
Water bodies	2.81	3.51	0.70	Increased

Table 5. LULC changes during 1985-2019

LULC class	Area covered (%)		Changes during 1985-2019	Remark
	1985	2019		
Agricultural land	51.94	48.74	-3.20	Decreased
Built-up and urban	0.65	1.34	0.69	Increased
Forest	41.54	43.36	1.82	Increased
Waste cum barren land	3.25	3.05	-0.20	Decreased
Water bodies	2.62	3.51	0.89	Increased

forest and water bodies and shrinkage of agricultural land and waste cum barren land (Table 5). Inside the study area, 3.2% of the agricultural land has been converted into other classes in the last 34 years and the major area was converted into the forest. There was a minute change in Waste cum Barren class, which is only 0.2%. The built-up and urban area expanded by 0.69% of the total area. In 1985, 0.65% of the study area was covered by Built-up and urban areas, while in 2019 was 1.34%. Similarly, water bodies were increased from 2.63 to 3.51% in the last three decades.

From the statistics of decadal LULC, observed that the significant land cover changes occurred in the last decade. The built-up and urban water bodies have increased significantly in the previous decade while agricultural land has converted into forest cover.

CONCLUSION

LULC change analysis indicated significant changes during 2005-2019, before that the changes were not very noticeable. In the last 34 years, the agricultural land was shrunk by 3.20%, while waste cum barren land reduced by 0.20% of the study area. The shrunk part of agricultural land converted into the forest, built-up and urban, and water bodies. The built-up expanded and variation in that period was 106% of the base period. The water bodies also grew. Quantified the changes in land use pattern using remote sensing and GIS techniques- Decadal Land use land cover change detection found the major changes in the agricultural land, which decreased by 3.20% of the total area in the last 34 years.

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