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Land Use and Land Cover Change Detection in Srikakulam District, Andhra Pradesh: A Geo-Informatics Approach

M. Karunakara Rao*
Department of Geography, Sri Krishnadevaraya University, Anantapur, India

***Abstract*: The current study attempts to examine land use and land cover changes of Srikakulam district in Andhra Pradesh in India for 2017 through 2024 using satellite images provided by Sentinel-2 Level-2A. The goal is to assess and analyze transitions in land use categories including agricultural crops, forests, water, built-up areas, and rangelands. According to the obtained data, most of the land in Srikakulam district belongs to agricultural crops covering 2,599.36 sq. km or 58.47% in 2024, which indicates the heavy dependence on agriculture. In addition, tree cover has been reduced to 939.19 sq. km or 21.13%, water bodies have stayed relatively unchanged comprising 106.51 sq. km or 2.4% of the total area. The growth of rangeland has reached 468.88 sq. km or 10.55% while built-up areas have been expanded up to 303.95 sq. km or 6.84%. Transitions detected in the analyzed area include the expansion of agricultural land through conversions of rangeland and built-up areas. It shows that the priority is given to crop farming as the dominant activity.**

***Keywords*: Land Use, Land Cover, Sentinel-2, RS & GIS.**

1. Study Area

The Srikakulam District lies in the far northeastern portion of Andhra Pradesh state in India. The geographic location of Srikakulam ranges from 18° 20' to 19° 10' N latitude and 83° 50' to 84° 50' E longitude. The district is noted for having various major rivers like the Vamsadhara, Nagavali, and Suvarnamukhi rivers that rise from the Eastern Ghats and drain into the Bay of Bengal. For example, the Vamsadhara river enters the district in the Bhamini Mandal region and drains into the Bay near Kalingapatnam. Srikakulam District has a 193 kilometer coastline and shares its borders with Vizianagaram District in the southern and western sides, Orissa in the northern side and the Bay of Bengal in the eastern side. Srikakulam District covers a geographical area of 583,700 hectares and includes 30 mandals. Of the district's total area the cultivated land occupies 61.10%, while forestlands occupy 11.76%. Non-agriculture land occupies 17.01% of the area. Srikakulam District has two major natural divisions one being the hilly agency area where most of the tribal groups live and the other one being the plain areas of the district. Some of the main irrigation schemes include BRR Vamsadhara Project and Madduvalasa project (fig.1).

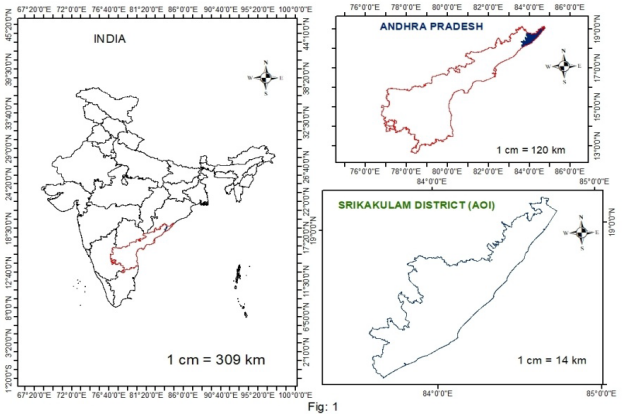

Fig: 1

2. Introduction

In this study, the researchers utilize satellite images and GIS technologies to explore changes in the land use in Srikakulam District for the last ten years. In particular, the paper pays attention to how the shift from agricultural lands to urban use affects local biodiversity (Reddy, K. R., & Reddy, P. S. 2018). Besides, the research deals with fast urbanization in Srikakulam and its influence on the changes in land cover as well as estimates socio-economic implications of the processes with the help of remote sensing techniques (Kumar, S., & Reddy, K. 2020). The authors analyze multitemporal satellite imagery for the assessment of dynamics in land use and land cover and emphasize agriculture expansion and deforestation.

The issue of coastal zones in Srikakulam District and application of geo-informatics to estimate the land use change due to coastal erosion and human activity is another subject of consideration in the presented literature review (Srinivas, K., & Reddy, M. 2021). The paper describes a GIS-based analysis of the dynamics of land use and change in land cover with an accent on the factors and their environmental consequences (Narasimha, R., & Kumar, A. 2022). In addition, the article presents Landsat data to provide a panoramic vision of the dynamics and changes in land use and land cover in the district and its environmental impacts (Vijay, K., & Reddy, S. 2023). Sustainable land management practices in Srikakulam District and evaluation of efficiency of geo-informatics approaches in

*Corresponding author: karunamrao@gmail.com

this sphere are considered in the literature review (Chandra, P., & Reddy, V. 2020).

Objectives:

1. To analyze the land use and land cover changes of Srikakulam district from 2017 to 2024.
2. To assess the land use and land cover change detection of Srikakulam district from 2017 to 2024.

3. Methodology

The study adopts an organized process when collecting satellite imagery data, targeting Sentinel-2 L2A imagery data between 2017 and 2024. The study highlights the need for obtaining clear satellite imagery data of the same season. This involves the application of algorithms on satellite imagery data to perform atmospheric correction. Geometric correction is performed by aligning all satellite images within the same coordinate system.

Software used: ArcGIS 10.3 and M.S. office.

4. Result and Discussion

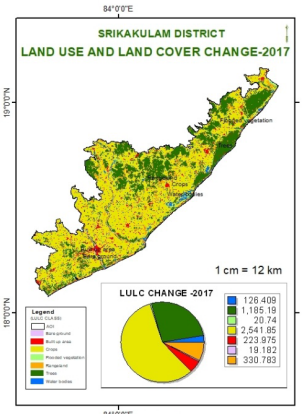

Fig: 2

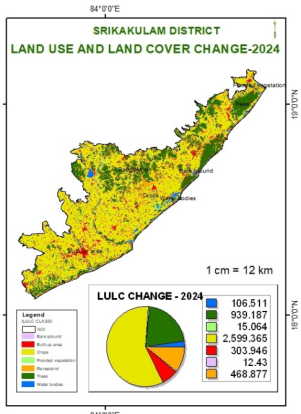

Fig: 3

Table 1
Land use & Land cover change of Srikakulam District: 2017

S.No.	Name of the class	Area in sq km	%
1	Water bodies	126.41	2.84
2	Trees	1185.19	26.64
3	Flooded vegetation	20.74	0.47
4	Crops	2541.85	57.14
5	Built up area	223.97	5.04
6	Bare ground	19.18	0.43
7	Rangeland	330.78	7.44

A detailed analysis of land use and land cover changes in Srikakulam District was conducted in 2017, shedding light on the distribution of different types of land cover across the region. According to (table 1 & fig. 2) the most common land use category in Srikakulam District is agricultural crops that cover 2,541.85 sq. km (57.14% of total land cover). This high share of agricultural crops implies that agriculture is one of the key industries of the studied region.

The second-largest land cover type is tree cover occupying 1,185.19 sq. km (26.64% of total land cover). As a result, a substantial share of land cover is forested or wooded, which makes possible the conservation of biodiversity in Srikakulam District. The next land cover type analyzed is water bodies covering 126.41 sq. km (2.84%). Thus, there is a relatively small amount of water bodies, which can be viewed as an indicator of limited water resources in the area.

Built-up areas cover 223.97 sq. km, meaning that 5.04% of Srikakulam District land cover is developed for urbanization purposes. Rangeland covers 330.78 sq. km, which makes up 7.44% of all land cover. These figures imply that there is a moderate share of rangeland in the region, which is useful for grazing cattle. It should be noted that flooded vegetation covers 20.74 sq. km or 0.47%, while bare ground covers 19.18 sq. km (0.43%).

In conclusion, provides the overview of land use categories in Srikakulam District and helps to better understand how land is used in this region. There is a relatively large amount of agricultural crops (57.14%), tree cover (26.64%), built-up areas (5.04%), and rangelands (7.44%). Other minor land cover categories include flooded vegetation (0.47%) and bare ground (0.43%).

Table 2
Land use & Land cover change in Srikakulam district: 2024

S.No.	Name of the class	Area in sq km	%
1	Water bodies	106.51	2.4
2	Trees	939.19	21.13
3	Flooded vegetation	15.06	0.34
4	Crops	2599.36	58.47
5	Built up area	303.95	6.84
6	Bare ground	12.43	0.28
7	Rangeland	468.88	10.55

The table 2 highlights the land use and land cover changes for the year 2024. The table depicts the breakdown of various land classes in terms of area covered and percentage of land cover. There are seven types of land classes highlighted in this report that represent the different types of land covers.

According to the findings presented in the major land use category in the given region includes crops. Crops cover an area of 2,599.36 square kilometers and represent 58.47% of total land cover. This shows the importance of agricultural land in the given area and indicates a heavy reliance on crop production activities. After crops, trees come second in the list with coverage of 939.19 square kilometers and 21.13% of total land cover. This implies the presence of forested or wooded lands, which are usually associated with rich biodiversity and ecosystems.

The third highest land use category is water bodies. These occupy an area of 106.51 square kilometers and account for 2.4% of total land cover. This low coverage rate of water bodies suggests that the land under investigation does not contain many aquatic resources. Rangeland occupies an area of 468.88 square kilometers or 10.55% of the total land cover. It is mainly comprised of grasslands or pasture areas and is important for livestock grazing purposes.

Built up area covers an area of 303.95 square kilometers and constitutes 6.84% of the total land cover. It reflects the rate of urbanization and land use development in the region under investigation. Finally, flooded vegetation and bare ground are the least represented categories in this report. The two occupy 15.06 square kilometers (0.34%) and 12.43 square kilometers

(0.28%) of total land cover respectively (table 2 & fig. 3).

Table 3
LULC change detection of Srikakulam District: 2021-2024

Land use & Land cover Change Detection	
Name of the Class	**Area change in sq. km**
Bare ground-Bare ground	5.7
Bare ground-Built up area	0.28
Bare ground-Crops	1.14
Bare ground-Flooded vegetation	0.01
Bare ground-Rangeland	7.45
Bare ground-Trees	0.11
Bare ground-Water bodies	4.3
Built up area-Bare ground	0.08
Built up area-Built up area	209.53
Built up area-Crops	10.07
Built up area-Flooded vegetation	0.15
Built up area-Rangeland	2.1
Built up area-Trees	1.7
Built up area-Water bodies	0.3
Crops-Bare ground	0.55
Crops-Built up area	52.99
Crops-Crops	2347.57
Crops-Flooded vegetation	2.34
Crops-Rangeland	73.8
Crops-Trees	42.5
Crops-Water bodies	21.39
Flooded vegetation-Bare ground	0
Flooded vegetation-Built up area	0.03
Flooded vegetation-Crops	3.75
Flooded vegetation-Flooded vegetation	9.03
Flooded vegetation-Rangeland	4.34
Flooded vegetation-Trees	1.33
Flooded vegetation-Water bodies	2.24
Rangeland-Bare ground	1.27
Rangeland-Built up area	10.64
Rangeland-Crops	69.31
Rangeland-Flooded vegetation	1.67
Rangeland-Rangeland	203.48
Rangeland-Trees	38.39
Rangeland-Water bodies	5.67
Trees-Bare ground	0.06
Trees-Built up area	29.15
Trees-Crops	132.5
Trees-Flooded vegetation	0.13
Trees-Rangeland	167.94
Trees-Trees	854.08
Trees-Water bodies	0.78
Water bodies-Bare ground	4.76
Water bodies-Built up area	1.37
Water bodies-Crops	34.97
Water bodies-Flooded vegetation	1.75
Water bodies-Rangeland	9.78
Water bodies-Trees	1.34
Water bodies-Water bodies	71.86

The results of this study in (table 3 & fig. 4) are a full overview of land use and land cover changes from 2017 to 2024. It provides information about the transitions between all existing land covers. The measurements are done in square kilometers. Therefore, it becomes possible to understand how many hectares are affected by specific changes.

The first category analyzed includes those lands, which remain stable. There is an enormous number of 2,347.57 sq km of crops. Moreover, there was also a transition from bare ground to crops of 5.39 sq km. In addition, the following transitions are recorded are built-up area to crops 133.92 sq km and rangeland to crops 71.69 sq km. Thus, this land cover type seems to be very important, since its area increased substantially.

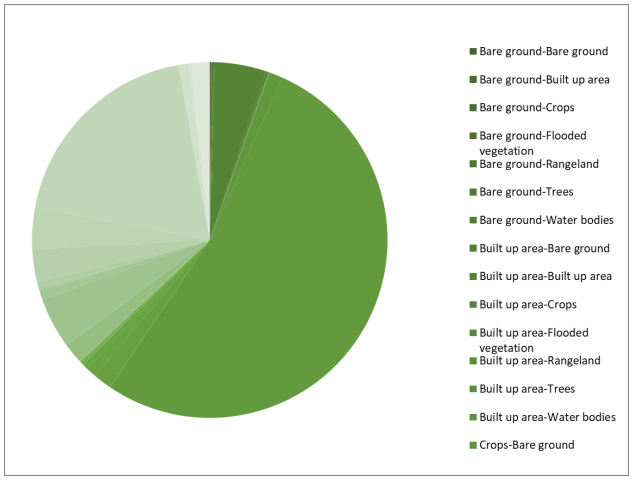

Fig. 4. Change detection of LULC: 2017-2024

There is an extremely small category called built-up area. Nevertheless, there is still some information about it, such as 209.53 sq km of lands, which remained unchanged during this period of time. At the same time, transitions are as follows: crops to built-up areas 52.99 sq km; bare ground to built-up areas 0.28 sq km and rangeland to built-up areas 10.64 sq km.

Trees category is also stable, because there were 854.08 sq km of forested lands. However, there are several transitions from trees to rangeland (167.94 sq km) and trees to crops (132.5 sq km). Therefore, it could be seen that something happens to these lands are perhaps, there are some reasons for such changes.

Water bodies are one more stable land cover category. Only a minor portion of waters is transferred to other categories are bare ground (2.89 sq km) and rangeland (4.67 sq km). In conclusion, there was enough evidence of changes in land uses and covers, especially concerning the increase of urbanized areas and agriculture in the studied region.

5. Conclusion

Finally, it can be concluded that land cover changes from 2017 to 2024 in Srikakulam District showed some trends and transitions. Agricultural crops have dominated during the period under consideration, taking 58.47% of area in 2024 and 57.14% in 2017. The slightly increased share of this type of land may suggest a tendency towards intensive crop cultivation.

Trees covered 21.13% of total land in 2024 and occupied 26.64% in 2017. Such decrease may imply problems with deforestation in the studied district. The reduction of tree coverage may adversely affect the environment in the region, and therefore there is a need to take care of its conservation. The coverage with water bodies was 2.4% both in 2017 and in 2024; however, it does not make it possible to relax because the share of water bodies is very small. It means that in case of additional development, the water resources could become insufficient for the needs of local inhabitants.

Rangeland increased from 7.44% in 2017 to 10.55% in 2024. This fact implies that grazing lands become increasingly

important due to increasing livestock requirements. Urbanization is obvious when analyzing the coverage of land in the district: the coverage of buildings rose from 5.04% in 2017 to 6.84% in 2024. This trend indicates further land use conflicts and problems with agricultural fields.

Some transitions have taken place during the considered period; first, there was the change from rangeland and bare ground to crop cultivation. Second, transition took place from trees to rangeland. Finally, the transitions between water bodies and other land covers were not significant, and water bodies remained stable. Despite many interesting tendencies and transitions, it should be mentioned that in order to solve the problem and provide adequate and rational land use, it is necessary to develop appropriate practices.

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