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Geospatial Analysis of Slum Growth using Multi-Temporal Satellite Imagery in Ranchi, India

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Abstract- Slum growth is not wealthy for city progress which requires to be resolved. This need to be done for understanding the growth of slum around the city. In the future, it will become a great barrier to city development and management to handle the slums in a conventional way.This study concentrated on the land use, land cover changes and the detection of slum growth in Ranchi municipality, Ranchi district. It has used remote sensing approach of temporal Landsat imagery for detecting the change the land-use/cover and using visual interpretation technique for detection of slums. The change detection analysis indicates the major changes in built-up land, vegetation, and non-cultivated land. Whereas there is a downfall of slum areas by 12.1% from 2003 to 2018. Slum growth analysis will be useful for the government to make policies for the poor to live in the slum areas.

Index Terms**: *Landsat Imagery, Multitemporal Data, Slum, Supervised classification, Urban Change Detection.***

I. INTRODUCTION

The slum is a highly dense population living in an urban area with improper sanitation access, drinking water access, poor quality house structure, sewage system, electricity, basic facilities, and services. Slum growth depends on rapid urbanization in the developing countries people from the rural area started migrating towards the urban area [1]. There has been huge growth in the urban population, over the last century. The growth of the population is not uniform everywhere in urban areas [2].

Most of the slum dwellers in Southern Asia – 63 %, or almost 170 million people – live in India. The portion of Southern Asia's slum residents constitutes 27 % of the global total. India alone accounts for 17 % of the world's slum residents. Even India has seen exceptional economic growth rates in recent times and has succeeded to reduce extreme poverty by 10 % in the last decade (UN-Habitat, 2006).

In 2000 Jharkhand separated from Bihar which leads to more acceleration in urban development. The urban population is showing an increasing trend almost all the district. Industrialization and infrastructural investment leads some districts very high urban growth compare to others. Rural to urban and small town towards cities migration major reason for the high population growth (Census of India).

The increase of urbanization is a significant concern for less developed countries while they usually lack basic services and infrastructure. Remote sensing is very competent to provide an excellent result for the urban environment. Multi-temporal satellite images are useful for monitoring and detect the changes in land use/land cover which covers a large area [3, 4, 5, and 6]. Detecting slums by the characteristics of housing density, structure, and roof composition where remote sensing Application is the best [7]. **Thus for this study area, slum and urbanization growth can be identified by the change detection technique**.

II. STUDY AREA

Ranchi is the state capital of Jharkhand. It was established on 15 November 2000. Its located in geometry coordinate lies between 23°15′0″N - 85°15′00″E and 23°25′0″ - 85°25′00″E. The municipal area of the Ranchi city is 175.12 square kilometer and average datum of elevation 651m from mean sea level. It is located in the southern part of the Chota Nagpur plateau, which is the eastern segment of the Deccan plateau

Ranchi district is very famous for its wide natural beauty, hospitality, and tribal culture, there is many tourist places are nearby Ranchi city, it is also known by the city of waterfall because of numbers of waterfalls are located nearby.

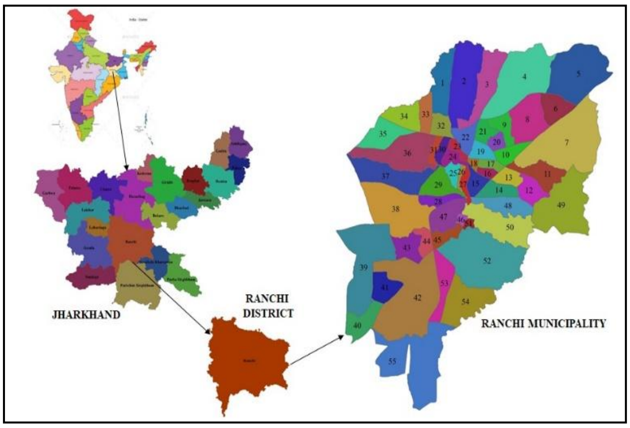

Fig.-1: Map location of study area

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There are 55 wards in the city shown (Fig.-1), among them ward No 31 is the most populated ward with a population of 38,358 and Ranchi Ward No 51 is the least populated ward with a population of 7,146 by census (2011).

III. EXPERIMENT

This cover the assessment of the land-use, land cover growth and detection of the slum areas within 15 years using change detection technique. A summary of the methodology used for this research is given as a flow chart (Fig.-2). From Spatial data satellite imagery and toposheet (AK47BC 73/7) have been collected. Base map was generated from the toposheet which shows the settlement, Lake, dam, roadway, railways, river, and some other permanent features. The satellite imagery used for the study is Landsat 5, 2003 and Landsat 8, 2018 of 1:120,000 scale were classified by the supervised classification for the preparation of thematic layers of land use and land cover and area calculation of the several features for the comparative years 2003 and 2018. Google earth time scale image 2003 and 2018 was used to identify and digitized the slum by visual interpretation technology. It was imported to the GIS platform to generate the slum map.

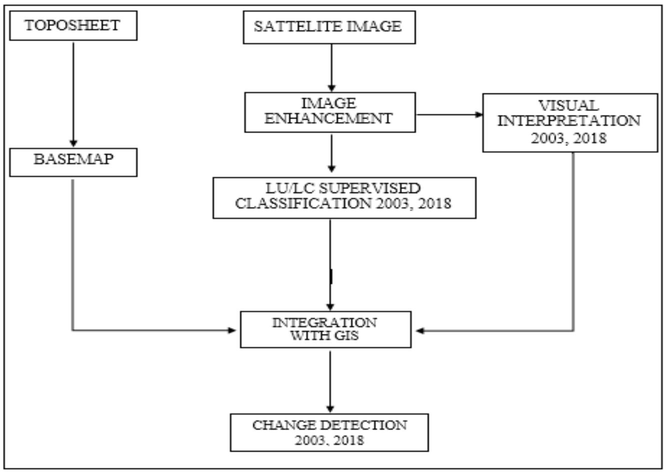


Fig.-2: Methodology of change detection analysis for slum

IV. RESULT AND DISCUSSION

A. Base Map

The base map presents a primitive measure by which the areas of cadastral parcels to be linked with the geodetic source framework; to primary natural and artificial features such as water body, Road, Railway, Settlement, and fences to municipal and political boundaries. Its further provides the information by which all land-related data will be linked graphically with cadastral parcels. A base map which consists of the settlement, national highway, cart track toad, railway, cultivated land, land, dam, Lake Etc. It is shown in the Fig.-3

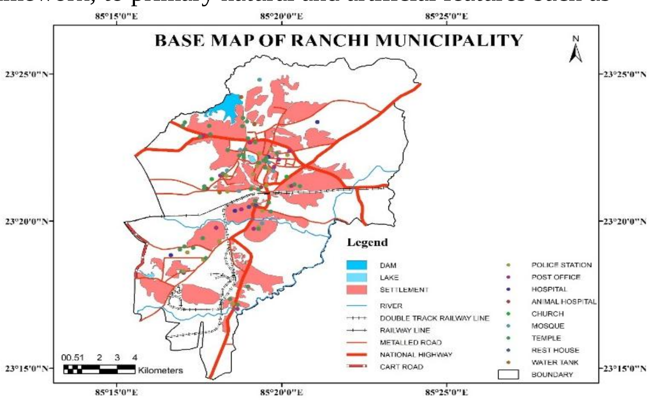
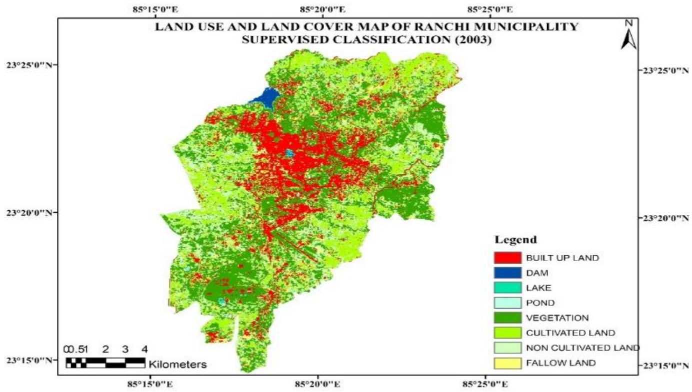


Fig.-3: Base map of Ranchi Municipality

B. Supervised Classification

Supervised classification is based on the user can choose individual pixels in an image that represent a particular group and therefore show the image processing software to use these training data set to classify all other pixels in the image[8, 9].

Fig.-4: land use and land cover supervised classification



of Ranchi Municipality (2003)

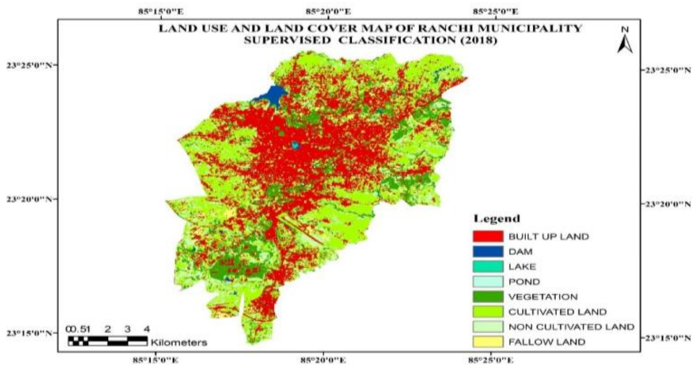


Fig.-5: land use and land cover supervised classification of Ranchi Municipality (2003)

Land use/land cover classification can be done by using this image classification [10, 11, 12, and 13]. Training data set are chosen based on the experience of the user. Fig.-4 shows the supervised classification.

It indicates the Built-up land, Dam, lake, pond, vegetation, cultivated land, noncultivated land,

and fallow land. Comparison of multi-temporal satellite data 2003 and 2018

have been done which shows the different land-use/cover feature.Area calculation has been done which state the ratio of

Table-1: Area calculation of supervised classification for 2003 and 2018

Name	Area in sq.km 2003	Area in sq.km 2018	Increase area In %	Decrease area In %
BUILT UP LAND	30.6126	62.1942	103	0
DAM	0.970604	1.28905	32	0
LAKE	0.403255	0.483847	20	0
POND	0.496913	0.186108	0	62.55
VEGETATION	65.7334	21.3059	0	66
CULTIVATED LAND	62.9749	64.4519	2.3	0
NON-CULTIVATED LAND	11.1894	20.5426	83.5	0
FALLOW LAND	2.47474	4.39097	77.7	0
TOTAL	174.8	174.8	-	-

built-up land, vegetation, non-cultivated land were changed tremendously. Built-up land in 2003 was 18% of the total area where it's in 2018 changed to 35%. It was increased by 17% in 2018. Vegetation in 2003 was 38% which changed to 12% in 2018. It was decreased by 26% in 2018. Non-Cultivated land was 6 % in 2003 which changed to 12 %. It was increased by 6%. Fallow land also increased by 1 %(2003) to 3% (2018). It was increased by 2% (2018). Cultivated land was changed by 1% from 2003 (36%) to 2018(37%). Whereas the dam, pond, the lakes remained the same as 1%, 0 %(below 1%), 0 % (below 1%). The percentage of the area growth shows in Table- 1. Whereas the built upland, noncultivated land, and fellow land got a noticeable increase. Vegetation and pond show a remarkable decrease in the area.

C. Visual Interpretation

The basic components of image interpretation are tone/color, texture, location, pattern, shape, size, shadow, and association. Visual interpretation keys were used to identify the slums in Ranchi Municipal Corporation which displayed in the map. House typology, the density of house, and rooftop of houses were playing a key role for detection of the slum areas.

D. Slum Detection

Slum maps (Fig.-6, 7) were prepared using visual interpretation technique from the satellite image where slums were detected in the municipal area. In the map, it shows almost every municipal ward is having more or less slum. Area calculation for slum was done for both of the years (2003 and 2018). Among the 55 wards in the municipal area ward, no 55 is the largest slum prone area of 0.4119 sq.km (2018) covered by the slum.

E. Change Detection Analysis

In 2003, slum areas covered by the municipal area was 5.1286 whereas in 2018 it was 4.5078 sq.km. Slum area was decreased by 12.1% in 2018, compared to the 2003 slum area. Slum growth map (Fig.-8) of 2003 to 2018 generated using the data retrieved from area calculation of 55 municipal wards. Where it's found that ward no 20, 27, 35, 39, 40, 41,44,49,54 (Table-2) shows the slum growth increased in between 15 years (above 50%). Whereas 1, 2, 3, 4, 6, 7, 8, 11, 13, 14, 18, 28, 30, 31,47, 48 (Table-3) shows the decrease (above 50 %).Ward no 25, 26, 32, 33, 37, 52 (Table-4) were found moderate slum growth in between 0-9% and rest of the ward were in-between 10-49%. There is no slum in ward no 23 (2018).

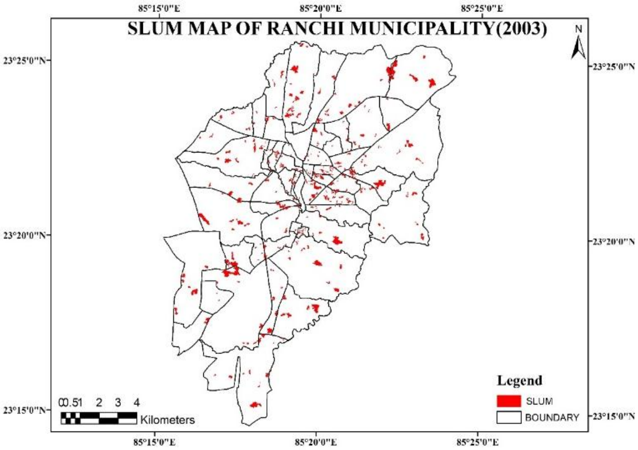


Fig.-6: Slum map of Ranchi Municipality (2003)

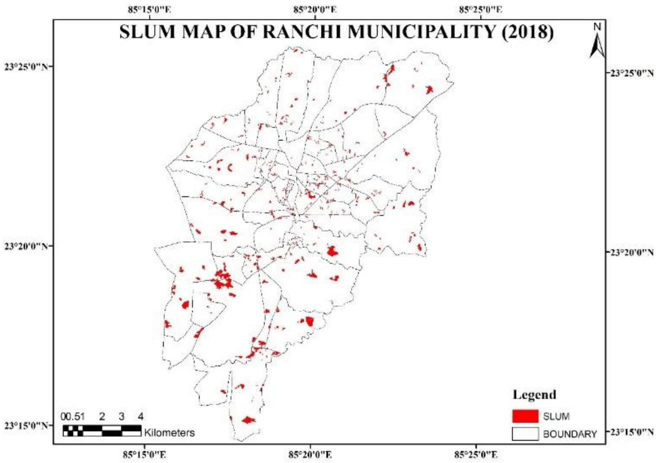


Fig.-7: Slum map of Ranchi Municipality (2018)

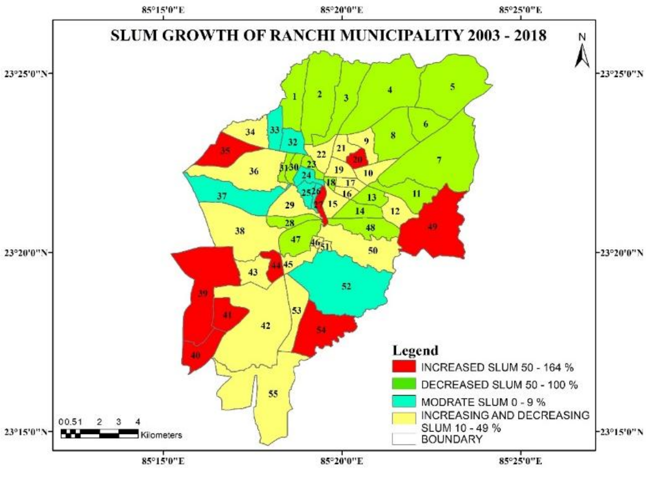


Fig.-8: Slum growth map of Ranchi Municipality (2003 - 2018)

Table-2: Slum area increasing in Ranchi Municipality between 2003 and 2018

Ward No	Area in sq.km 2003	Area in sq.km 2018	Increase area in %
20	0.0076	0.0183	141
27	0.0046	0.0115	55
35	0.0182	0.0362	99
39	0.1839	0.3558	93
40	0.0388	0.0825	112
41	0.0045	0.0119	164
44	0.0253	0.0643	154
49	0.1136	0.1935	70
54	0.1506	0.2357	56

Table-3: Slum area decreasing in Ranchi Municipality between 2003 and 2018

Ward No	Area in sq.km 2003	Area in sq.km 2018	Decrease area in %
1	0.0566	0.0215	62
2	0.3621	0.1218	66
3	0.0466	0.0097	79
4	0.2398	0.1048	56
6	0.0518	0.0152	71
7	0.1593	0.0790	50
8	0.0621	0.0294	53
11	0.1890	0.0326	82
13	0.0888	0.0396	55
14	0.1311	0.0494	62
18	0.0109	0.0032	71
28	0.0679	0.0293	57
30	0.0646	0.0261	60
31	0.0191	0.0074	61
47	0.0645	0.0298	54
48	0.0498	0.0123	75

Table-4: Slum area moderate growth in Ranchi Municipality between 2003 and 2018

	Area in sq.km	Area in sq.km	Moderate	
Ward no	2003	2018	Increase in area %	The decrease in area%
25	0.0277	0.0266	0	6
26	0.0316	0.0339	7	0
32	0.0385	0.0374	0	3
33	0.0126	0.0124	0	2
37	0.0906	0.098	8	0
52	0.2035	0.2157	6	0

V. CONCLUSION

Base map was prepared from the survey of India toposheet. From the base map, artificial features like settlement, irrigation, transportation, and utility services are recovered. Image classification technique was used to identify the changes in land use and land cover. Supervised classification was done for a better result. From the image classification of Landsat 5 (2003) and Landsat 8 (2018) shows that rapid urbanization growth ensued in-between 15 years where the built-up land increases most. It was noted that the built-up land in 2003 was 30.61 sq.km which in 2018 increase to 62.19 sq.km. It represents the highest growth of 103% among the other features present in the municipal area. Whereas vegetation in 2003 was 65.7334 sq.km which decreases to 21.3059 sq.km. By, this vegetation were decreased to 66%. Non cultivated and fallow land has been increased. Identified the slums over the 55 wards with visual interpretation techniques. Slum detection and slum growth have been carried out successfully where it's clear that in 2018 slums were 12.1% decreased compared to 2003. It has been found that ward no 23 has no slum by 2018. The state of work is useful for Ranchi Municipal Corporation for better understanding the slum growth in the municipal areas for development of policy-making.

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