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Urban Sprawl Dynamics and its Impact in Tumakuru, Karnataka - A Geomatics Approach

Indhira Gandhi S
Sr. Section Engineer
South Western Railway,
Karnataka, India

Stalin M
Dy. Surveyor General
Survey of India,
Meghalaya, India

Aishwarya Amaravathi
Research Scholar
Manipal Institute of Technology,
Karnataka, India

(Corresponding author. E- mail id: sindhiragandhi@gmail.com)

Abstract- Rapid urbanization brings drastic growth in economic and prosperity to the region. Due to urban sprawl the city faces problems like water, energy, transport, pollution and land use. Urban growth has become a major issue in growing cities, which results in the increase in population and converts natural land cover to built-up land. The main objective of this research is to carry out Urban Dynamics study on land use land cover and to analyse the impact in land use pattern. The integration of Remote Sensing and GIS technologies have been applied to dissect the land use land cover changes and the process of urban sprawl in the areas of Tumakuru city. According to 2011 census, the total population of Tumakuru city is 3,05,821. Remote sensing data (TM and LISS III), SOI Toposheet and Google Earth Image are widely used for mapping and monitoring of urban sprawl. To carry out this research, the study area has been classified into 6 major categories. The increase in built-up area of the total geographical area from 1973 to 2015 is 5 percent, 7 percent and 24 percent respectively. The radical changes of built-up land occurred after the Karnataka Govt. announced the Tumakuru city as a Smart city. Highways expanding, single storied homes gradually growing in length and small factories bloating to occupy thousands of acres of land have collectively led to shrinkage in cultivation land. There is considerable decrease in water bodies which is also a cause for environmental alarm. Thus, the change detection study gives a clear picture of the changing environmental and economic conditions of Tumakuru.

Keywords: Urban Sprawl, Remote sensing, GIS.

I. INTRODUCTION

Urbanization is one of the most dynamic geographical phenomena in the history of mankind. Urban expansion has become a critical issue in most of the developing countries due to uncontrolled migration from rural regions to the developed regions, which results in increased population, which in turn stretches the infrastructure resources available. Due to the growing population in a country like India, urban expansion takes place very rapidly which changes many of the isolated population centres into large metropolitan cities and hence the conversion of natural land cover into urban use is inevitable. Conversion should not affect the sustainability of the environment, rather it should be planned to be eco-friendly while leading to development of a smart and planned city.

Geomatics is the branch of science that deals with the collection, analysis, and interpretation of data relating to the earth's surface. Geomatics is a natural consequence of the accelerated development of information technology; it's a combination of the basic concepts of Geodesy and Geoinformation. Geomatics encompasses a wide range of fields, including tools and techniques used in surveying, mapping, remote sensing, Geographic Information Systems (GIS), Global Navigation Satellite Systems

(GNSS), Photogrammetry, Geography and other forms related to the mapping of the Earth. GIS is a very potent tool for decision making in almost all areas like infrastructure, environment, demography, urbanism, health, sociology, economics, tourism, administration, transportation and many others.

II. OBJECTIVES

The main objective of this paper is to carryout Urban Dynamics study on land use land cover and to analyse the impact in land use pattern due to urban sprawl by preparing a base map of the study area.

III. STUDY AREA

Tumakuru is an industrial city located in the state of Karnataka. It is situated at a distance of 70 km, northwest of Bengaluru. Tumakuru is the head quarters of Tumakuru district. Tumakuru Urban area lies between 13° 20'17" N Latitude and 77 ° 6'5" E Longitude which is shown in Figure 1.

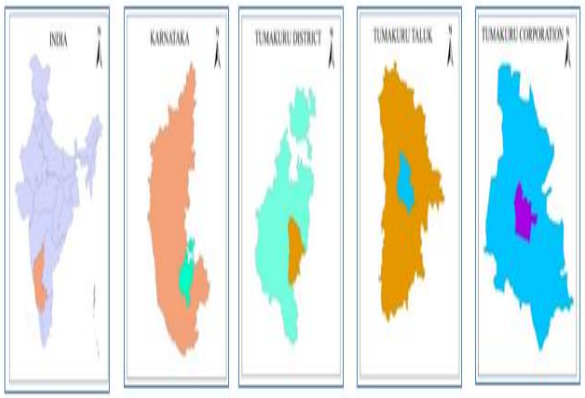

Fig 1. Location Map of Study Area.

The Tumakuru district is known for the production of coconut called as "Kalpataru Nadu". The city population is about 305821(2011 census).

The area is covered by 48.21sq.km. Total number of wards in the city is 35. Total length of road in the city is 575 Km. Total water supply in city is 46-47MLD. Temperature of city in summer ranges from 32°C to 40°C and 17°C to 30°C in Winter.

Tumakuru is a good study hub from primary education to higher education. It has an average elevation of area is 822 meters from mean sea level.

IV. DATA COLLECTION

The base materials which include various raster data are:

1. Toposheet:
57G3 of the year 1973 and updated OSM sheet of 2005 (Source : SOI)

2. Satellite Data:
LISS III Satellite image of 2006 (Source : Bhuvan Portal), Google earth image of (12/2011) and TM Satellite image of 2015 (Source : USGS Portal).

3. Master Plan (2031) of Tumakuru city:
(Source: Tumakuru Urban Development Authority (TUDA)).

4. Ward Maps from City Municipal Corporation of Tumakuru (CMC).

5. Population Data:
(Source : Census of India 2011)

V. METHODOLOGY

The process involved capturing data from hard copy maps or images in digital format using scanner. The scanned image was then georeferenced in Projected Coordinate System of WGS_1984_UTM_Zone_43N. The flow chart for the methodology is depicted in Figure 2.

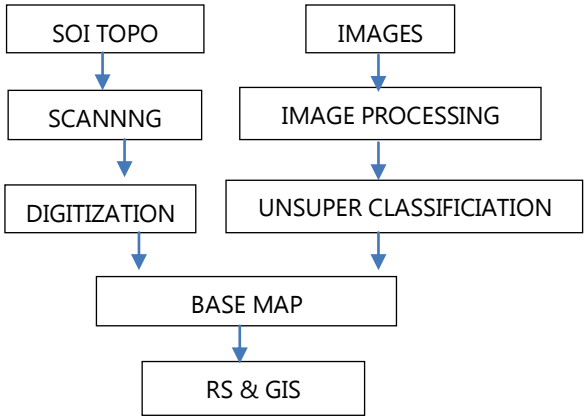

Fig 2. Methodology.

Topographical maps obtained from the Survey of India are used for the ground reference. Survey of India (SOI) topographical map is rectified using geographic latitude-longitude and WGS 84 datum. By using georeferenced topographical map, satellite

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images are registered using map to image as well as image to image registration procedure. ERDAS imagine software version 9.2 is used for the purpose of georeferencing and registration. All the images are geometrically corrected.

The image acquired in 2006 is geo-referenced to the UTM coordinate system, zone 44 North based on 1:50,000 scale topographical maps using control points on the map. The other images are registered through an image-to-image registration with the 2006 scene. All image data processing is carried out using ERDAS image processing system. Each satellite imagery is resampled to 30 m resolution using the nearest neighbour 3x3 pixel method and the study area is then extracted from each of the images.

VI. RESULTS AND DISCUSSION

1. Population Growth of Tumakuru City:
As per 2011 India census, Tumakuru had a population of 3,02,143. More than 2,00,000 people live in the corporation limit. At 2001 census, males constitute 52% of the population and females 48%.

Tumakuru had an average literacy rate of 75%, higher than the national average of 59.5%, male literacy was 79% and female literacy was 70%. About 11% of the population was under 6 years of age. The most spoken language in the city is Kannada.

Table 1. Population data (Source: Census of India).

Year	Town Population	Area (sq. km.)	Population Density	No of house holds	Growth Rate Town (%)
1971	70,476	12.95	5442	----	49.07
1981	1,08,670	15.32	7093	19060	54.19
1991	1,79,877	36.71	4900	11888	65.53
2001	2,48,929	64.27	3873	53958	38.39
2011	3,02,143	64.27	4710	72300	21.38

From the above table 1, it is inferred that though there is a gradual increase of population from 1971 to 2011, but within 4 decades, the population growth spurted to 76.67%, because of the greater industrialisation. No. of households is also in increasing trend as Tumakuru is closer to Bengaluru city.

2. Dynamic Changes of Land use and land cover:
The land use and land cover are the major factors in the global environmental change. In order to carry out the dynamic change detection study, base maps have been prepared for 4 different epochs by defining the relevant Toposheets in Arc GIS environment.

2.1 Land use Map of 1973: The Base map of 1973 is prepared from the toposheet of 57G3. The toposheet is collected from SOI and the same is georeferenced in Arc Map. The land use details have been digitized and the same has been classified into 6 categories as shown in Figure 3. The built-up area is located at the centre part of the city.

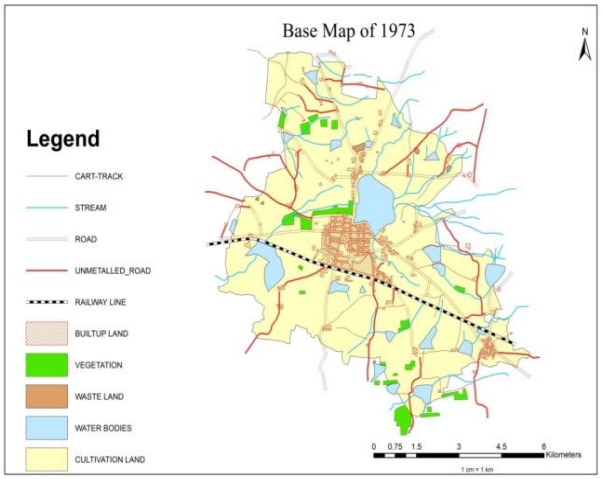

Fig 3. Base Map of 1973 (Source : SOI).

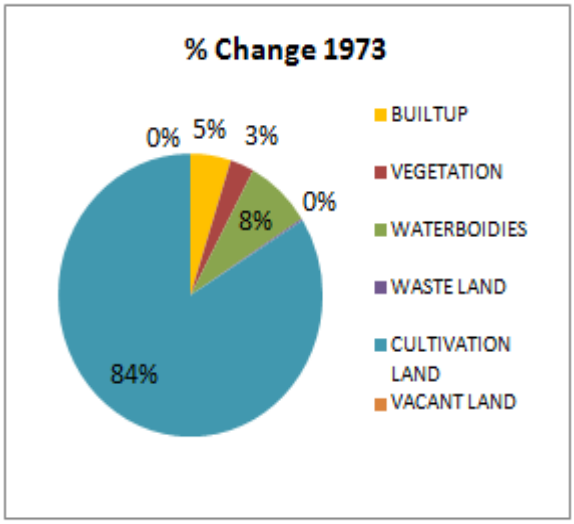

Fig 4. Chart 1: Land use change 1973 (Source : Generated).

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From the Chart 1, it can be seen that the percentage of vegetation land is very less as in the toposheet, the vegetation was considered as a group of trees. The percentage of water bodies to land is more due to presence of various lakes and ponds in the city.

The maximum area is cultivation land with major crops like Paddy, Ragi, Maize, Red gram, Groundnut, Horse gram and Horticulture crops. There was neither waste land nor vacant land in Tumakuru in the year of 1973 because of hefty agriculture.

2.2. Land use Map of 2006: The base map of 2006 is prepared from Satellite image of LISS III. The image is downloaded from Bhuvan and the image is processed in ERDAS.

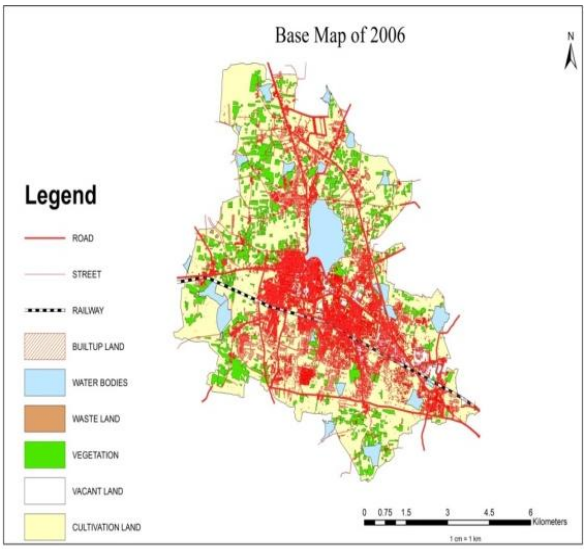

Fig 5. Base Map of 2006 (Source : Bhuvan Portal).

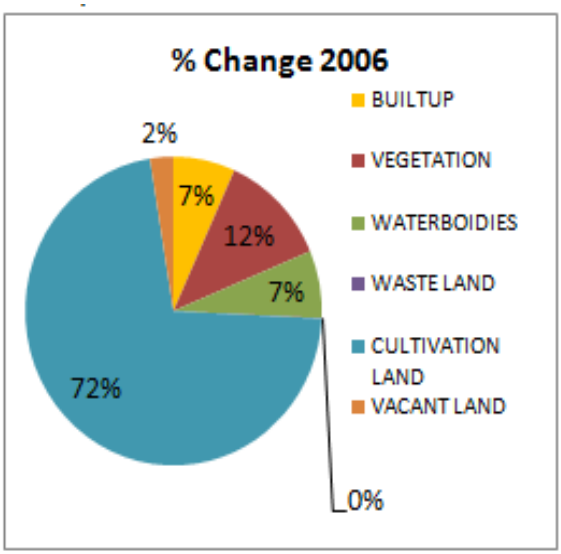

Fig 6. Chart 2: Land use change 2006 (Source : Generated).

The image has been classified into 6 land use categories which is depicted in Figure 4. The changes in cultivation land can be observed from the chart which is shown in Chart 2.

The cultivation area has decreased because of invading of industrialisation in Tumakuru City. Whereas the vacant land is increasing as the practice of agricultural work has gradually come down. There is not much variation in the water bodies.

2.3 Lad use Map of 2011: The base map of 2011 is prepared from Google earth image. The image is downloaded from Google Earth and the image is processed in ERDAS. The image has been classified into 6 land use categories and depicted in Figure 5.

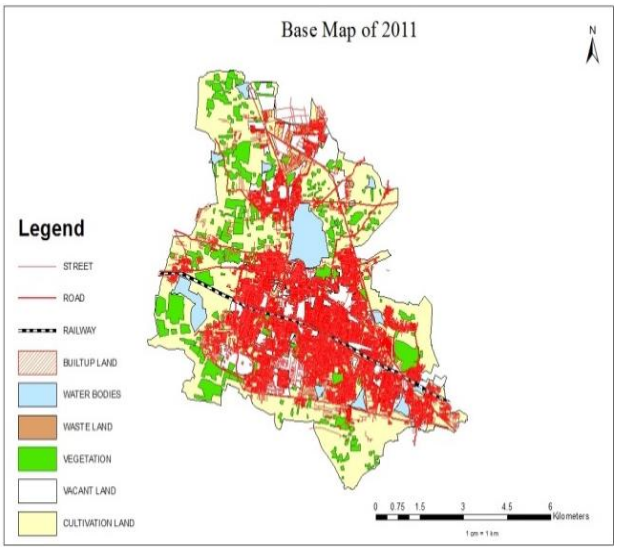

Fig 7. Base Map of 2011 (Source : Google earth).

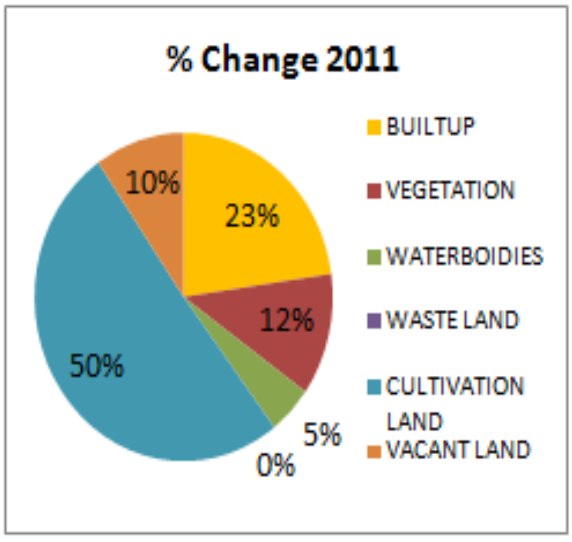

Fig 8. Chart 3: Land use change 2011 (Source : Generated).

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The rapid changes in the Built-up areas due to urban sprawl can be observed from the chart as shown in Chart 3.

Tumakuru as a satellite town, less than 70 km from Bangalore, was all set for expansion ever since the technology industry began to flourish in Bangalore in the early 2000s.

First, the highways expanded and the agricultural fields started decreasing beside them. Single storied houses gradually grew in length and small factories bloated to occupy thousands of acres of land. The cultivation land started shrinking due to rapid urbanisation.

The spurt in water-intensive industries such as electronics, automobile manufacturing, textiles and food processing, have adversely affected the already fragile water system in this part of Karnataka. The vacant land is upgraded due to reduction of the cultivation land.

2.4 Land use Map of 2015: The base map of 2015 is prepared from Satellite image of TM. The image is downloaded from USGS and processed in ERDAS. This image has been classified into 6 land use categories and depicted in Figure 6.

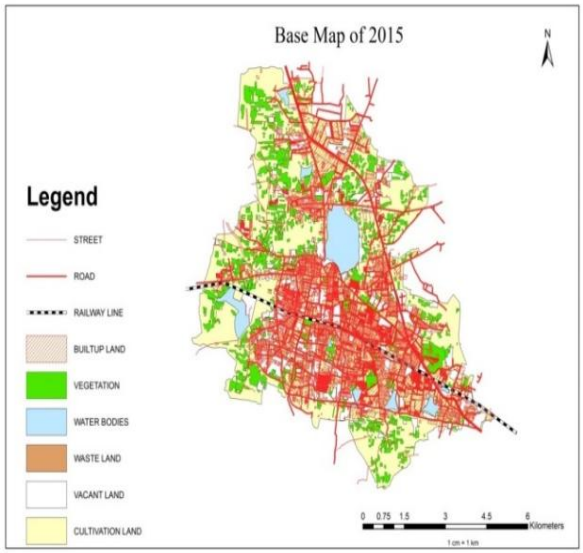


Fig 9. Base Map of 2015 (Source : USGS Portal).

The rapid changes in the Built-up due to urban sprawl can be observed from the chart shown in Chart 4. There is slight increase in the Built-up area, vegetation cover and vacant land. There is not much change in the water bodies.

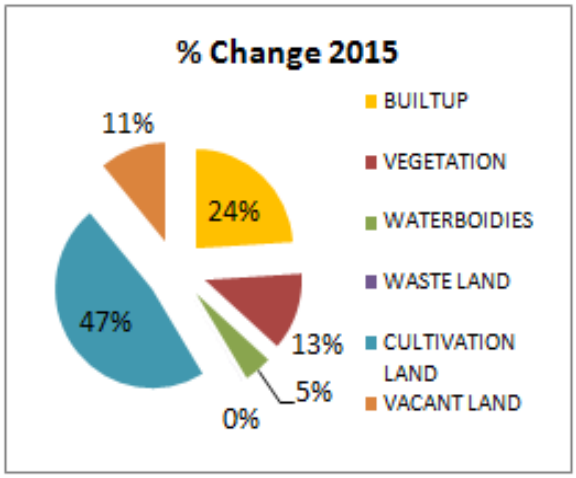
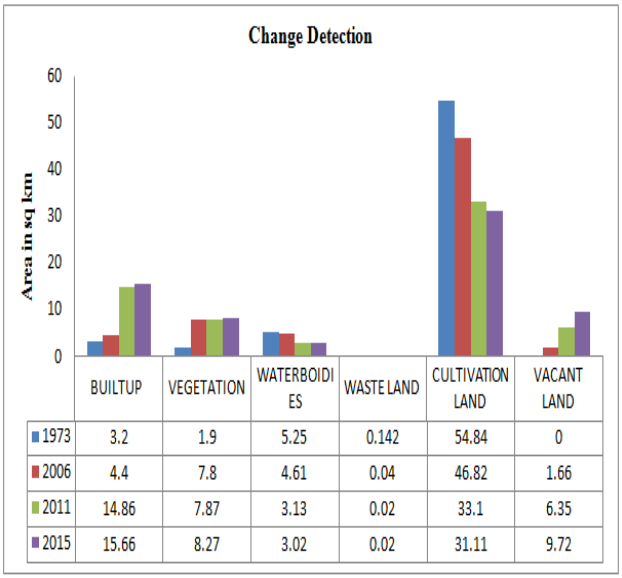


Fig 10. Chart 4: Land use change 1973 (Source : Generated).

3. Impact of Urban Sprawl in Tumakuru:

The overall change detection of land use and land over and its impact are shown in Chart 5. In the year 1973, the Built-up Land cover is about 3.2 sq km or 4.9% of the total geographical area. The increase of the city population to 79.53% is due to increase in built-up area from 2006 to 2011. The population density in the city is increased due to rapid industrialisation.



	BUILTUP	VEGETATION	WATERBOIDIES	WASTE LAND	CULTIVATION LAND	VACANT LAND
1973	3.2	1.9	5.25	0.142	54.84	0
2006	4.4	7.8	4.61	0.04	46.82	1.66
2011	14.86	7.87	3.13	0.02	33.1	6.35
2015	15.66	8.27	3.02	0.02	31.11	9.72

Fig 11. Chart 5: Over all View of Change Detection Study (Source : Generated).

The city has developed significantly due to efficient road and railway network facilitating the people to commute between Bangalore and Tumakuru. The Tumakuru Road is a massive four-lane road and is punctuated by over-crowded residential colonies.

The built-up area is increased at the expense of cultivation land and water bodies.

The increase in Barren land area from 1973 to 2015 is about 77.01% due to non-practising agricultures which is shown in Table 2. As people are migrating from Bangalore to Tumakuru, all agricultural land becomes barren land due to house construction. Further, there is decrease in agricultural land due to conversion into built-up areas.

Table 2. Changes in Land use and Land cover Distribution (Source : Calculated through ArcGIS).

Landuse Categories	1973		2006		2011		2015		% change between 1973-2015
	Area (Sq.km)	Area %	Area (Sq.km)	Area %	Area (Sq.km)	Area %	Area (Sq.km)	Area %	
Built-up	3.2	4.90	4.4	6.74	14.86	22.75	15.66	23.97	79.55
Veg-Land	1.9	2.91	7.8	11.94	7.87	12.05	8.27	12.66	77.01
W-Bodies	5.25	8.04	4.61	7.06	3.13	4.79	3.02	4.62	-13.63
Waste land	0.142	0.22	0.04	0.06	0.02	0.03	0.02	0.03	-63.3
Cult-land	54.84	83.94	46.82	71.67	33.1	50.67	31.11	47.62	-15.16
Vac-land	0	0.00	1.66	2.54	6.35	9.72	7.25	11.10	1
Total	65.332	100.00	65.33	100.00	65.33	100.00	65.33	100.00	

Tumakuru is situated in the eastern region of Karnataka, which is away from major rivers and the ocean. The people from Tumakuru depend on the lakes and ponds for agricultural work. Due to increase in industrial activities, the ground water is getting very much polluted. Area of water bodies decreased to 13.63% from the year 1973 to 2015. From table 3, it can be inferred that there is a continuous decrease in area of water bodies. This is observed mainly due to increase in the built-up area and variation in climatic conditions.

In 2013, the town was declared as National Investment and Manufacturing Zone (NIMZ) and the Tumakuru Machine Tool Park was set up. In addition, Tumakuru was also named as one of the three industrial nodes along with proposed Chennai-Bangalore Industrial Corridor (CBIC).

VII. CONCLUSIONS

The study of urban dynamics clearly shows increase in built up area due to boom in urban growth. The increase in vacant land is also related to decrease in cultivated land. The significant decrease in water bodies causes environmental alarm.

Thus, the urban sprawl study reveals the dynamic change in environmental and economic conditions of Tumakuru. Being only 70 km away from Bengaluru, the densely populated hub of economic activity, Tumakuru is moving rapidly from an agrarian economy to an industrial and urban economy. Fast growing migrant population, urbanisation and industrialization has led to development of new urban centres and urban fringe areas.

Tumakuru is thus poised for a spurt in growth being in the fringe area of State capital, Bengaluru. In this scenario, Tumakuru is ideal for development as a Smart City. The infrastructure, facility and utility management have to be scientifically implemented.

Geomatics solutions will optimize use of resources, maximize management and minimize waste while ensuring that development is environmentally stable so that development is sustainable and not detrimental or lopsided.

REFERENCES

[1] Jitendra Kumar and Rohtak. (2011). Mapping and analysis of land-use/land cover of Kanpur city using remote sensing and GIS technique. Trans. Insl. Indian Geogpherc Vol 33, No. 1.

[2] Nithesh Nirmal S., Abdul Rahaman S and Balasundareshwaran A. (2017). Urban Change

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Detection and Site Suitability Analysis in Thiruverumbur Taluk, Tiruchirappalli District - A Geospatial Approach" Conference Paper.

[3] Sandipan Das., Sagar P. Mali and Ankita Misra. (2012). Urban Land use/Land-Cover Change Detection Analysis of Aurangabad City Using Geoinformatics Techniques. International Journal of Scientific and Research Publications, Volume 2, Issue 9, 1 ISSN 2250-3153.

[4] Sukanya Ghosh., Dr. Prafull Singh., Maya Kumari. (2017). Assessment of Urban Sprawl and Land Use Change Dynamics, Using Remote Sensing Technique: A Study of Kolkata and Surrounding Periphery, West Bengal, India. Conference Paper.

[5] Rahman, A., Agarwal, S. and Sarkar, A. (2007). Monitoring Urban Sprawl Using Remote Sensing and GIS Techniques: Study of Fast Growing City, India. Epidemiology, 18(Suppl), p.S79.