

# URBAN CHANGE DETECTION AND SITE SUITABILITY ANALYSIS IN THIRUVERUMBUR TALUK, TIRUCHIRAPPALLI DISTRICT – A GEOSPATIAL APPROACH

Nithesh Nirmal S.<sup>1</sup>, Abdul Rahaman S.<sup>2\*</sup>, Balasundareshwaran A.<sup>3</sup>

<sup>1</sup> IV<sup>th</sup> M.Sc Student, Department of Geography, Bharathidasan University, Tiruchirappalli, Tamil Nadu, India

<sup>2,3</sup> Research Fellow, Department of Geography, Bharathidasan University, Tiruchirappalli, Tamil Nadu, India  
Email: [nirmalgsarath@gmail.com](mailto:nirmalgsarath@gmail.com), [abdulatgeo@gmail.com](mailto:abdulatgeo@gmail.com), [balasundareshwaran@gmail.com](mailto:balasundareshwaran@gmail.com)

**Keywords:** Urban, Urban Landscape, Urbanisation, GIS, Built-up land.

**ABSTRACT:** The sudden growth of a city is an indicator of rapid urbanisation and industrialisation, which causes huge pollution and decreases the quality of environmental health. The study on urban landscape changes at different time period would provide the information about the present state of expansion and the nature of the changes that have occurred. Using change detection analysis to compare the satellite data from different times to assess the change of nature, understand the ways in which humans alter the land and water, and characterise climatic and seasonal changes to the landscape. So, current study attempts to identify the changes and suitable site for future urban development in Thiruverumbur taluk, Tiruchirappalli District, Tamil Nadu using integrated GIS and Multi-Influence Factors (MIF). The agricultural land, Built-up land, water bodies, barren land and road networks, terrain, geomorphology, and geology are taken as the key features to map the changes in Thiruverumbur taluk. The satellite images were obtained in the three different periods such as Landsat 7 (2001), Landsat 5 (2011), and Landsat 8 (2017), which were used in the present study along with the topo-maps. Mapping of urban changes have been done in the view of developing urban land with four different classes such as more suitable, suitable, less suitable and not suitable for urban development. Identification of suitable sites for urban development is also important for planners, policymakers, and rulers to do sustainable development.

## 1. INTRODUCTION

Urbanization is one of the most dynamic geographical phenomena in the history of mankind (Weldu, et al., 2016). Due to which urban expansion has become a common issue in most of the developing countries due to uncontrolled migration from rural regions to the developed regions, which results in increased population (Scariah, et al., 2016). Due to the growing population in a country like India, urban expansion takes place very rapidly which changes many of the isolated population centers into large metropolitan cities and hence the conversion of the natural land cover into urban use is inevitable (Hauser, et al., 1982). So, the natural land cover which is converted into urban use should not affect the sustainability of that environment, it should be planned to be eco-friendly and moreover, it should lead to the development of a smart and planned city. Moreover, urban expansion takes place with a view of having a planned infrastructure which focuses on the concept of sustainable development. So, identifying the particular site for the urban development and growth is inexorable. So, the development of the urban area in the recent past decades is identified using change detection analysis which is useful in detecting the nature of urban expansion and development and the rate at which the urban area is growing. Change detection is the process of identifying differences in the state of an object or phenomenon by observing it at different times. Several researchers have attempted to use digital satellite data to address the change detection problem: Several procedures of land cover change detection using digital data have been proposed which could aid in updating resource inventories. These methods include comparison of land cover classifications, multi-date classification, image differencing/ratting, vegetation index differencing, principal components analysis and change vector analysis (Singh, 1989). Monitoring of changes using remote sensing technologies are widely used in different applications such as land use/land cover change, disaster monitoring, forest and vegetation change, built-up land and hydrology (Rokni, et al., 2014). Site suitability analysis helps in identifying the suitable sites that meet specific criteria or restrictions. It is the method of understanding present site qualities and aspects that will determine the location for a particular activity. It involves the detailed investigation of natural resources and processes that characterize a site and include mapping techniques including GIS tools that help in processing the geographical database that display the areas of the site, suitable for various objectives and alternatives (Kumar, et al., 2014) (Misra, et al., 2015). Land use / land cover changes in semi-arid mountain landscape in southern india through geoinformatics and CA-Markov Chain approach is done by Rahaman, et al., (2017), the study reveals that Lu/Lc changes in past three decades (1995, 2005, and 2015) were identified and projected for 2020 and 2025. Detection of urban changes and site suitability analysis in Tiruchengode taluk, Namakkal District was done by Arivazhagan, et al., (2016) using the satellite images. Change detection in the urban area of Tiruchengode taluk has been identified using the satellite images of two different periods and the sites suitable for further urban development is identified using integrated GIS and Multi Influence Factor (MIF) techniques. Four different classes have been identified for further urban development of which 109.89 km<sup>2</sup> of the area comes under more suitable for urban development and 51.10 km<sup>2</sup> of

the area which comes under areas not suitable for urban development. Site suitability analysis for urban development in Krishnagiri taluk, Tamil Nadu was done by Scariah, et al., (2016) using geographic information system (GIS) and numerical Multi Criteria Evaluation (MCE) techniques. Highly suitable, suitable and not suitable areas for urban development has been identified of which 678 km<sup>2</sup> is highly suitable for urban expansion and this study has been carried out using pairwise comparison matrices by analytical hierarchy processing technique. A review of site suitability analysis for urban development has been done by Misra, et al., (2015). Site suitability analysis for urban development using GIS in Roorkee town was done by Jain, et al., (2007). A suitable site for urban development has been identified for Mussoorie Municipal Area, Dehradun District, Uttarakhand, India by Kumar, et al., (2013) using GIS and Multi Criteria Evaluation (MCE). The topographic sheets and IKONOS were used to generate various thematic layers using ArcGIS software and the generated thematic layers were standardized using pair-wise comparison matrix in analytical hierarchy process (AHP). A weight for each criteria has been assigned and based on this weight and criteria, final site suitability was prepared. Rahaman, et al., (2015) has conducted a study on Prioritisation of watershed using Fuzzy Analytical Hierarchy Process in Kallar watershed of Bhavani basin. Urban growth analysis using remote sensing and GIS in China has been done by Chen, et al., (2000). The present study focused on the development of the urban area and the changes in the land use and land cover in Thiruverumbur taluk, Tiruchirappalli District, Tamil Nadu has been monitored by satellite data and Survey of India topo-maps. This study highlights the changes that are detected in the built-up land, agricultural land, waterbodies, scrub land and salt affected land during different time periods of the study i.e. 2001, 2011 and 2017 and identify the site suitability analysis for urban development. Mapping of the urban changes in the study area has been done in the view of developing urban land with four different classes which are suited for future development in an eco-friendly and sustainable way.

### **1.1 Aim**

The aim of the study is to assess the urban change detection and identifying the suitable sites for urban development in Thiruverumbur taluk. To achieve the aim, following objectives are followed

### **1.2 Objectives**

The objectives of this study are,

1. To detect the changes occurred in the land use and land cover (urban) during 2001-2017.
2. To assess the rate of urban changes between 2001, 2011 and 2017.
3. To identify the best sites suitable for urban development using MIF (Multi Influence Factor) technique.
4. To compare the identified best suitable sites with the current land use.
5. To suggest the best site suitable for urban development and growth.

## **2. STUDY AREA**

The Thiruverumbur taluk which is a suburb, located in Tiruchirappalli District, Tamil Nadu, India. The study area lies between the northern latitude of 10°38'15" to 10°49'50" and eastern longitude 78°41'57" to 78°51'53" and it covers an area of about 258 km<sup>2</sup>. It is located 13.2 km towards the District headquarters. Thiruverumbur taluk is bounded by Lalgudi taluk in the North, Tiruchirappalli taluk in the west, Thanjavur District in the east, Pudukkottai District in the south. The Cauvery River flows west to east above the Thiruverumbur taluk, Tiruchirappalli District. Thiruverumbur taluk is one of the most important industrialised areas in Tiruchirappalli District and some of the important industries located in the Thiruverumbur taluk are Bharath Heavy Electricals Ltd. (BHEL), Ordnance Factory (OFT), and Heavy Alloy Penetrator Project (HAPP). There are fine educational institutes located in the study area. The warmest months in the Thiruverumbur taluk are from April to June and the rainfall is heaviest in the north east monsoon between October and November, and from December to February, the climate is cool and moist. The annual average rainfall is 841.9 mm (33.15 inches) and the monthly average temperature ranges between 25°C (77°F) and 32°C (90°F). According to the 2011 census, the Thiruverumbur taluk had a population of 225,338 with 114,623 males and 110,715 females. There were 966 women for every 1000 men. The taluk had a literacy rate of 81.74%. Thiruverumbur is an important landmark on Tiruchirappalli - Tanjore National Highway (NH 67). Thiruverumbur has a railway station, which is located on the Tiruchirappalli - Tanjore railway line. The nearest airport is Tiruchirappalli International Airport. The majority of the study area is covered by shallow weathered/shallow buried Pedic plain. Moderately weathered/moderately buried Pedic plain is present in the eastern part of the study area. The study area also contains geomorphic features such as Shallow Flood Plain, which is present in northern part of the study area along the Cauvery River. Alluvial Plain Canal Command mostly covers the northern part of the study area. Eroded Pedic plain with shallow basement, Pediment / Valley Floor is scattered all over the study area. The study area comprises of distribution of three soil types. They are Gravelly Loam Soil, Loamy Soil, and Gravelly Clay Soil. The study area location map is shown in Figure 1.



some membership value based on a linear scale, with the larger input values being assigned a greater possibility, or closer to 1.

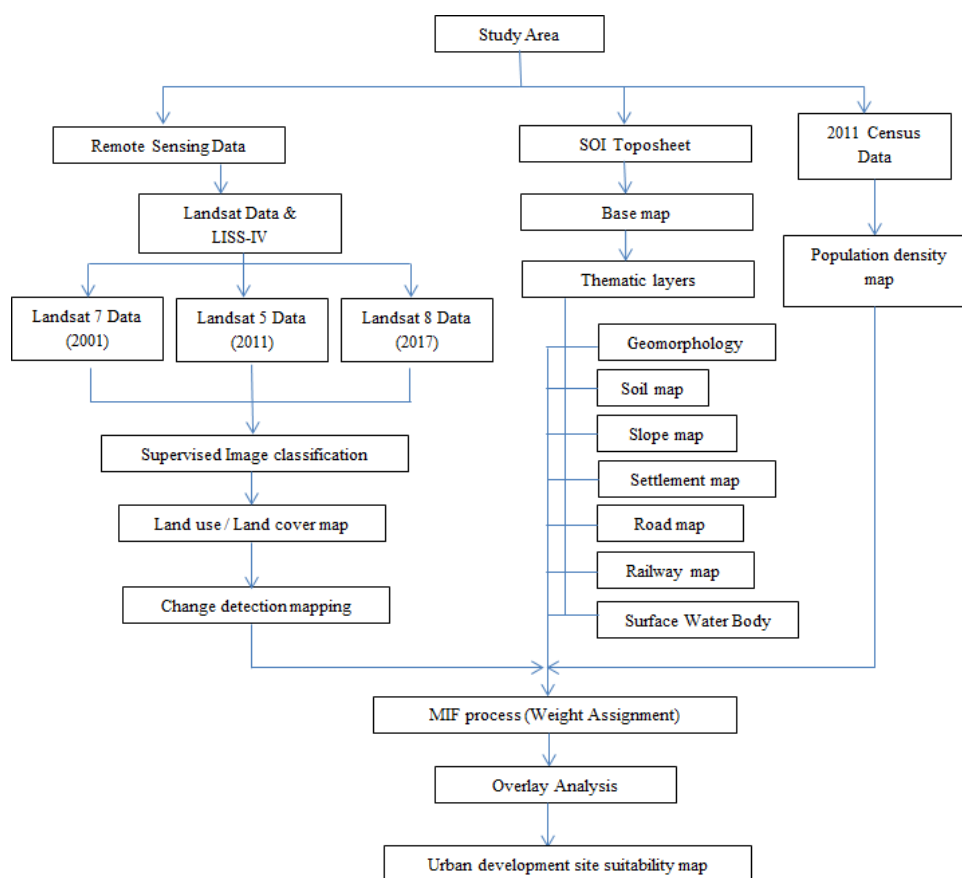


Figure 2: Methodology adopted in the present study

## 5. RESULT AND DISCUSSION

### 5.1 Land use/Land cover

In the present study with the reference of the NRSC LULC level 1 classification, five features viz., agricultural land, built-up land, waste land, salt-affected land and water bodies are classified for the Thiruverumbur taluk using Landsat 7 (2001), Landsat 5 (2011) and Landsat 8 (2017) data, to understand the change in the land use/land cover in the Thiruverumbur taluk.

#### 5.1. Land use/Land cover change detection

The present study focuses to delineate the changes occurred in the built-up land of the Thiruverumbur taluk. The study has been carried for a period of 17 years from 2001 to 2017 through the change detection analysis. The change detection analysis is performed through generating land use/ land cover map for different time periods i.e. for 2001, 2011 and 2017. The areal coverage of overall land use changes have been given in table 2 and figure 3, the spatial distribution of land cover are shown in figure 3.

Table 2: Aerial coverage and overall changes of Land use/Land cover occurred in-between 2001, 2011 and 2017

S.No.	Classification	2001 (sq.km.)	2011 (sq.km.)	2017 (sq.km.)	Changes of 2001-2011 (%)	Changes of 2011-2017(%)	Changes of 2001-2017 (%)
1	Agricultural land	197.1	153.7	165.2	-28.2	+6.9	-19.3
2	waste land	13.3	55.4	33.9	+75.9	-63.4	+60.7
3	Built-up land	21.6	29.1	47	+25.7	+38.1	+54
4	Salt affected land	16.3	14.4	10.7	-13.6	-33.8	-52.1
5	Water bodies	10.1	5.9	1.7	-71.5	-239.5	-482.3

Note: (-) represents a decrease in the percentage of aerial coverage. (+) represents an increase in the percentage of aerial coverage.

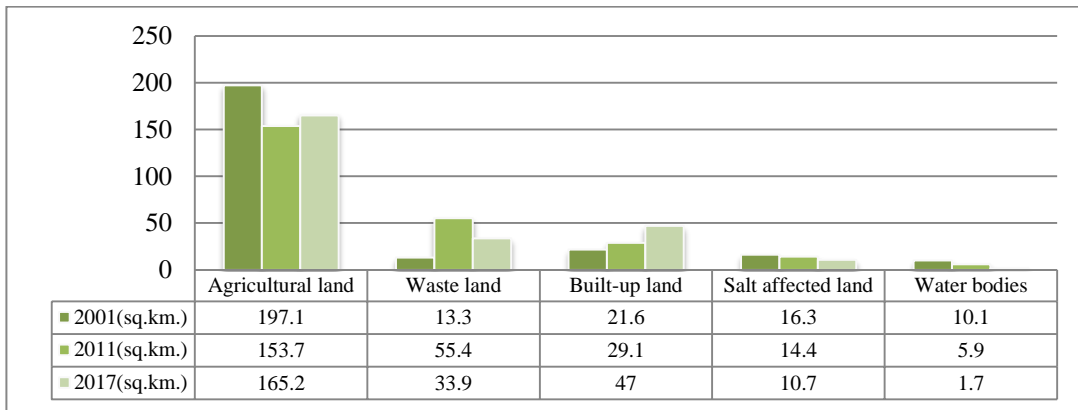


Figure 3: The overall changes occurred in-between 2001, 2011 and 2017

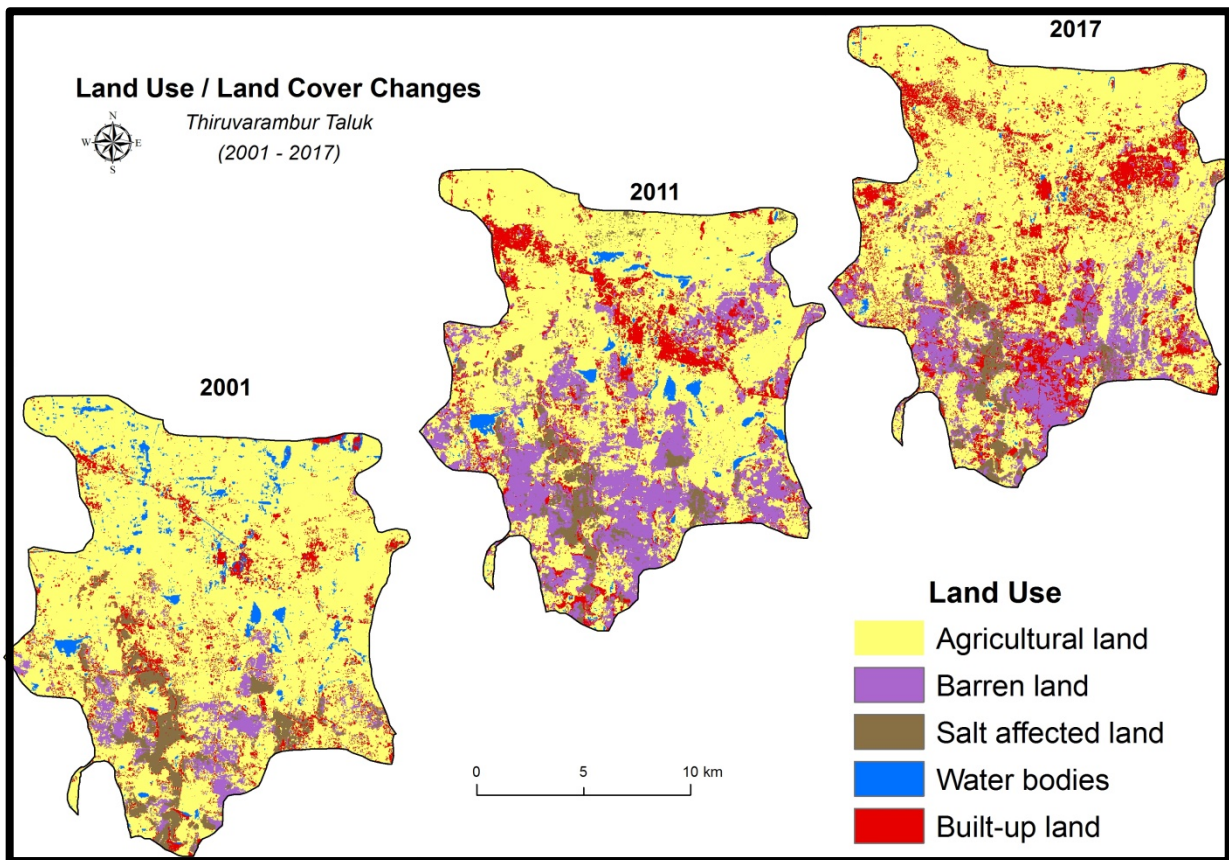


Figure 4: Land use/Land cover map (2001, 2011, and 2017)

The present study reveals that built-up land has been increased 54% from 2001-2017 and it has been gradually increasing from 25.7% in 2001-2011 and 38.1% in 2011-2017, this result reveals that built-up area in and around the Thiruvarambur taluk is rapidly expanding. So, the suitable sites for urban development in the Thiruvarambur taluk should be identified on the basis of spatial analysis using geo-spatial techniques. The final result also shows that the scrub land is also increased by 60.7% in between 2001-2017 which indicates that there is more area available for the urban development. As the Thiruvarambur taluk is fast growing in its economical, physical and social aspect, it is essential for site suitability analysis for the urban development, as this analysis will develop the city into eco-friendly and a planned urban center.

## 5.2 Site suitability Analysis through MIF

In this study the Multi Influence Factor (MIF) was used to arrive at the weightages of the each thematic layers based on the method followed by Arivazhagan, et al., (2016). The integration of all thematic layers of the study area is essential in order to obtain an urban development site suitability map. All the thematic layers do not have the same kind of influence so, the multi influence factor decision-making technique is applied. To identify the

site suitable for the urban development, the relative values of factor are given as 1 and 0.5 i.e., 1 for major effects and 0.5 for minor effects. The proposed relative weight is arrived based on the cumulative value of minor and major effects and the proposed weightage for each factor is given based on the formula given in table 3 and the framework of MIF for site suitability analysis shown in figure 5.

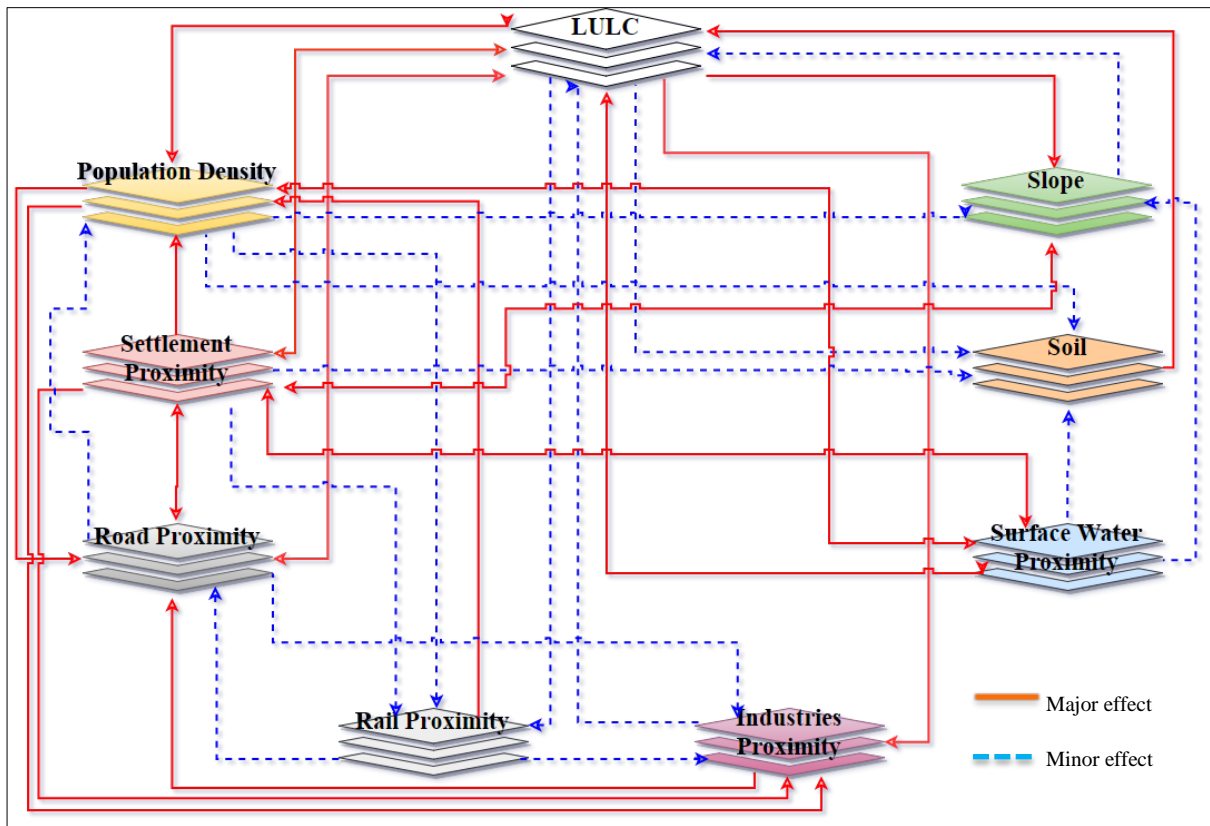


Figure 5: Framework of Multi Influencing Factor (MIF) for site suitability analysis

Table 3: Assigning factors weight through Multi Influencing Factor (MIF)

Factors	Major Effects (A)	Minor Effects (B)	Proposed relative rates (A+B)	Proposed weight for each IF $\frac{[A+B]}{\sum[A+B]} \times 100$
Land use/Land cover	1+1+1+1+1	0.5+0.5	7	21
Population Density	1+1+1+1	0.5+0.5+0.5	5.5	16
Slope	1	0.5+0.5	2	6
Soil	1	0.5+0.5	2	6
Surface Water Body	1+1+1	0.5+0.5	4	12
Rail proximity	1	0.5+0.5+0.5	2.5	7
Road proximity	1+1	0.5+0.5	3	9
Settlement proximity	1+1+1+1+1	0.5+0.5	6	18
Industrial proximity	1	0.5	1.5	4

### 5.3 Site Suitability Analysis for Urban Development

In this study, to identify the site suitability analysis nine various thematic layers has been taken such as Land use/Land cover (Lu/Lc), soil, slope, distance from the road, distance from the railway, settlement, Industries, surface water body, and population density. Site suitability for urban development has been done with the help of the multi influence factor (MIF) and geo-spatial technology.

**Road Proximity:** The road network plays a very important role in the urban development. The road networks were digitized from the SOI topo-sheets. The National Highway NH-67 connecting Tiruchirappalli and Tanjore District is the main road network running west to east across the study area. As more settlement develops near the road networks because of the transportation facilities and very easy access to the nearby places and city centers. The five different classes' of proximity regions for road networks were generated viz., 50m, 100m, 150m, 200m, and >200m proximity respectively. High weightage has been given for 50m class which covers an area of about 27.44 km<sup>2</sup> as the development of settlements and multi-story buildings are highly possible near the road networks. Low

weightage has been given for >200m proximity class which covers an area of about 171.85 km<sup>2</sup>, as there are fewer chances for the development of settlements away from road networks.

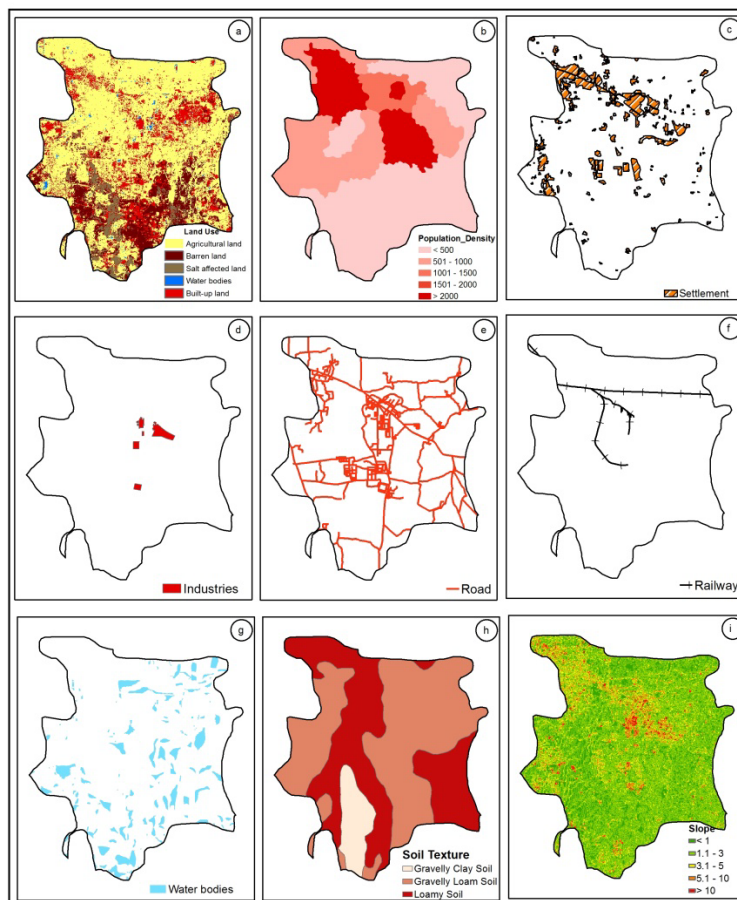


Figure 6: a) Land use/Land cover, b) Population Density, c) Settlement, d) Industry, e) Road network, f) Rail network, g) Surface water body, h) Soil Texture, i) Slope

**Population Density:** The population density is also an important criterion in urban development because people migrate from their dwellings to the places where the density of population is high. The census data of 2011 is used to generate the population density map of the study area. Four different classes have been classified. The highest weightage is given to the class where the population density is high which covers an area of about 44.07 km<sup>2</sup> and the low weightage has been given to the class where the population density is low which covers an area of about 130.31 km<sup>2</sup>.

**Settlement Proximity:** The distance from the settlements also plays an important role in the urban development. The settlements in the Thiruverumbur taluk is captured from the LISS IV satellite images of the study area. The settlement proximity map has been generated and four different classes of proximity regions were classified. As more settlements are developed near the established settlements to reduce the occurrence of built-up land and to create coherence with the pre-developed area. So, the highest weightage is given to the places near the settlements i.e. for 50m proximity which covers an area of about 36.08 km<sup>2</sup> and lowest weightage has been given to the >200m buffer region which covers an area of about 186.35 km<sup>2</sup> where the settlements is very low.

**Land use/Land cover:** Land use/Land cover of the study area is generated using Landsat 8 (2017) satellite image. Five different classes of land use/land cover have been categorized i.e. agricultural land, built-up area, wasteland, salt-affected land and water bodies. The agricultural land covers the total area of 165.20 km<sup>2</sup>, the built-up land covers an area of about 47.08 km<sup>2</sup>, wasteland covers an area of about 33.94 km<sup>2</sup>, salt-affected land covers an area of about 10.77 km<sup>2</sup> and the water bodies' covers an area of about 1.75 km<sup>2</sup>. The highest weightage is given to the wasteland as the land is readily available for the creation of new urban dwellings and the agricultural land is given the lowest weightage as the development of urban dwellings in the agricultural land is prohibited.

**Surface water body proximity:** Surface water bodies like lake, pond, and tanks play an important role in the development of the urban settlements, as the primary need for the construction of a settlement is the availability of water. So, the area near the water bodies develops more rapidly than the area which is away from the surface water

bodies. The surface water bodies of Thiruverumbur taluk were captured using SOI (Survey of India) topo-sheets and the proximity to the surface water bodies was generated. Four different classes have been classified. The weightage and the score is given based on the fuzzy membership and the highest weightage is given to the <50m proximity class which covers an area of about 36.29 km<sup>2</sup> as the development of urban area is mostly in accordance with the nearest distance from the water bodies and the least importance is given to the >200m proximity class which covers an area of about 178.22 km<sup>2</sup> as the development of settlements is least suitable here.

**Railway Proximity:** In the study area, the Ponmalai railway station which also called as Golden Rock Railway Workshop, is one of the three mechanical workshops serving the southern zone of the Indian Railways. The railway lines are captured from the SOI topo-sheets and proximity has been generated around the rail network. Four different classes have been classified. The weightage and ranking is given with the help of fuzzy membership function. The highest importance is given to the <50m proximity as it has the most probability of getting developed due to the presence of mechanical workshop which enhances the economic importance of that region and the least importance is given to the >200m proximity as the development of settlements away from the railway network is least probable.

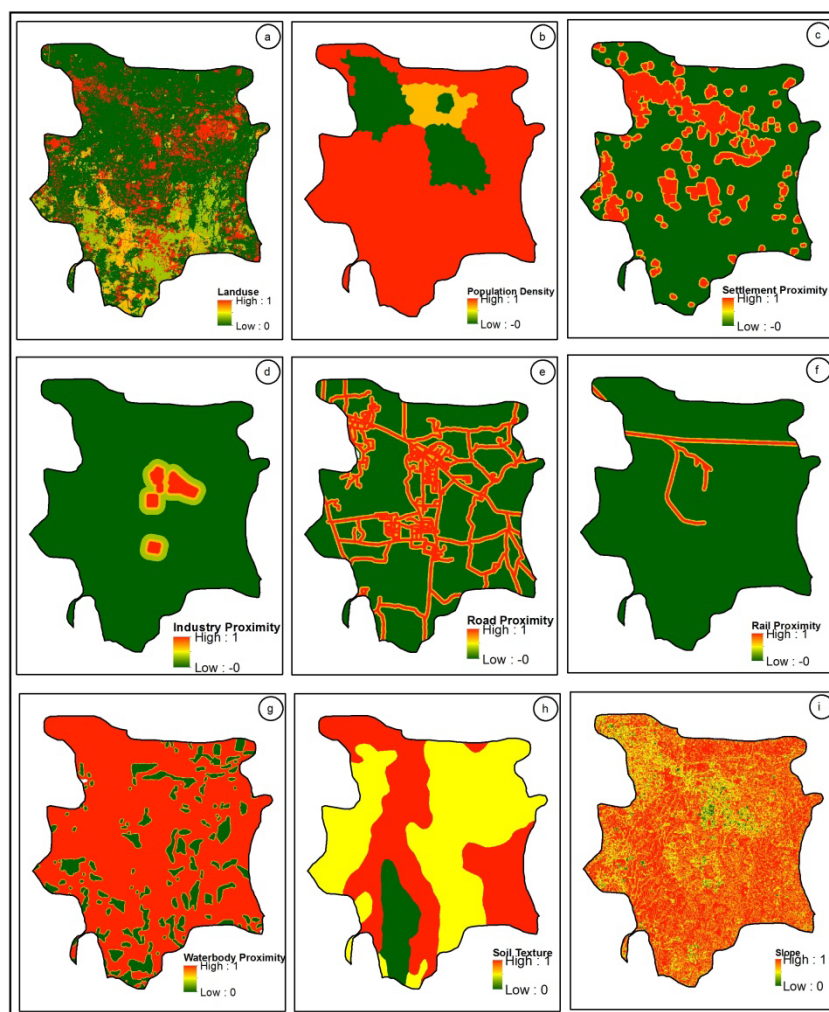


Figure 7: a) Land use/Land cover, b) Population Density, c) Settlement proximity, d) Industrial proximity, e) Road network proximity, f) Rail network proximity, g) Waterbody proximity, h) Soil Texture, i) Slope

**Industries Proximity:** Industries play an important role in the development of urban settlements for more economical reasons. Industries in the study area have been captured using the LISS-IV satellite image, proximity has been generated. Four different classes have been classified. The highest importance is given to the 0-200m proximity area, as the development of urban settlement is more near the Industries, as the people working in the Industries and others migrate their dwellings to these surroundings for their profession and economical aspects.

**Slope:** The slope of the study area has been classified into five classes as low (<1), medium (1-3), gentle slope (3-5), steep slope (5-10) and very steep slope (>10). The highest weightage has been given to the low (<1) slope which



covers an area of about 76.39 km<sup>2</sup> and the lowest weightage is given to the very steep slope which covers an area of about 3.19 km<sup>2</sup>.

**Soil Texture:** The soil texture of the study area has been classified into three type's i.e. gravelly clay soil, gravelly loam soil, and loamy soil respectively. Here, the highest weightage is given to loamy soil which covers an area about 103.89 km<sup>2</sup> and the least weightage is given to the gravelly loam soil which covers an area of about 20 km<sup>2</sup>.

Table 4: Factors weightage

Factor	Class	Area (km <sup>2</sup> )	Weightage
Land use/Land cover	Built-up land	47.08	21
	Agricultural land	165.20	
	Scrubland	33.94	
	Waterbody	1.75	
	Salt-affected land	10.77	
Population Density	0-500	130.31	16
	500-1000	70.83	
	1000-1500	13.49	
	>1500	44.07	
Settlement Proximity	<50m	36.08	18
	50-100m	12.16	
	100-200m	24.04	
Road Proximity	>200m	186.35	9
	<50m	27.44	
	50-100m	23.09	
	100-200m	36.13	
Rail Proximity	>200m	171.85	7
	<50m	3.13	
Industrial Proximity	50-100m	2.98	4
	100-200m	5.84	
	>200m	246.74	
Slope	0-200m	6.10	6
	200-400m	4.33	
	400-800m	8.88	
	<800m	239.41	
	<1	76.39	
Soil Texture	Medium (1-3)	132.22	6
	Gentle Slope (3-5)	32.00	
	Steep slope (5-10)	14.3	
	Very steep slope (>10)	3.19	
Surface water body proximity	Gravelly clay soil	20.00	6
	Gravelly loam soil	134.68	
	Loamy soil	103.89	
Surface water body proximity	< 50m	36.29	12
	50-100	14.02	
	100-200	29.94	
	> 200	178.22	

#### 5.4 Suite Suitability for Urban Development

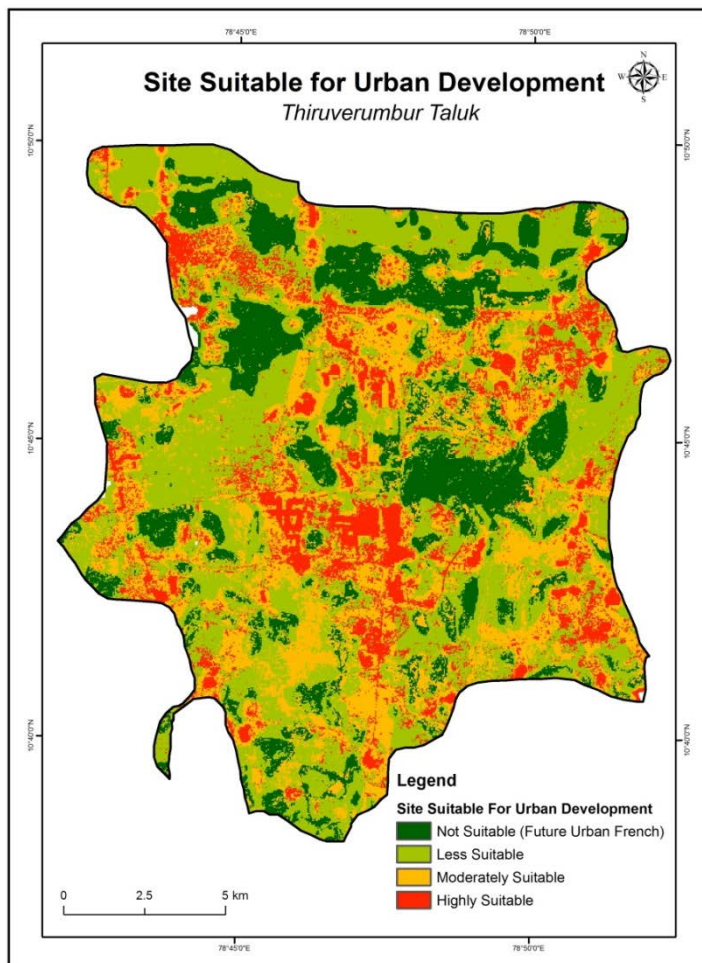


Figure 8: Site Suitable for urban Development

In this study, identification of site suitability for urban development in Thiruverumbur taluk, Tiruchirappalli District has been done: nine thematic layers such as Land use /Land cover (Lu/Lc), Population density, Settlement, Distance from Road, Distance from Railway, Industry, Surface Water Body, Soil, and Slope were considered in this study, through Multi Influencing Factor (MIF) and fuzzy membership function with geospatial techniques. The highest factor weight is given for more importance to urban development: land use (21), settlement proximity (18), population density (16), surface water body (12), road network proximity (9) and the least weight is given to the urban development, rail network proximity (7), soil and slope (6 each) and very least weight is given to industrial proximity (4) (Table 3).

The individual factors, sub-classes weights were given through fuzzy membership function which the highest rating represent 1 and least rating represent 0. Finally, all nine thematic layers were overlaid through raster operation and site suitability map for urban development is obtained. The resultant map (figure 8 ) is classified into four site suitable classes which are highly suitable, moderately suitable, less suitable and not suitable. The highly suitable class covers an area of about 37.4 km<sup>2</sup> (14.5%) which lies on the northern and middle part of

the study area followed by moderately suitable area is 63.8 km<sup>2</sup> (26.7%), it is located around the highly suitable class, 104 km<sup>2</sup> (40.5%) is covered by less suitable class and 46.9 km<sup>2</sup> (18.1%) of area is not suitable for urban development.

## 6. CONCLUSION

In recent days, fast-growing population, urbanisation and industrialisation which leads to the development of new urban centers and urban fringe areas. In this scenario, Thiruverumbur taluk is also one of the fast-growing suburbs in Tiruchirappalli District. Therefore, land use/land cover changes and site suitability for urban development is studied, in detail. The major changes in the built-up areas from 2001-2017 in land use/land cover is around +54% and the highly suitable class in site suitability analysis for urban development falls around the built-up areas. It clearly shows the rate of changes in built-up and the highly suitable class is positively correlated in both the studies. May be not suitable class is the future location for urban fringe and the site for disposal of solid waste. This study would be helpful from global to local level of planning in all the Government and Non - Government sectors, planners and policy makers for the effective sustainable development in the urban areas which leads to eco-friendly environment.

## REFERENCES

- Abdul Rahaman S., Aruchamy, S., Balasubramani, K., and Jegankumar, R. 2017: Land Use/Land Cover Changes In Semi-Arid Mountain Landscape In Southern India: A Geoinformatics Based Markov Chain Approach, *Int. Arch. Photogramm. Remote Sens. Spatial Inf. Sci.*, XLII-1/W1, 231-237. (doi.org/10.5194/isprs-archives-XLII-1-W1-231-2017).
- Abdul Rahaman S., Abdul Ajeez S., Aruchamy S. Jegankumar R., 2015. Prioritization of Sub Watershed Based on Morphometric Characteristics Using Fuzzy Analytical Hierarchy Process and Geographical Information System – A Study of Kallar Watershed, *Tamil Nadu Aquatic Procedia* 4, pp.1322-1330.
- Chen S., Zeng S. and Xie C., 2000. Remote Sensing and GIS for Urban Growth Analysis in China, *Photogrammetric Engineering & Remote Sensing*. Vol. 66, pp.593-598.
- Hauser P.N., 1982. *Population and the Urban Future*, New York: State University Press,
- Jain K. and Subbaiah Y. V., 2007. Site Suitability for Urban Development using GIS *Journal of Applied Sciences*. pp. 2576-2583.
- Kumar M. and Shaikh V.R. 2013. Site Suitability Analysis for Urban Development using GIS Based Multicriteria Evaluation Technique - A Case Study of Mussoorie Municipal Area, Dehradun District, Uttarakhand, India *Journal of Indian Society of Remote Sensing*. pp.417-424.
- Kumar S. and Kumar R. 2014. Site Suitability Analysis for Urban Development of a Hill Town Using GIS Based Multicriteria Evaluation Technique: A Case Study of Nahan Town, Himachal Pradesh, India, *International Journal of Advanced Remote Sensing and GIS*. Vol. 3, pp. 516-524.
- Misra S.K. and Sharma S. 2015. Site Suitability Analysis for Urban Development: A Review, *International Journal on Recent and Innovation Trends in Computing and Communication (IJRITCC)*. Vol. 3.
- Rokni K., 2014. Water Feature Extraction and Change Detection Using Multitemporal Landsat Imagery, *Remote Sensing*. Vol. 6, pp. 4173-4189.
- Scariah N.V., and Vinaya M.S., 2016. Site Suitability Analysis for Urban Development in Krishnagiri Taluk, Tamilnadu, *International Journal of Innovative Research in Science, Engineering and Technology*, 3: Vol. 5.
- Singh A., 1989 Review Article Digital Change Detection Techniques Using Remotely-Sensed Data, *International Journal of Remote Sensing*. Vol. 10. - pp. 989-1003.
- Sundaram A. and Muniraj K. 2016. Detection of Urban Changes and Statistical Site Suitability Analysis in Tiruchencode taluk using Geoinformatic Techniques, *International Journal of Earth Sciences and Engineering*. Vol. 09, pp. 1465-1473.
- Weldu W.G. and Deribew I.A, 2016. Identification of Potential Sites for Housing Development Using GIS Based Multi-Criteria Evaluation in Dire Dawa City, Ethiopia *International Journal of Sciences: Basic and Applied Research (IJSBAR)*. Vol. 28. - pp. 34-49.