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IMPACT OF LAND USE ON ENVIRONMENTAL QUALITY DUE TO URBANIZATION A CASE STUDY – TIRUMANGALAM TALUK, MADURAI

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ABSTRACT

Large amount of natural lands have been converted to urban due to rapid population growth and rural to urban migration. Prior land use pattern also getting changed in their activities. Finding out the ways and means for protection of land using environmental quality is the need of the hour. Sustainable land management is a critical challenge of earth system and resources on the land. Protection of productive agriculture land has become a major priority in many regions of the world. Impact can be defined as any change in the physical, chemical, cultural (or) socio-economic, environmental system as a result of activities related to that of land use. In particular the changes of Land Use and Land Cover modify the physical parameter of earth surface thus affecting material and energy interchanges between land and atmosphere. LULC - change directly impacts bio diversity, modifying the composition, and structure of ecosystem. Agricultural land used as an urban area have significant (-ve) effects on the environmental quality as they generate environmental problems such as impact of the water cycle, impact on the ground (or) surface water, emission of water pollutants, air pollutant, soil degradation etc. This research is mainly concentrates on LULC - change by using Quantum GIS Software (QGIS). The range of land use conversions is identified and the ways & means for the various impacts are analysed based on LULC. This research paper has identified the ranges in variations of land use and degradation of the environmental quality.

Keywords: LULC; GIS; remote sensing; urbanization; change analysis

1. INTRODUCTION

Land use and land cover is an important component in understanding the interactions of the

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human activities with the environment and thus it is necessary to stimulate changes [1]. Urban expansion has increased the exploitation of natural resources and has changed land use land cover patterns. Rapid urbanisation therefore brings opportunities for new urban developments. LULC is a major issue of global environment change [2, 3]. Scientific research community called for substantive study of land use changes during the year 1972 (Stockholm conference) on the human environment and again 20 years later at 1992 United Nations Conference on Environment and Development (UNCED). At the same time, International Geosphere & Biosphere (IGBP) programme and International Human Dimension Programme (IHDP) co organized a working group to set us a research agenda and promote research activity for LULC changes [1]. Land use refers to man's activities and the varied uses which are carried-on over the land and land cover refers to natural, vegetation, water bodies, rock, soil, artificial cover and others noticed on the land (NRSA-1989) [1]. Land use includes agriculture land, built up land, recreation area and wildlife management area etc [1]. Mapping is an essential component, where in other parameters are integrated on the requirement basis to derive various development indexes for land and parent water resource.

Land degradation results mainly due to population pressure which leads to intense land use without proper management practices. Remote sensing and Geographic Information System (GIS) provide efficient methods for analysis of land use issues and tools for land use planning and modelling [4-7]. In water sheds the land use has direct effect in determining water quality. The change in any form of land use is largely related either with the external forces and the pressure built up within the system (Bisht and Kothyari – 2001). UDR programme provides basic data, predictions, and perspectives to help in forming sound policies for guiding environmentally sustainable growth [8].

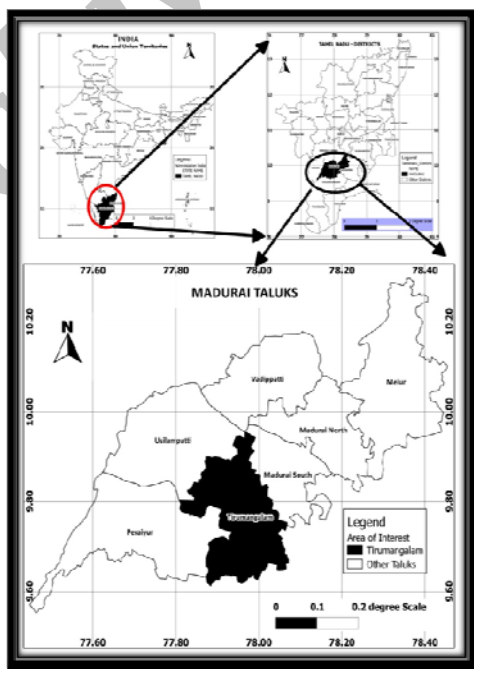

Figure 1. Study area

1.1 Study area

The latitude and longitude extension of the Tirumangalam Taluk (Study area) is 9°37'32.89"N to 9°57'55.95" N and 77°48' 55.17"E to 78°57' 18.52" E respectively and its altitude range from 52 to 353m above mean sea level. The climate is dry and hot, with rains during October - December. Temperatures during summer reach a maximum of 40 and a minimum of 26.3 degrees Celsius. Winter temperatures range between 29.6 and 18 degrees Celsius. The average annual rainfall is about 85 cm. As of the 2001 India census, the city of Thirumangalam had a population of 196,642. Males constitute 98,877 of the population and females 97,765.

1.2 Software used

Quantum GIS (QGIS) is a powerful and user friendly Open Source Geographic Information System (GIS) that runs on Linux, Unix, Mac OSX, and Windows. QGIS supports vector, raster, and database formats. QGIS is licensed under the GNU Public License.

2. METHODOLOGY

2.1 Data collection

Topographic sheets: A topographic map is a detailed and accurate graphic representation of cultural and natural features on the ground. A topographic map is a type of map characterized by large-scale detail and quantitative representation of relief, usually using contour lines in modern mapping, but historically using a variety of methods. Traditional definitions require a Topographic map to show both natural and man-made features. Index number of Survey of India Toposheets 58G13, 58G14, 58K1NW, 58K1SW and 58K2 were collected. Toposheets were prepared during 1972, contains settlements, roads, water bodies (ponds, lakes and rivers), forest area etc. Topographic sheets were georeferenced in QGIS software environment.

2.2 Methodology flow diagram

The methodology adopted is shown as flow diagram in Figure 2.

2.3 Taluk map

In India, Districts are divided into Taluks for the purpose of Revenue Administration. Taluks consist of a group of Revenue Villages. A Revenue Village is a small administrative region, a village with defined borders. One revenue village may contain many hamlets. The Taluk map of Tirumangalam (1:75000) has been collected from Survey and Land records, Chennai. It consist of 108 revenue villages, was georeferenced with help of GPS coordinates and toposheets.

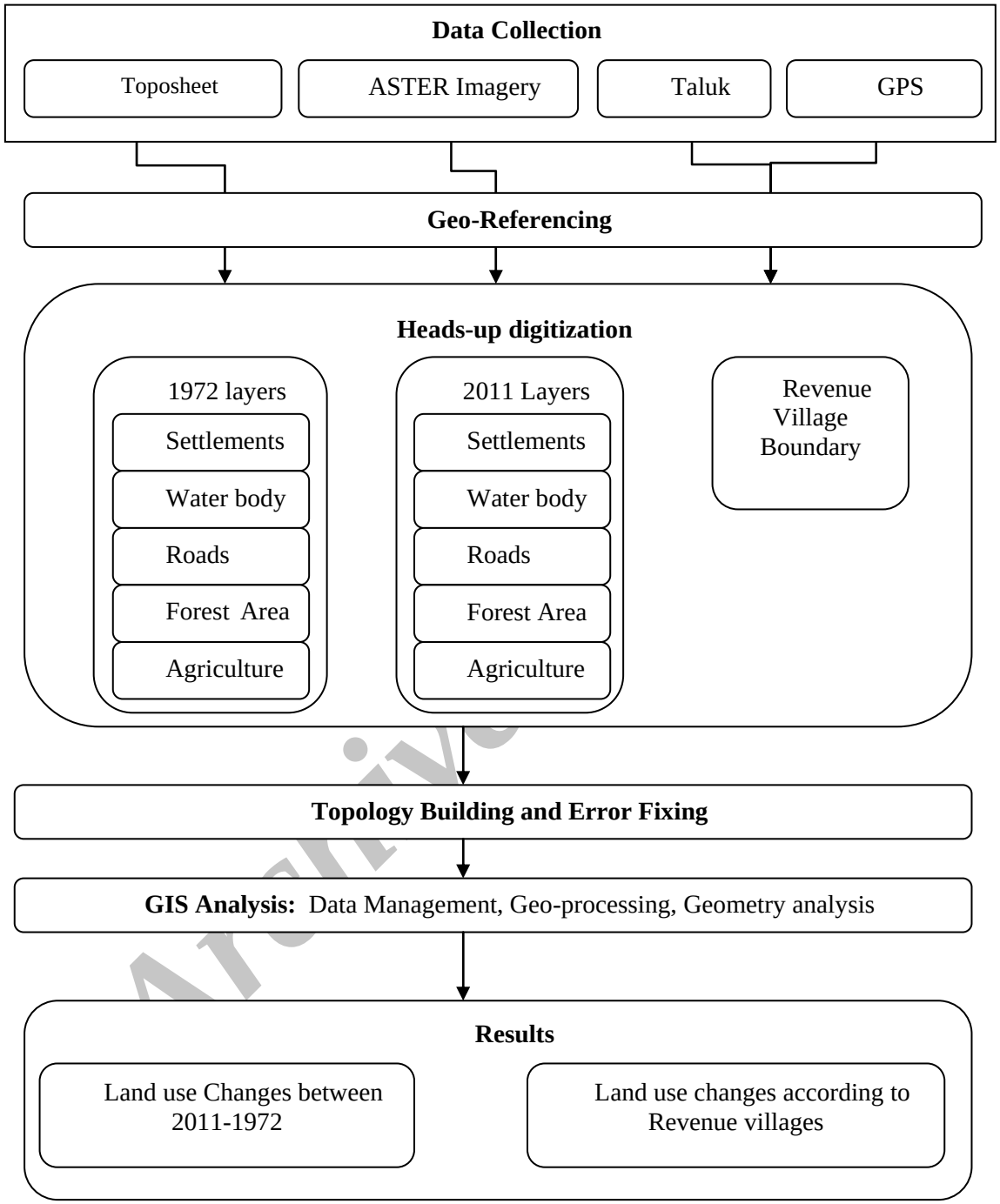

Figure 2. Methodology flow diagram

2.4 Satellite imagery

The ASTER sensor provides multi-spectral images of the Earth with each image granule covering roughly 60 km by 60 km on the ground. The ASTER images have 14 spectral bands, three in the visible and near-infrared (VNIR instrument, 0.52 – 0.86

mm), six in the short-wave infrared (SWIR instrument, 1.60–2.43 mm) and five in the thermal infrared (TIR instrument, 8.12–11.65 mm) (Yamaguchi et al. 1998). The spatial resolution is 15 m (VNIR), 30 m (SWIR) and 90 m (TIR). Two ASTER image granules were collected. Both images are nearly 100% cloud free and combined provide complete coverage of the Tirumangalam taluk.

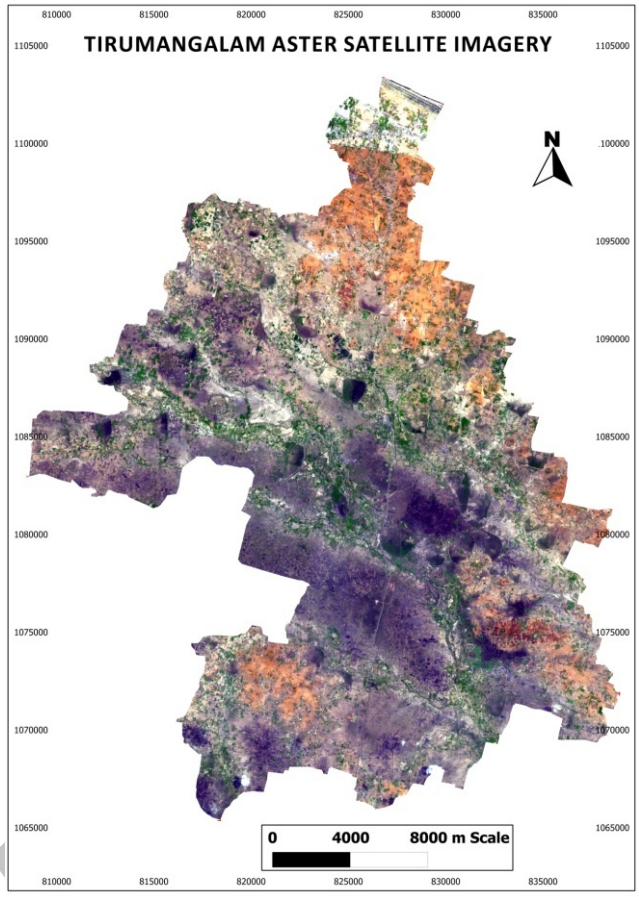

Figure 3. Terra Satellite – ASTER imagery

Figure-3 shows an RGB color composite of the 'mosaic' image. A grid of reference points with latitude and longitude is provided on the header files of ASTER data Level 1B. The accuracy of an image transformation based on these reference points was evaluated. It was verified that an image rectification based on these points alone is reasonably accurate for flat areas, except for a small offset that can be easily fixed. The satellite imagery of Tirumangalam taluk was acquired in the year of 2011, which has been shown in Figure 4.

2.5 Digitization

The entire research was followed uniform coordinate reference system i.e. WGS 84 UTM zone 43N. The digitization process was performed in manual.

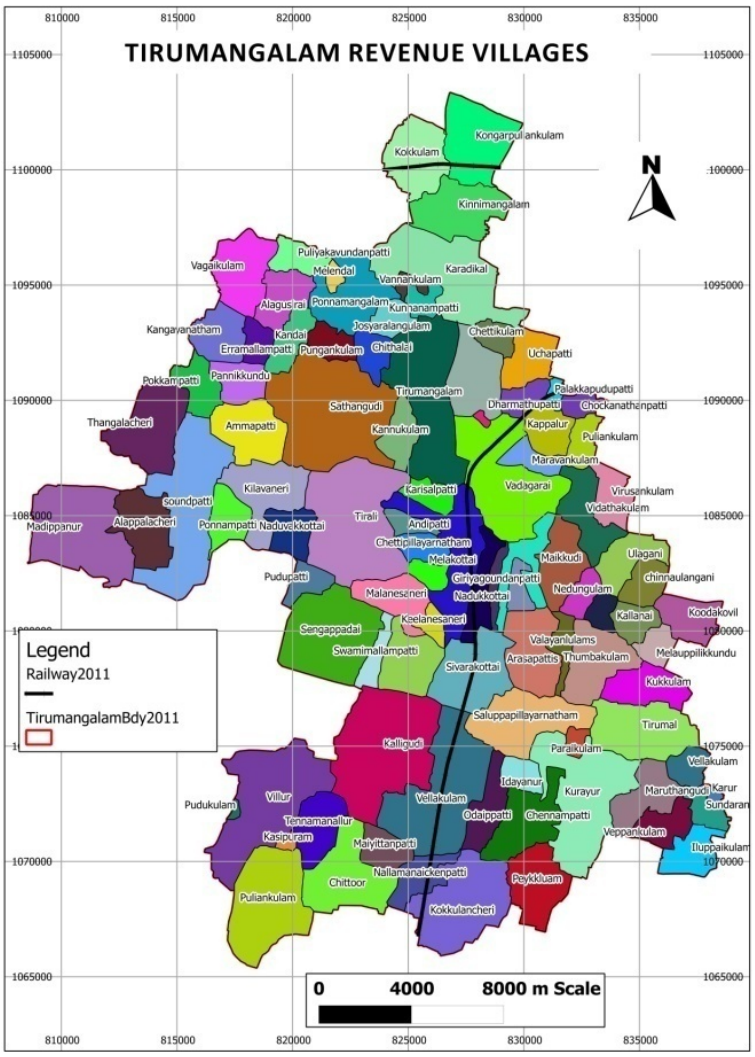

Figure 4. Revenue villages map

The manual digitization can be done in two basic ways. One is heads-up digitization and another is heads-down digitization. First method uses scanned copy of the tracing sheet in JPEG or TIFF format and digitization is being done on the screen of the computer monitor. Therefore it is also known as onscreen digitization. While the heads-down digitization is being done on a digitizing table using a magnetic pen known as Puck. These days the heads-down digitization became obsolete as it is a strenuous way of digitizing. The digitization process thus requires the use of appropriate software. For this purpose Quantum GIS and GRASS were used. The taluk map of study area was digitized and attributed. Land use map of Tirumangalam taluk (1972) was prepared by using toposheets. It has been shown in Figure 5.

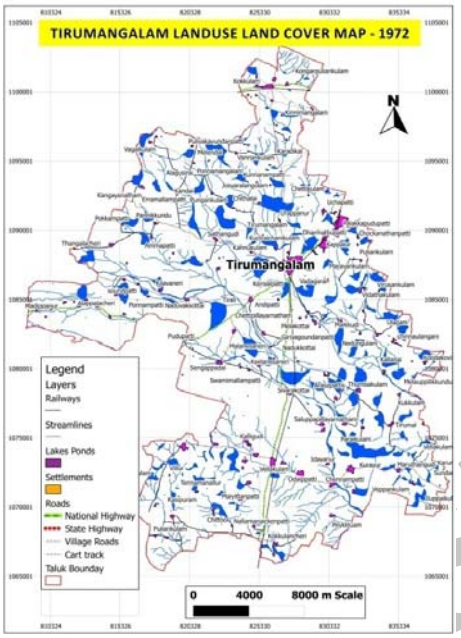

Figure 5. Land use Map 1972

The features of administrative boundary, railways, road network, water bodies & streamlines and settlements were digitized and attributed in esri-shape file format. Similarly the land use map of Tirumangalam (2011) was interpreted by using ASTER satellite imagery and attributed in Figure 6.

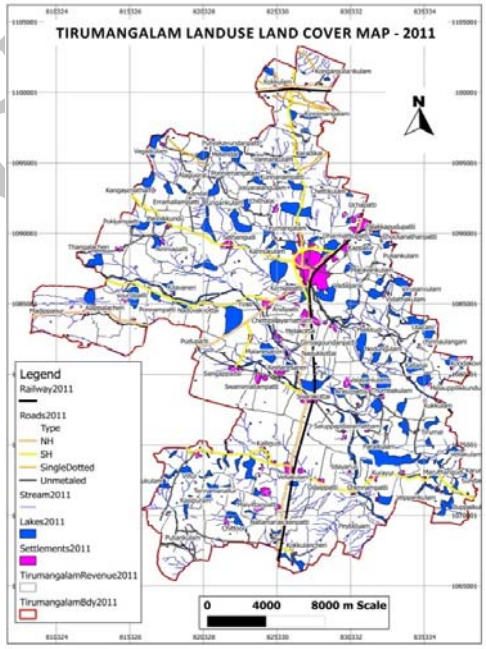

Figure 6. Land use map 2011

3. RESULTS AND ANALYSIS

The total area of land use for Tirumangalam Taluk for the year 1972 and 2011 has been compared under the land use category like settlements, water bodies, agriculture, roads and railways. The Summary of Changes is shown in Table-1. Changes in Settlements, Water bodies, Agriculture, roads & railways in each revenue villages of Tirumangalam Taluk are shown in Table 2, Table 3, Table 4, Table 5 respectively. Significant changes in area are occurred in settlements, agriculture and water bodies. The area for settlement during 1972 was 8.34km^2 which has increased significantly to 19.39km^2 during the year 2011 with a positive change of 11.04 km^2. This positive change is due to the negative change in water bodies of 6.99 km^2 and negative change in agricultural land use amounting 4.60 km^2. This negative changes lead to negative impact on environmental quality. The conversion of land used for water bodies to settlements pollutes water quality and poor imperviousness. The conversion of agricultural land to settlements leads to soil erosion, degradation in socio economic activities, modification of vegetation, sedimentation, land productivity, changes on bio diversity, climatic condition etc.

Table 1: Changes – summary

Layer Name	Land use 1972	Land use 2011	Change
Settlements in km^2	8.34	19.39	+11.04
Water bodies in km^2	60.626	53.62	-06.99
Agriculture in km^2	496.23	491.35	- 4.60
Roads in km	849.95	856.24	+ 7.00
Railways in km	33.21	33.21	---
Streams in km	439.11	439.11	---

Table 2: Changes in settlements (km^2**)**

Revenue Villages	1972	2011	Change
Vadagarai	106.39	413.28	306.89
Tirumangalam	29.51	158.99	129.48
Melakottai	4.69	107.63	102.95
Vellakulam	32.17	95.64	63.47
Sivarakottai	13.64	57.75	44.11
Sengappadai	10.09	49.54	39.45
Karisalpatti	0.46	36.58	36.11
Arasapattis	8.92	41.28	32.36
Sathangudi	7.95	35.80	27.85
Swamimallmpatti	1.49	26.54	25.05
Andipatti	7.28	30.11	22.84
Rayapalayam	4.79	25.60	20.81
Maiyittanpatti	5.51	26.26	20.75

Table 3: Changes in water bodies (km^2)

Revenue villages	1972	2011	Change
Tirumangalam	375.88	298.45	-77.43
Urappanur	125.52	81.25	-44.27
Sathangudi	264.35	236.60	-27.75
Chithalai	63.04	37.01	-26.03
Arasapattis	129.76	105.23	-24.53
Uchapatti	38.23	18.91	-19.32
Kappalur	67.24	50.59	-16.65
Sivarakottai	139.65	124.54	-15.12
Nadukkottai	26.53	13.21	-13.32
Vidathakulam	102.70	90.10	-12.60
Dharmathupatti	20.36	8.88	-11.48
Vadagarai	242.13	231.23	-10.90
Maruthangudi	64.34	53.65	-10.68
Karadikal	51.10	40.76	-10.34

Table 4: Changes in road (km)

Revenue villages	Road 1972	Road 2011	Change
Tirumangalam	16.82	19.70	2.89
Vadagarai	22.25	24.34	2.09
Melakottai	18.57	19.68	1.11
Sathangudi	25.16	25.39	0.23

Table 5: Changes in agriculture area (km^2**)**

Revenue villages	Agri 1972	Agri 2011	Change
Vadagarai	1228	826	–402
Melakottai	941	841	–99
Vellakulam	1621	1529	–92
Tirumangalam	1550	1468	–82
Sengappadai	1326	1277	–49
Sivarakottai	899	857	–43
Palakkapudupatti	81	39	–42
Kalligudi	1924	1886	–38
Karisalpatti	204	168	–37
Dharmathupatti	214	182	–32
Kokkulam	740	710	–31

4. CONCLUSION

The analysis results show that there is a significant increase in settlement and reduction in water bodies and agriculture. These land use changes cause negative impact on Environmental Quality like Degradation in soil, Water quality, Natural Eco system, Socio Economic Cultures. Therefore understanding the process of urban growth and exploring its effects on Natural Eco system. Sustainable land management is more essential to prevent the exploitation of environmental quality. Local planning authority must take care for the urban expansion areas. Land degradation results mainly due to population pressure which leads to intense land use without proper management practices. The purpose of using GIS is that the maps provide an added dimension to data analysis which brings us one step closer in visualizing the complex patterns and relationships that characterize real world-planning and policy problems. We have one planet with a sensitive environment and finite supply of resources. If we don't sustain them they will not sustain us.

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