IDENTIFICATION AND MANAGEMENT OF SPECIAL ECONOMIC ZONES (SEZ) USING SPATIAL AND NON-SPATIAL TECHNIQUES (A CASE STUDY OF SRIPERUMBUDUR TALUK, CHENNAI)

M.Nagarajan,
School of Civil Engineering, SASTRA University, Tanjavur,
Tamil Nadu, India – 603203
nagarajan@civil.sastra.edu.

M.Sureshkumar,
Department of Civil and Structural Engineering, SCSVMV University, Kanchipuram,
Tamil Nadu, India
sureshgis@rediffmail.com
N.Syed Jaffer Sadiq
jaffer.86@gmail.com

ABSTRACT

A study was conducted for Identification and Management of Special Economic Zone (SEZ) in Sriperumbudur Taluk of Tamil Nadu, India using GPS & GIS Analysis. In this study the thematic maps of Landuse / Landcover map, Road network maps (LISS IV) and Soil map has been prepared by using ArcGIS 9.2 software. The landuse / landcover map of 2003 & 2007 were analyzed and delineated the industrial area & built-up area. In the year 2003, the aerial extent for the SEZ in the study area is 1.2sq.km and it will be extended upto 1.4 sq.km in the year of 2007. The change detection is mostly acquired in Agriculture land & water bodies. The extended area was converted in to shape file format and imported into ExpertGPS software and validated by using Google Earth. During the validation 90% of data exactly merged with Google Earth features. The built-up area of expected Multi-storey building development in that region has been analyzed through GIS software. For increasing Multi-storey building the proportionate development of SEZ was delineated with considering population strength, Water Requirement and Sewage estimation at different FSI conditions. The future population can be estimated at different methods of Arithmetic method, Geometric method, Incremental Increase method & linear method from 2011- 2029 with different periods like (2001-2011 and 2011-2029) and compared with previous decade (1991-2011). The growth rate of population was found out 25.8% previously, 29.2% as presently and future it will be expected to change up to 34%. For considering population estimation, other requirements like water and sanitary are also predicted and prepared the thematic map for different FSI. The maximum permissible limits of population at different FSI for SEZ are 84247, 138769 & 196596 respectively. The water demands for three FSI values (1.5, 2.5 & 3.5) were found to be 8888305, 18733815 & 26540460 lpd respectively and the sewage capacity was found out from 7582230 lpd (1.5 FSI) to 17693640 lpd (3.5 FSI). This study has been undertaken in order to understand the impacts of SEZ likely to be created in the physical and social infrastructure in the study area and also to be suggested the remedial measures required to be undertaken to meet the requirement for future population.

Keywords: SEZ, FSI, GIS, GPS and Remote sensing.

1. INTRODUCTION

Land covers, as the biophysical state of the earth’s surface and immediate subsurface, are sources and sinks for most of the material and energy movements and interactions between the geo-sphere and biosphere. Changes in land cover include changes in biotic diversity, actual and potential primary productivity, soil quality, runoff and sedimentation rates [15], and cannot be well understood without the knowledge of land use change that drives them. Therefore, land use and land cover changes have environmental implications at local and regional levels and perhaps are linked to the global environmental process. Because of the interrelated nature of the elements of the natural environment, the direct effects on one element may cause indirect effects on others. Urbanization, the conversion of other types of land to uses associated with Urbanization, land to uses associated with growth of populations and economy and is a main type of land use and land cover change in human history. It has a great impact on climate and the temperature difference between the urban and the rural areas are usually modest, averaging less than 1°C, but occasionally rising to several degrees when urban, topographical and meteorological conditions are favorable for the urban heat island (UHI) to develop [13].

In India, unprecedented population growth coupled with unplanned developmental activities has resulted in rapid but skewed urbanization. This has posed serious implications on the resource base, access to infrastructure and the development of the region [11]. The problems created by the haphazard and unrestricted growth of city aggravates irregular and chaotic development of residential, industrial and commercial areas resulting in traffic bottle necks, slums, polluted environment and others all known and felt by the residents of the city [10]. The urbanization takes place either in radial direction around a well-established city or linearly along the highways. This dispersed development along highways or surrounding the city and in rural countryside is generally referred as sprawl. Sprawl is a term that is often used to describe perceived inefficiencies of development, including disproportionate growth of urban areas and excessive leapfrog development. Sprawl is a cumulative result of many individual decisions and it requires not only an understanding of the factors that motivate an individual landowner to convert land, but also an understanding of how these factors and individual land-use decisions aggregate over space [9]. Some of the causes of the sprawl include - population growth, economy and proximity to resources and basic amenities

Land Degradation threatens livelihoods and communal habitats. There is a well-established tendency for water runoff to increase with land degradation [16]. Degradation is caused by over cultivation, over grazing, deforestation, inefficient irrigation and industrialization. In the recent times productive lands are converted to Special Economic Zones (SEZ) by the government for the benefit of the society. Recent advances in the application of remote sensing technology in mapping and monitoring degraded lands, especially in salt affected soils, Overgrazing, Deforestation, Drought, flood leads to natural land degradation and shown great promise for enhanced speed, accuracy and cost effectiveness [12].

A Special Economic Zone (SEZ) is “a specifically delineated duty free enclave and deemed to be a foreign territory for the purpose of trade operations and duties and tariffs”. Goods carrying into the SEZ area from Domestic Tariff Area (DTA) are considered as exports and goods coming from the SEZ area into DTA shall be treated as imported. In any SEZ, goods may be imported or procured from DTA, without payment of duty for the purpose of manufacture of goods and services, production, processing, assembling, trading, repair, reconditioning, re-engineering, packaging, etc.

Rapid urban development and increasing land use changes due to population and economic growth in selected landscapes is being witnessed of late in India and other developing countries. In the recent times, remote sensing and GIS is gaining importance as vital tool in the analysis and integration of spatial-temporal data. The integration of remote sensing and geographic information systems (GIS) has been widely applied and been recognized as a powerful and effective tool in detecting urban land use and land cover change in urban development with SEZ [7], [17] & [8].

2. STUDY AREA

The study area is identified in Sriperambadur Taluk (Fig. 1), Kancheepuram district SEZ. The areal extent of this study area is 3.79 sq.km and it located in the latitude of 12^{o} 0’ 0’’N to 13^{o} 50’ 0’’N and longitude of 79^{o} 0’ 0” E to 80^{o} 30’ 0” E. Kancheepuram district comprises of eight taluks viz., Sriperumbudur (638.29); Tambaram (243.25); Kancheepuram (638.24); Chengalpattu (764.74); Uthiramerur (427.70); Tirukalukundram (369.47): Cheyyur (614.09) and Maduranthakam (766.32) sq.km. covering an total area of 4432 sq.km. In the recent past, Government of Tamil Nadu has opened the new era of Special Economic Zones (SEZ) in and around Tamil Nadu. In particular, the Kancheepuram district has been chosen to be favorable destination for SEZ considering the facts like nearer to Chennai city, harbor, airport, very fast developing area, cheap laborer and about 30% of SEZ of Kanchipuram district is located in Sriperambadur Taluk.

Interesting fact is that the entire district is an agriculture productive district, surplus irrigation is available by means of rainfall, number of tanks with surplus water (1942), number of tube well and bore wells (9096). Whereas, recent development of SEZ has ruined most of the agricultural productive areas/ zones covering taluks like Sriperumbudur, Tambaram, Kancheepuram and Cheyyur to an extent of 48.21 sq.km [14]. Through geospatial technological method, buffer zones were created around all the SEZ to predict future growth and development of the study area that ultimately affects the productivity of the region.

3. MATERIALS AND SOFTWARE USED

The spatial and non spatial data are used in the study. The spatial data includes Land use/Land cover maps (LISS IV) for two different years and GPS tracking points using Hand-held GPS instruments. The non-spatial data includes census data; House- holds information, Area-wise Distribution of SEZ, Education

Level, Migration etc. The softwares used for this study are ArcGIS 9.2, Erdas Imagine 9.1, Expert GPS and MS Office 2003.

3.1. *Methodology*

The detailed methodology adopted for this study is given in Fig.1.

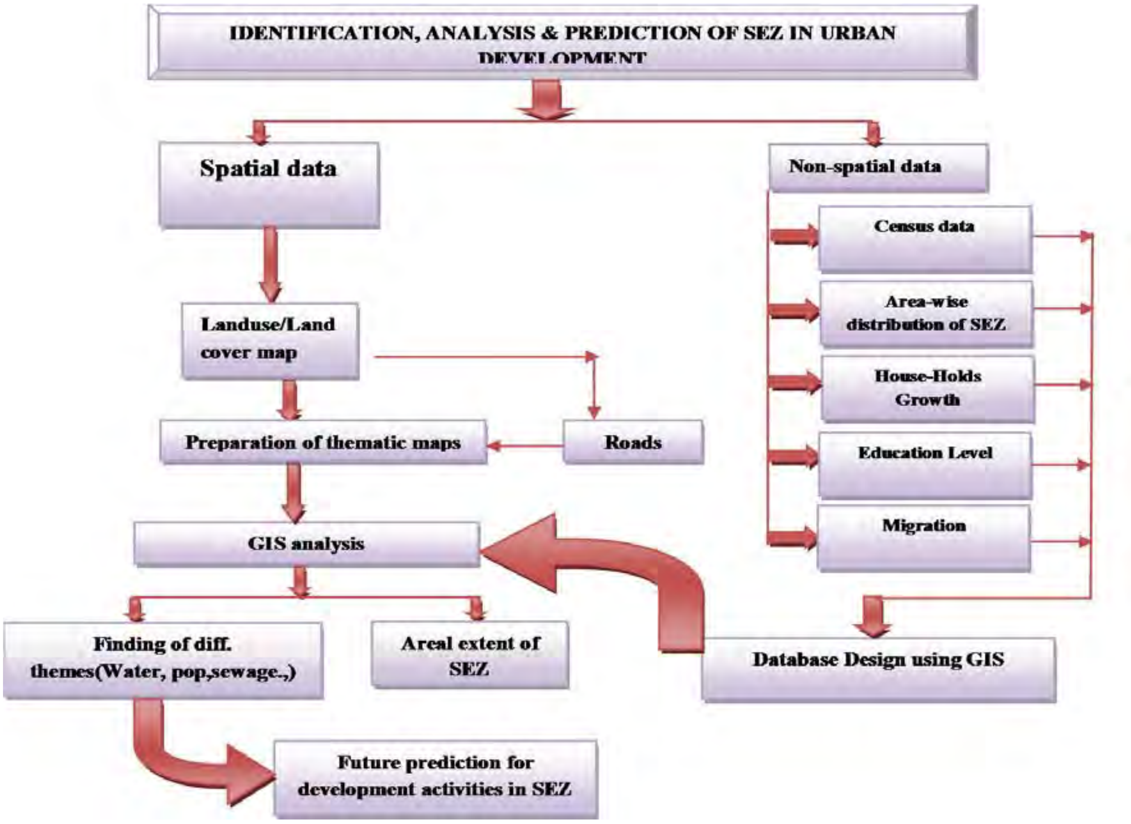

Fig. 1. Flow Chart for Methodology

3.1.1. Landuse/Landcover map

The landuse / land cover was obtained from IRS, Anna University, Chennai for two different years viz., 2003 & 2007. The land use / land cover map was prepared from LISS IV images for the above two years. The study area was exactly delineated through boundary of village. The boundary of village was superimposed with two landuse maps and subsetted through Erdas software.

3.1.2 Change detection

The change detection of Landuse Patterns from agriculture land, water bodies to industries, Built-up area & etc., are determined from the year 2003 to 2007.

3.1.3 GPS data collection

The co-ordinates of important features like industries, multistoried buildings, commercial buildings, water tank & etc are collected through GPS and incorporated with spatial data using ArcGIS software.

3.1.4 Expert GPS & validation

The collected GPS data are imported into Expert GPS software and the file will be converted into Google Earth KML file (.kml) format. The converted Google Earth file will be validated in Google earth.

3.1.5 Population projection

The future population can be estimated at different methods of Arithmetic method, Geometric method, Incremental Increase method & linear method from 2011-2029 with different periods like (2001-2011 and 2011-2029) and compared with previous decade (1991-2011)**.**

3.1.6 Population, Water & Sanitary prediction

The population will be predicted for three different Floor Space Index (FSI) at 1.5, 2.5 & 3.5, based on this population prediction the other requirements like water and sanitary also predicated at different FSI. Finally, achieved a separate thematic layers of each prediction with different FSI was identified.

4. RESULTS AND DISCUSSION

4.1. Land Use / Land Cover map

In this study area there are two land use / land cover map are analyzed and identified the major changes. These maps initially prepared thematic maps and identified the areal extent of different types of landuse patterns. In the year 2003 and 2007 the predominant land use patterns are agricultural land and water bodies. In addition that the roads are extracted from these landuse maps using ArcGIS software.

4.2. Change detection

Change detection is identified by using Land cover/Land use of the year 2003 and 2007 is depicted in Fig. 2 & 3. The aerial extents for the SEZ zones are identified from 2003 to 2007. In 2003 aerial extent for the SEZ is 1.2sq.km and it will be extended upto 1.4sq.km in 2007. The change detection is mostly occurred in Agriculture land & water bodies and to be converted into industrial area & built-up. Extended areas are converted to shape file format. This converted shape file is imported in to ExpertGPS software and validated by Google Earth. The change detection of Industrial and Built-up areas was mostly changed from Agriculture land and water bodies were presented in Table 1 & 2.

Table 1. Change detection from cropland to Industrial area

Landuse / Landcover 2003	**Landuse / Landcover 2007**	**Change detection from 2003 to 2007**	
		Area (m^2)	**Perimeter (m)**
Fallowland	Industrial	33051.62	832.36
Cropland	Industrial	1441991.26	11904.73
Total		1475042.90	12737.13

Table 2. Landuse / Land cover change detection from year 2003 to 2007

Landuse / Land cover 2003	**Landuse / Land cover 2007**	**Change detection**	
		Area (m^2)	**Perimeter (m^2)**
Cropland	Built Up area (Rural)	1371846.71	15892.27
Cropland/Land with scrub	Built Up area (Rural)	315089.32	4294.17
Barren Rocky/Stony waste	Built Up area (Rural)	63438.14	1145.60
Cropland/Land with scrub	Built Up area (Rural)	144332.58	1869.33
Cropland/Industrial	Built Up area (Rural)	341181.23	4062.02
Villages(Rural)	Built Up area (Rural)	71150.42	1267.19
Total		**2307038.45**	**28530.58**

4.3. Importing GPS data and validation

The collected GPS data are imported into Expert GPS and converted to GPS Exchange file (.gpx) format. The Expert GPS was re-projected with the collected waypoints and the tracks were created shape files for further analyzing using GIS software. Imported data are converted into shape file (.shp) format for analyzing. After analyzed the data are imported into Expert GPS then the file will be converted into Google Earth KML file (.kml) format. The converted Google Earth file will be validated in Google earth (Plate 1). During the validation more than 90% of the data were exactly merged only less than 10% errors will be occurred due to instrument error, human error, natural calamatics., etc.

4.4. Population projection

Using FSI method, first identify the MSB developable plots and then use the plot area for finding the build up area. Estimate population strength to accommodate in their particular plot. The model calculation is given below.

4.4.1. Model calculation

Road width -18m

Plot size -1500sq.m

Plot Coverage - 30%

FSI - 2.5

30% coverage-(1500X0.3) -450sq.m

Max built up area-(1500X2.5) -3750sq.m

No. of floors required to achieve FSI - 8

Avg. one flat size -116sq.m

No of flats-(3750/116) -32

Average family size - 4.5 members
(as per SMP)
Population - (32X4.5) -144 persons

4.4.2. MSB permissible areas

To identify the MSB maximum permissible areas and minimum requirements are;

- Min plot size -1500 sq.m
- Min road width -18m
- Min frontage -25m

Based on the above details three roads are identified for MSB permissible areas in this SEZ. By adopting the FSI calculation, the population is predicted for FSI 1.5, 2.5 & 3.5. The predicted data are incorporate in ArcGIS software as an attribute data and prepared the layout for population prediction of different FSI 1.5, 2.5, 3.5 as shown in Fig. 4, 5 & 6. For increasing population the different FSI values (1.5, 2.5, & 3.5) the maximum permissible limit of population in SEZ is 84247 when we considered the FSI is 1.5. At the same time when the

FSI is increased for 2.5 & 3.5 the maximum population also increased 138769 & 196596 respectively.

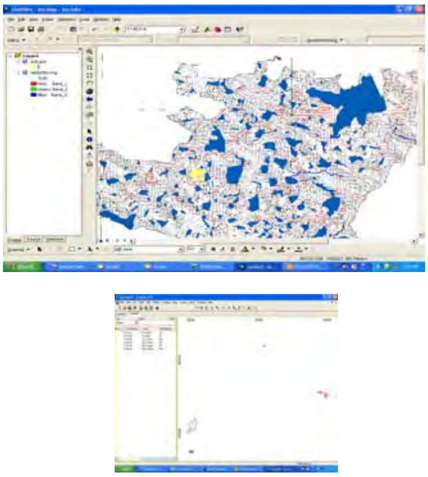

Fig. 2. Delineation of industrial area, 2003

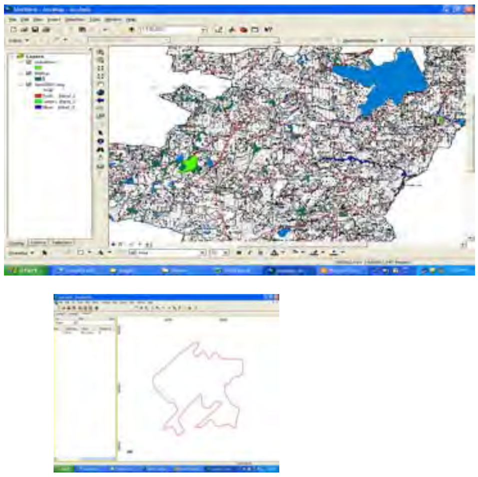

Fig. 3. Delineation of industrial area, 2007

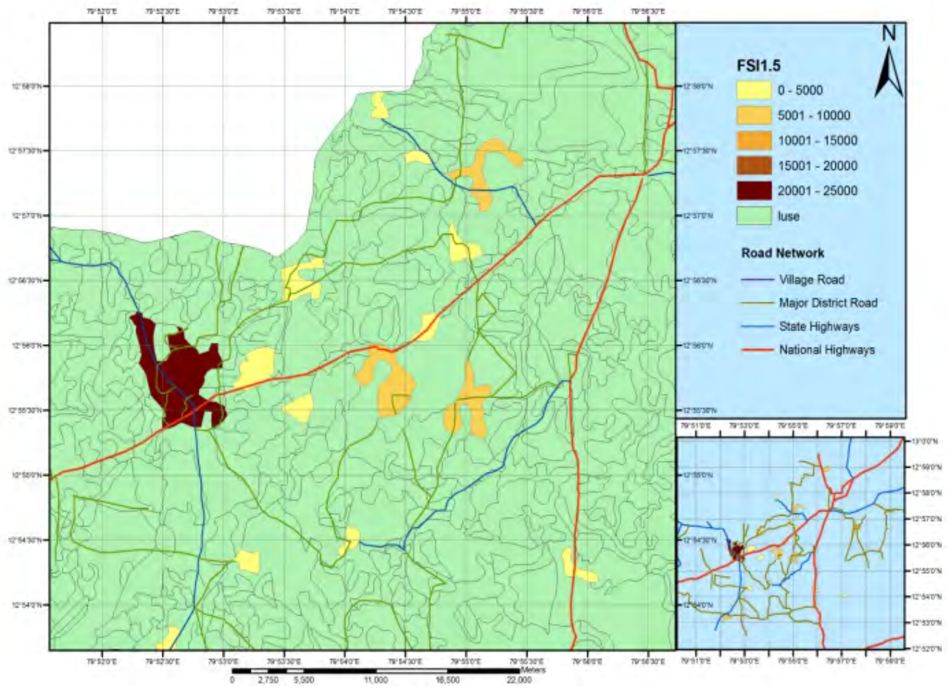

Fig.4. Population prediction for FSI@ 1.5

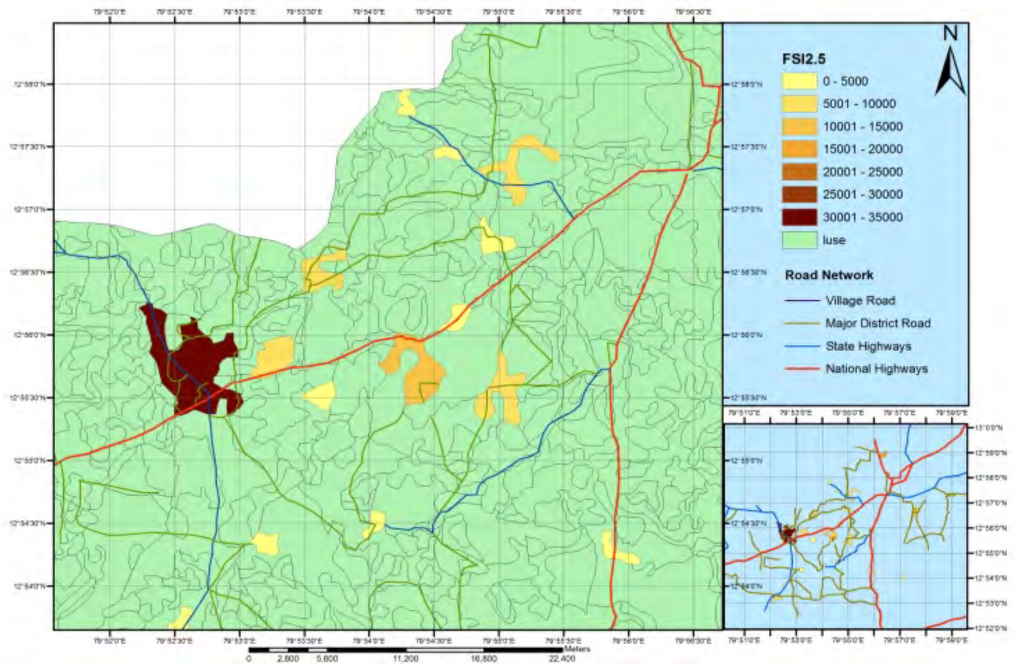

Fig.5. Population prediction for FSI@ 2.5

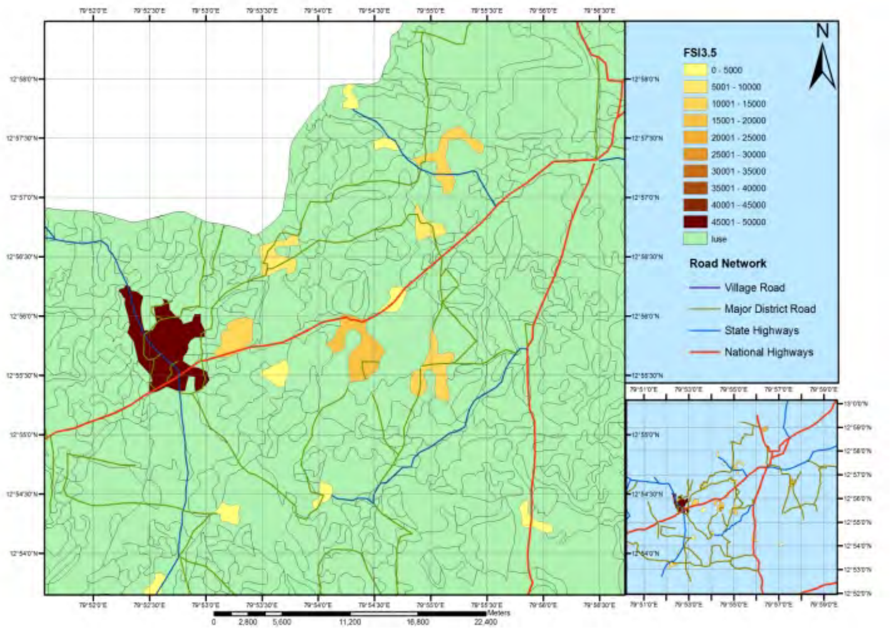

Fig.6. Population prediction for FSI@ 3.5

4.5. Water demand

In this study zone, 21% of people depends on public tap, 72% depends on two sources of water (of which most of them use bore well and public tap) and 7% having three sources (ULB supply, open well, bore well).

4.5.1. Model calculation

Avg demand of water for a person per day = 135 lpcd

Therefore,

As per 1.5 FSI - 9157 persons, the water demand for a day = 9157 x 13 = 1236195 lpd

By using this calculation per captia demand for FSI 1.5, 2.5 & 3.5 were computed. The predicted data are incorporate in ArcGIS software as an attribute data and prepared layout for water demand of FSI 1.5, 2.5 & 3.5 as shown in Figure 7, 8 & 9. For increasing population the other requirements of water and sanitary are also estimated. The water demand for projecting population of 1.5 FSI is calculated at the maximum of 8888305 lpd. At the same time when increasing the FSI values of 2.5 & 3.5 with relevant population growth the changeable demands are 18733815 & 26540460 lpd respectively.

4.6. Sewerage capacity due to increasing population growth

There is no formal sewerage scheme. The sewage from the houses is conveyed to individual septic tanks for treatment. In some cases the soil absorption system has been provided to the septic tanks. But they do not function due to high water table. In most cases, the effluent from the septic tanks is discharged into open channels along the roads. The conditions are unhygienic giving rise to bad odours, severe mosquito breeding, ground water pollution and contamination of water mains. In this study zone, it is identified that 90% of the peoples use own house hold toilet, 8% of them using common toilets and rest of them (2%) do not have toilets, they may use open space only. 81% of the sewage is discharged through open drain and to the garden (13%). The open drainage capacity can be estimated for different FSI with relevant population growth which is given below.

4.6.1. Model calculation

Sewage disposal for a person per day

= (2 /3) x Daily percaptia per Demand

= (2/3) x 135 lpcd

= 90 lpcd

Therefore

9157 persons sewage contribution for a day = 9157 x 90 = 824130 lpd

Based on above calculation sewage capacity for FSI 1.5, 2.5& 3.5 were estimated. The predicted data are incorporate in ArcGIS software as an attribute data and prepared layouts for sewage capacity at different FSI 1.5, 2.5, & 3.5 as shown in Fig. 10, 11 & 12. The sewage capacity was found out from 7582230 lpd (1.5 FSI) to 17693640 lpd (3.5 FSI).

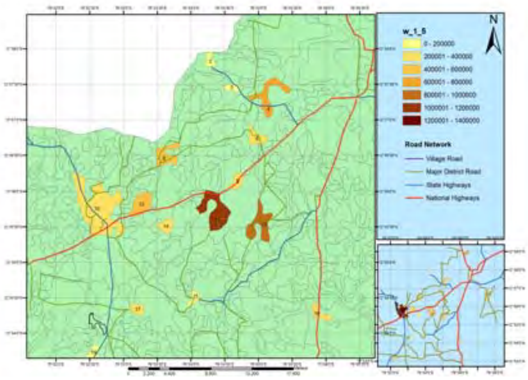

Fig.7. Water Demand for FSI@1.5

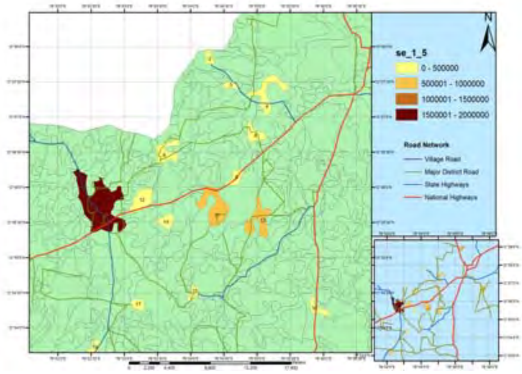

Fig.10. Sewage capacity for FSI @1.5

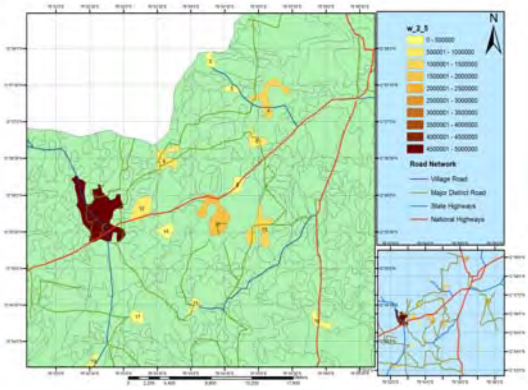

Fig.8. Water Demand for FSI@2.5

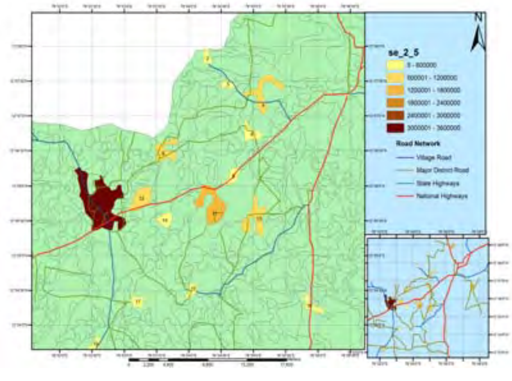

Fig.11. Sewage capacity for FSI @2.5

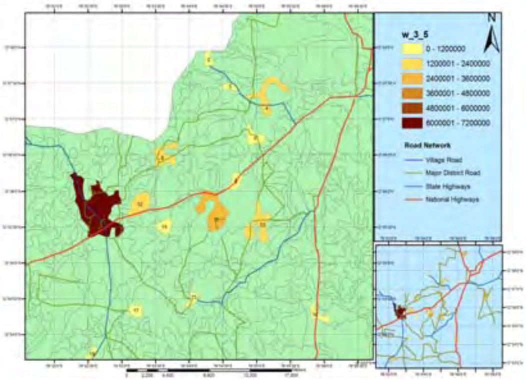

Fig.9. Water Demand for FSI@3.5

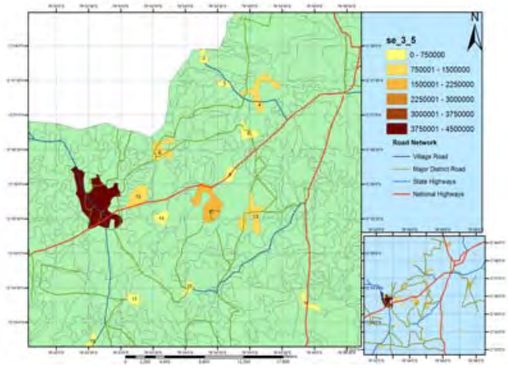

Fig.12. Sewage capacity for FSI @3.5

5. Conclusion

Land use Change detection (1997-2007) has been compared and identified in SEZ areas. Most of the crop lands are changed into industrial/built up area (cropland is 2.18sq.kms, other lands like fallow land, land with scrub, barren rocky is 0.009sq.kms). The major development features like industries, water tank etc., in SEZ areas are collected through GPS coordinates incorporated in land use map and validated Google earth for identifying development activities for study areas. The future population can be estimated at different methods of Arithmetic method, Geometric method, Incremental Increase method & linear method from 2011- 2029 with different periods like (2001-2011 and 2011-2029) and compared with previous decade (1991-2011). The growth rate of population was found to be 25.8% previously, 29.2% as presently and future it will be expected to change up to 34%. For considering population estimation, other requirements like water and sanitary are also predicted and prepared the thematic map for different FSI. The maximum permissible limits of population at different FSI for SEZ are 84247, 138769 & 196596 respectively. The water demands for three FSI values (1.5, 2.5 & 3.5) were found to be

8888305, 18733815 & 26540460 lpd respectively and the sewage capacity was found to be from 7582230 lpd (1.5 FSI) to 17693640 lpd (3.5 FSI). This study has been undertaken in order to understand the impacts of SEZ likely to be created in the physical and social infrastructure in the study area and also to suggest the remedial measures required to be undertaken to meet the requirement of future population.

Acknowledgement

The authors wish to his sincere thanks to DEAN, SoCE, REGISTRAR of SASTRA University, Thanjavur, Tamil Nadu, India. The authors wish our sincere thanks to HOD, Department of Civil & Structural Engineering, REGISTRAR of SCSVMV University, Kanchipuram, TamilNadu, India. The author also wish to record deep sense of gratitude to Vice-Chancellor, Director (E &T), Faculty of Engineering & Technology, SRM University, Kattankulathur, Chennai, Tamil Nadu, India.

References

[1] Aggarwal, “Impact of Special Economic Zones on employment, poverty and human development - Indian council for research on international economic relations, Mumbai”, *Paper provided by Indian Council for Research on International Economic Relations*, New Delhi, India, 2007, pp. 61 - 65.

[2] Amirahmadi, Hooshang and Weiping Wu, “Export Processing Zones in Asia”, *Asian Survey*, 2005, 35(9), pp. 45 -56.

[3] BATTY, Susan et al., “Multi-disciplinary overview of Land use”, Published by text book (2001), *London: Spon Press. CMDA* “Action Plan for Tiruporur IT Corridor”, 2001.

[4] Butterworth and Co. John Prescott et al., “Integrated Transport and land use planning”, Published by *Annual report, 2002*, London

[5] Development Control Rules (As Amended upto September 2004) For Chennai Metropolitan Area-2004. A Report for Development Control Rules For Chennai Metropolitan Area.

[6] Howard et al., “Direct and Indirect Impacts of urban sprawl”, *Published by Text book (2004), Washington, Island Press*.

[7] Ehlers, M. Jadkowski, M. A. Howard, R. R and Brostuen, D. E., “Application of A remote sensing–GIS evaluation of urban expansion of 2013 SPOT data for regional growth analysis and local planning”, *Photogrammetric Engineering and Remote Sensing*, **56**, 1990, pp. 175–180.

[8] Harris, P. M and Ventura, S. J., “The integration of geographic data with remotely sensed imagery to improve classification in an urban area”, *Photogrammetric Engineering and Remote Sensing*, 1995, **61**, pp. 993–998

[9] Husain, I and Siddiqi, L., “Urban Encroachment on Rural Lands”, A Case Study of Modinagar, *The Geographer*, Aligarh, 26, 1979, pp. 11-21

[10] Hussain, M. I., “Urban Expansion and Encroachment”, *The Geographer*, 30, 1983, pp.82- 93.

[11] Jothimani, P., “Operational Urban Sprawl Monitoring using Satellite Remote Sensing”, Excerpts from the studies of Ahmedabad, Vadodara and Surat, India,Paper presented at *18th Asian Conference on Remote Sensing*, 1997, Malaysia.

[12] Khan, N.M., Sato, Y., “Monitoring hydro-salinity status and its impact in irrigated semi-arid areas using IRS- 1B LISSII data”, *Asian J. Geoinform*, 1 (3), 2001, pp. 63–73.

[13] Mather, A. S., “Text book of Land Use”, London: *Longman publications*, 2001.

[14] Nethaji Mariappan, V.E. & P. Mohana, “Spatial Urban Sprut Analysis in Kancheepuram district due to Special Economic Zones (Sez)”, *12th ESRI India user conference*, 7 – 8th December 2011, Noida, Delhi.

[15] Steffen, W. L., Walker, B. H., Ingram, J. S., and Koch, G. W., “Global change and terrestrial ecosystems: the operational plan”, *IGBP Report No. 21, International Geosphere–Biosphere Programme, Stockholm* 1992.

[16] Symeonakis, E. and N. Drake, “Monitoring desertification and land degradation over sub-Saharan Africa”, International Journal of Remote Sensing, 25 (3), 2004, pp. 573-592

[17] Treitz, P.M., Howard, P. J and Gong, P., “Application of satellite and GIS technologies for land-cover and land-use mapping at the rural-urban fringe”: a case study. *Photogrammetric Engineering and Remote Sensing*, **58**, 1992, pp. 439–448.

[18] www.SEZindia.com