

## Urban Hydrology - A Case Study On Water Supply And Sewage Network For Madurai Region, Using Remote Sensing & GIS Techniques

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**Abstract:** An increasing demand for water and sewage due to population growth, industrial development and improvement of economic require management of water & sewage transfer and improve operation of distributed network systems. The information of land use, tin and existing water supply was generated using the Resourcesat (IRS P6 LISS IV data) and Survey of India (SoI) toposheets of scale 1:25,000 and integrated them with GIS to identify the distribution supply networks of the study area. This paper explains the demand of sewage network and scarcity of water supply system in and around Madurai Region using Remote Sensing and GIS techniques. In addition, GIS based analysis of the pattern of urban expansion over the demographic change and land use modifications has also indicated that urban growth has mainly taken place linearly along the major roads in the study area.

**Keywords:** Land use Mapping, Water supply network, Sewage network, OPSGIS, Madurai.

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### I. Introduction:

The population, of Madurai city is growing very fast due to Urbanization and settlement of rural population from adjacent areas. Industrials growth is also play a Major role in water utilization. The drinking water needs is also increasing in trend. Usually most national reports describe the total population of a whole town as covered if there is some kind of water supply system that functions in the city. Typically, the large urban areas represent concentrated demands, both due to large populations and large per capita use and waste. The sanitation cover of the urban population in the Madurai town is extremely unsatisfactory. Only about 62-63% of the total urban population is reported to have access to basic sanitation. In the low income slum and squatter settlements, the percentage is even less, with only 25% of the households having toilets and another 21% having access to community toilets. What is important to that 51% of the poor households use 'open spaces' for personal sanitation. The inadequacy of water supply by urban authorities has led to boom in bottled water around the town in the name of 'mineral water'. More importantly, the demand makes the people to buy the more expensive bottled water and this is not a solution of drinking water needs of the society<sup>[3]</sup>. The urban water supplies need to decentralise planning, regulation and monitoring functions for evolving efficient water supply demands. This will enable to facilitate participation and help inter-sectored co-ordination, develop and operate water supply that is more responsive to the needs of the people. The aim to meet future requirements of water supply and sewage network systems can be efficiently achieved by performing Land use Mapping and using distribution system. The Remote Sensing and GIS is the latest techniques to identify the pattern of growth and its demand.

### II. Study Area

Madurai District lies between 9°30' and 10°10' of the North Latitude and between 77°10' and 78°30' of the Eastern Longitude<sup>[2]</sup>. The general geographical information of the district is simple and flat as well as hill area. Vaigai River is flowing in the district and is dry during the summer season. Madurai is bound on its North by Dindigul and Tiruchirapalli districts, on the East by Sivagangai District, on the South by Virudhunagar District and West by Theni District.

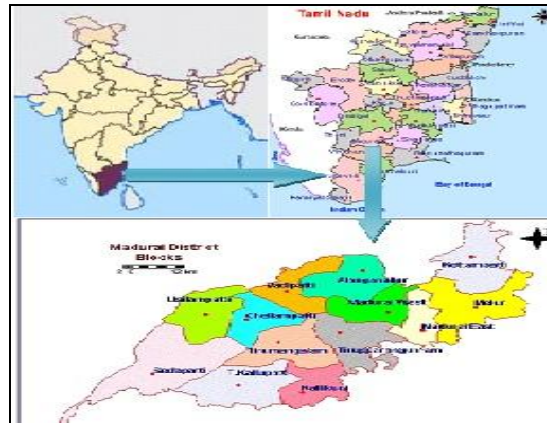


Figure 1 Location Map of the Study area

The water supply and sanitation requirement of Madurai was managed by a City Council from 1866 to 1970. In 1970, Madurai was upgraded to the status of a Municipal Corporation. Further in 1974, 13 Panchayats on the outskirts of Madurai City were included in Madurai Corporation and wards were increased to 65. In 1990, a delineation committee was formed to identify new wards and the total number of wards increased from 65 to 72. Madurai Corporation meets its water demand through surface and subsurface sources through water supply schemes on the Vaigai River. It consists of totally 79 villages excluding Madurai Corporation. The villages are classified into two rings. First ring comprises of 28 villages (105.025 Sq.kms) and second ring with 51 villages (168.718 Sq.kms) respectively. The total area including Madurai city covers around 327.419 Sq.kms<sup>[2]</sup>.

Details	North Bank of Vaigai River	South Bank of Vaigai River			Total
	North Zone	East Zone	South Zone	West Zone	
Wards	21	16	19	16	72
Comprising Wards	1 to 21	44 to 59	31 to 43 & 60 to 65	22 to 30 & 66 to 72	1 to 72
Population	2,85,000	2,65,000	3,20,000	3,10,000	11,80,000
Area (Sq.km)	19.50	6.12	7.40	18.78	51.85

Table 1 Madurai Divisional Zone Details

### III. Data Used

Indian Satellite imagery IRS-P6(Resource satellite) LISS IV, Survey of India Toposheets 58 K/1/NW and 58 K/1/NE on 1:25,000 Scale, Warp Map on Scale 1:5000, Sewage Network data, Water Supply Distribution data and Population data from Madurai Corporation.

#### Software used:

1. OPS-GIS 5.0
2. PG-Steamer 4.1
3. AutoCAD 2008
4. MS-Office Packages

#### IV. Methodology

The Methodology was developed according to the needs and requirements for the studies based on overlaying the features on Land use and Land cover map and to determine the Water Distribution and Sewage Network.

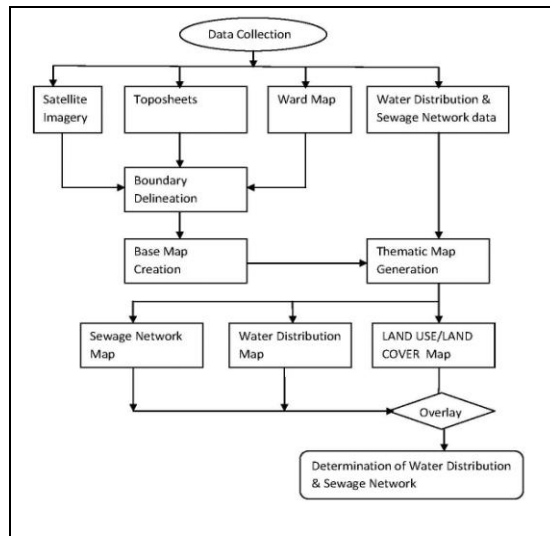


Figure 2 Schematic diagram of Methodology

#### V. Base Map Creation

To delineate the boundary first step is to digitize the ward map with reference to toposheets.

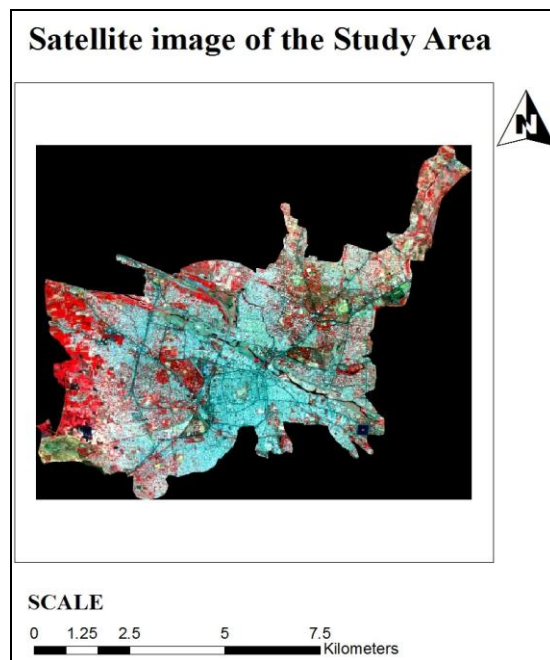


Figure 3 Madurai Corporation Boundary

The base map is created by delineating the boundary by means of creating a shape file on the ward map and overlaid on the IRS P6 LISS IV MX & Toposheet, and then the boundary is extracted. The extracted boundary map is imported to GIS software for digitization purpose. Several features such as settlements, roads, water bodies, vegetation and industrial areas are digitized and a digitized map is generated. From this digitized map several thematic maps are prepared according to the necessity.

## VI. The Land Use/Land Cover Map

Most conventional definitions have land cover relating to the type of feature on the surface of the earth such as rooftop, asphalt surface, grass and trees. Land use associates the cover with a socio-economic activity such as factory or school, parking lot or highway, golf course or pasture and orchard or forest.

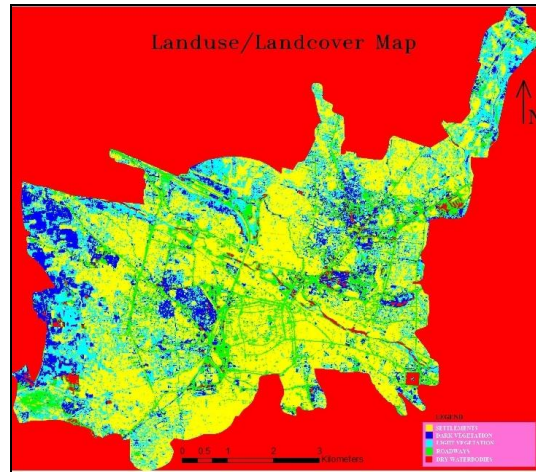


Figure 4 Land use/Land cover map

Urban Hydrology often uses the term, land cover and land use interchangeably because the inputs to the models require elements from each definition<sup>[5]</sup>. Land use mapping is used to identify the existing and expected future land uses. The timely information about the changing pattern of urban land use plays significant role in urban land use planning and sustainable urban development<sup>[1]</sup>. The mapping and monitoring of urban land use/land cover require a land use classification system. The most significant contribution in this respect has been made by the human settlement<sup>[4]</sup>. The land use map is generated by means of digitizing the features like settlements, roads, water bodies, vegetation and etc. For the identification and interpretation of land use pattern of the area, image interpretations through remote sensing data (IRS P6 LISS IV) were adopted and the various land use classes has been delineated.

## VII. Sewage Network Mapping:

The underground drainage in the city covers six-lakh population. Out of 72 wards of Madurai Corporation, 13 wards have no underground drainage system and another 16 wards are partially covered. The sewage inflow is 61mld, which is partially pumped to the treatment plant<sup>[3]</sup>.

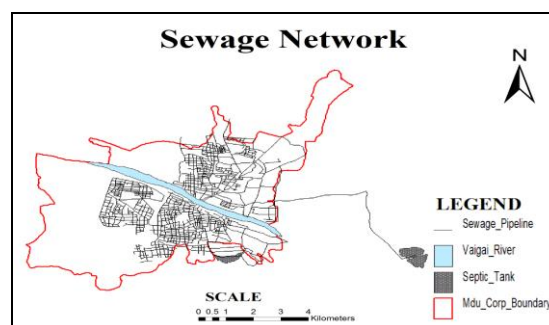


Figure 5 Sewage Network Map

The key issues related to this sector are due to dense population coverage and treatment capacity constraints. The sewage network mapping is done through the process of digitizing the sewage network features, and then it is overlaid on land use and land cover map.

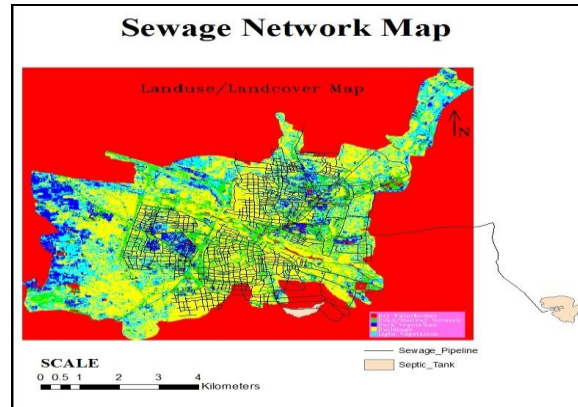


Figure 6 Overlap Map of LULC & Sewage Network

### VIII. Water Distribution Mapping

In Madurai, the frequency of water supply is once in three days and the population covered is 36 percent. The per capita availability of water ranges between 60 lpcd to 75 lpcd <sup>[2]</sup>.

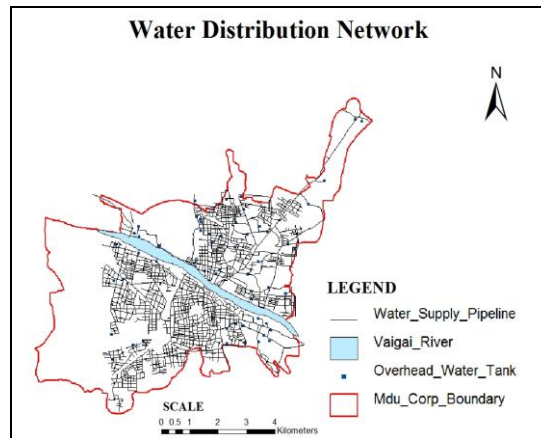


Figure 7 Water Distribution Network Map

The situation becomes worse in summer season with reduced per capita supply. These deficiencies in the water supply sector are mainly because of inadequate treatment capacity, inadequate network coverage, inadequate summer storage, need for source augmentation and need for asset management action plan.

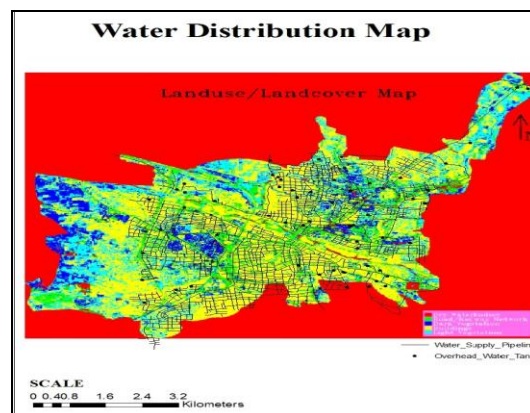


Figure 8 Overlap Map of LULC & Water Distribution Network

It is also noticed that simultaneously water is distributed through two or more distribution mains to different areas without any system of valve regulation. Due to this operation, even consumers residing near to the service reservoirs do not get water at sufficient pressure. The population residing in the south zone of Madurai Corporation and those living in extended areas face significant hardship during summer months due to inadequate water supply. The Water Distribution Mapping is done through the process of digitizing the sewage network features, and then it is overlaid on land use and land cover map.

### **IX. Conclusion:**

GIS based analysis of the pattern of urban expansion over the demographic change and land use modification is identified by Satellite image. The existing Sewage Network & Water Distribution Network is digitized by using toposheets. The above maps are overlaid with Land use & Land cover Map. Present population and expected rate of growth are critical factors in design of Water Distribution and Sewage Network in Madurai City. A review of the existing condition indicates that Madurai Corporation may not have been fully involved in the design, according to the Growth rate by means of settlement and population. The study has focused on the utility of Remote Sensing and GIS in the identification of existing system. The result shows the present scenario situation of sewage and water network of Madurai City.

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