

Site Suitability Evaluation For Sewage Treatment Plant In Nagercoil Municipality, Tamil Nadu Using Remote Sensing Techniques

Benujah.B.R^a, Mrs. G.Devi^b

^aM.Tech Student, Regional Centre of Anna University Tirunelveli, India

^bAssistant Professor, Regional Centre of Anna University Tirunelveli, India

ABSTRACT

Site suitability evaluation for waste management is becoming a major criteria for defending the environmental degradation. If proper location for the treatment plant is not selected then it may lead to soil degradation and ground water pollution. The study area is situated in the southern portion of Tamil Nadu, India that is currently experiencing high rates of population growth and economic development. Potential sites for the treatment plant are evaluated using suitability score based on planning and design constraints, including ground slope, landuse pattern, and distance to river and roads. Spatial analyst tool of ArcGIS software is used for selection of suitable reclamation plant site. Finally based on weightage value, suitable site for treatment plant have been selected and classified into good, moderate and poorly suitable areas respectively.

KEYWORDS: GIS, Weighted Index Overlay Method, Sewage Treatment, Remote Sensing, supervised classification, thematic map.

INTRODUCTION

Sewage is the wastewater from residential areas and it generally consists of wastewater from kitchens, toilets and bathrooms. It is necessary to collect, treat and safely dispose off the sewage, because if it is let into the environment without treatment it will be naturally drained by the existing ground slope and will reach the nearby water bodies such as lakes and rivers. The organic waste present in the sewage will undergo decomposition in the water bodies causing depletion of dissolved oxygen in it and causing unhygienic condition leading to the spreading of water borne diseases. Sewage carry pathogenic organisms that transmit diseases to human. It contains organic matter that causes odor and nuisance problems. It carries nutrients that cause eutrophication of receiving water bodies and leads to ecotoxicity. Proper collection and safe disposal of the sewage are legally recognized as a necessity in an urbanized, industrialized society. Globally around 90% of wastewater produced remains untreated causing widespread water pollution especially in low-income countries.

Geographic Information System (GIS) can be used as a decision support tool for planning waste management. The manual methods adopted for the analysis of many factors would be a tedious and lengthy work. Also the possibilities of errors increase when merging the spatial and non spatial data. But in case of GIS, as the work is carried out in layers, the chances of error will be less and the system is capable to coordinate between spatial and non spatial data.

STUDY AREA

Nagercoil Municipality has been selected for the present study which is situated in southernmost side of the Kanyakumari District of TamilNadu state, India. The study area is located between 8° 4' N to 8° 13' N Latitude and 77° 19' E to 77° 35'E Longitude. It covers an area of 24.27sq.km. The study area has a population of 2,55,716. Average annual rainfall of the area is 1188.6mm. Paddy and Banana are the major crops in the study area. The elevation in the study area varies from 10 to 70 m. The study is experiencing highest rates of population growth. But it currently lacks a sewage treatment plant system. Instead the people depend entirely on septic systems in order to manage its wastewater needs. It may become necessary in the near future to construct a sewage treatment plant in the study area associated with the projected population growth. Fig.1 shows the location map of the study area.

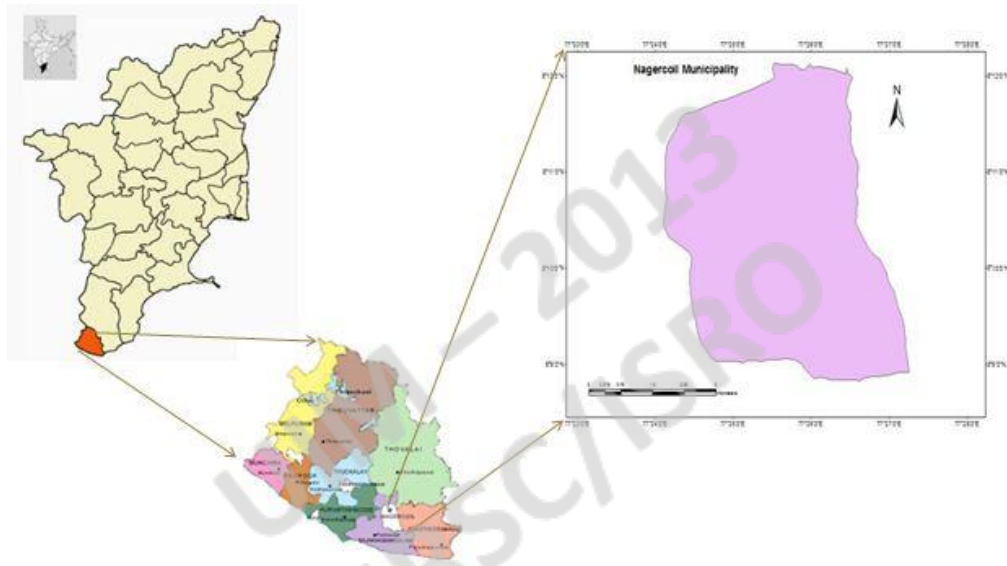


Figure 1 Location map of the study area

Geomorphologically, the study area falls under eolian plain, older coastal plain and pediplain canal command. The sub group classifications of soil in the study area are Aquic haplustalfs, Typic Haplustalfs, Typic Tropudalfs, Udic Rhodustalfs. The study area comes under the hydrological soil group of class A having high rate of infiltration and low runoff.

PROBLEM IN THE STUDY AREA

Satellite remote sensing is one of the most effective tools that can be used for analysis of site suitability in a rapid and accurate manner. Currently the study area lacks underground drainage system. It only has shallow open drains and septic tanks for disposal of the sewage. The leakages from the septic tank pollute the surface and subsurface water. Open drain system is the major cause of spreading of waterborne diseases and inducing environmental degradation. The soil in this area is Alfisols and hydrologically this will come under class A. This group of soil has high permeability and low runoff which leads to the sewage waste penetrate into the soil and contaminating the ground water. This paper presents a conceptual based Geographical information system (GIS) site suitability evaluation for the sewage treatment plant.

AIM AND OBJECTIVE

- Analysing the characteristics of the study area through field survey and visual interpretation of satellite images.
- Preparation of various thematic maps such as landuse map, slope map, road map.
- Preparation of suitability map by overlaying the thematic maps with suitable weightage.

MATERIALS AND METHODS

Thematic maps of the study area can be prepared by integrating toposheet of 1:50000 scale, existing maps and satellite image IRS P6 by using the software ArcGIS 9.3. ENVI 4.2 is used for sub setting the satellite imagery and for supervised classification. This map was verified in the field through extensive ground truth and necessary corrections were made wherever required. The area under various landuse categories was calculated from this map. The thematic maps prepared are integrated by weighted index overlay analysis and weightage is assigned to each theme depends on the importance of influence for locating the plant. The satellite imagery of the study area is shown in Fig.2. It is extracted by mask using ArcGIS software as given in Fig.3.

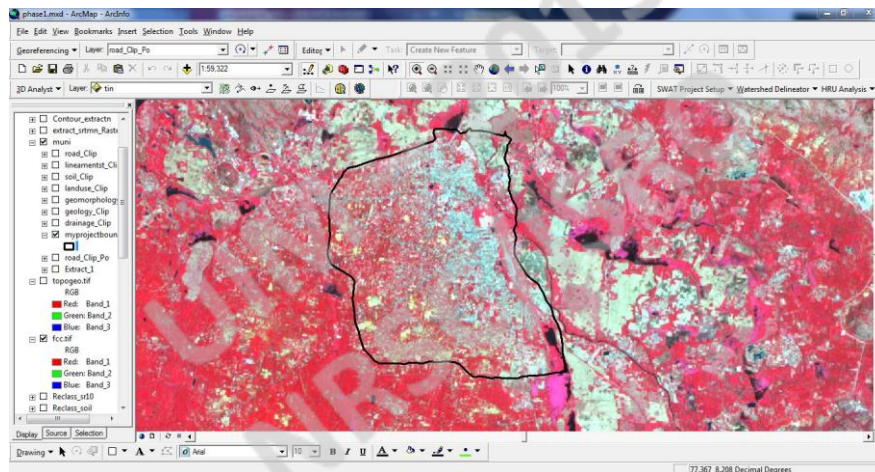


Figure 2 IRS P6 LISS III Satellite Image

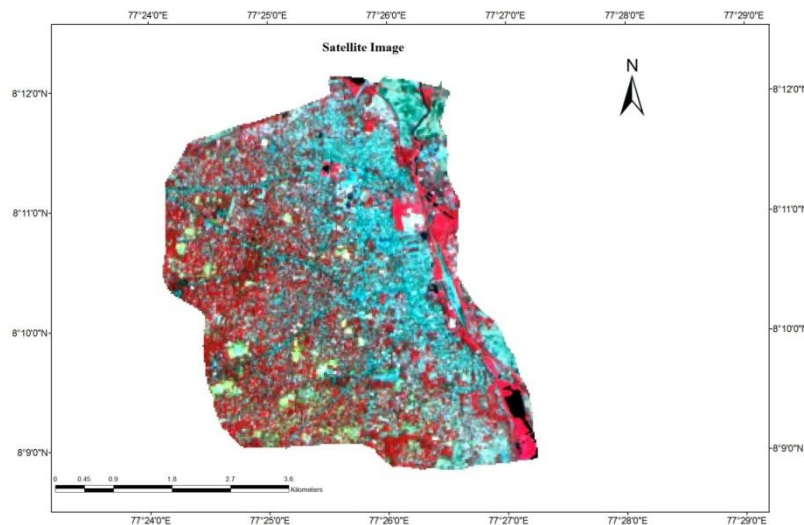


Figure 3 Extracted Satellite Image

Criteria

For the selection of site for sewage treatment plant, it should satisfy the following criteria should be satisfied.

- Slope of the surface should be less than 15%
- away from the thickly habitated areas
- 200 meters away from the main roads
- 200 meters away from the water bodies

Landuse

Landuse plays a vital role as it is used for identifying the suitable site. The land use pattern of the study area is classified into various types such as built up lands, agricultural land, and reservoir and river stream based on the level 1 classification by using supervised classification which is shown in fig 4.

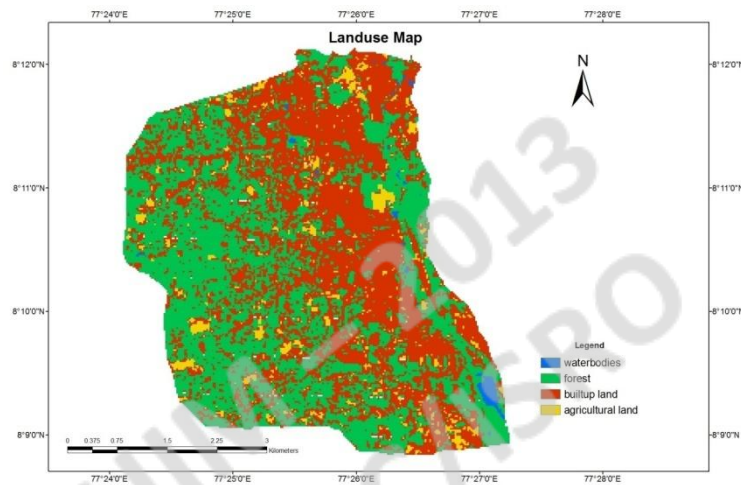


Figure.4 Landuse Map

Road map

The map indicates the national highways, district road and village roads. The national highways in the study area from Nagercoil to Trivandrum and also to Kanyakumari. Ideally, the sewage treatment plant should be away from major roads. Road map is shown in fig 5.

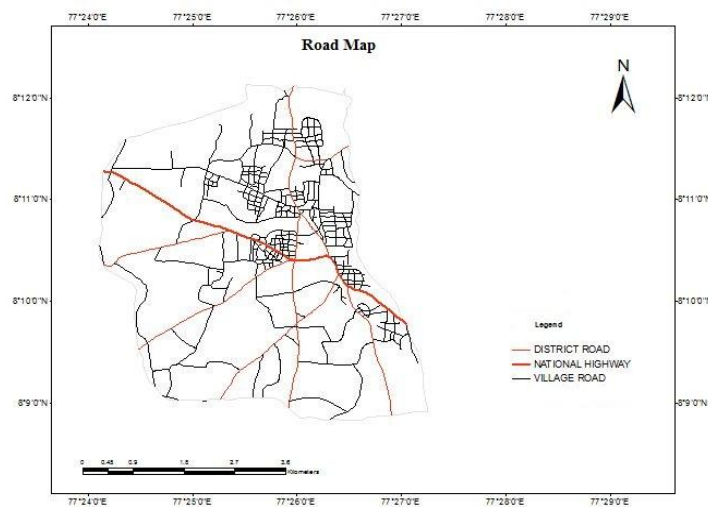


Figure.5 Road Map

Drainage

There is no major river draining through this municipality. Pazhayar river is a small channel which is draining the municipality. It flows from north to south and this is the main source for both domestic purpose and agriculture in this area which is shown in fig 6. Other waterbodies in the study area are chemmankudi lake, pazhayar, sabayar kulam, parakkai lake.

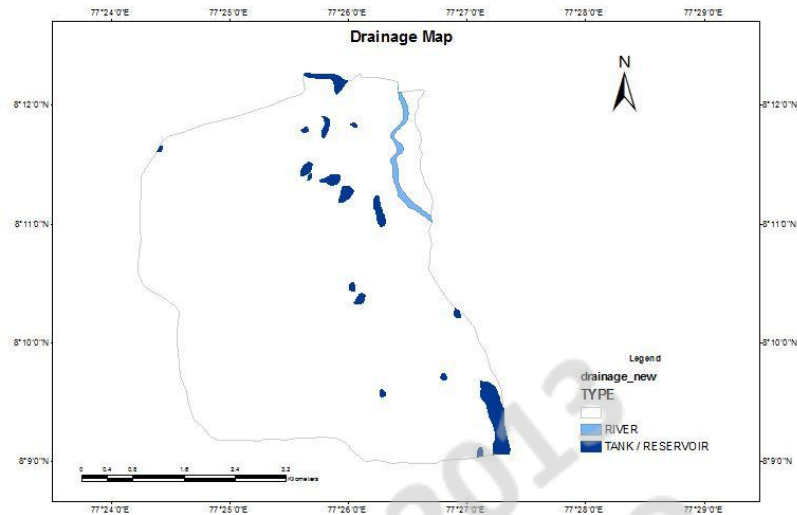


Figure.6 Drainage Map

Slope

Slope refers to change in height across a region of surface. Slope is an important factor as it affects the land stability. Slope map is prepared from SRTM DEM of 90m resolution. In order to improve the overall efficiency of the sewage treatment plant and to minimize the pumping costs a slope value of maximum 15% is considered.

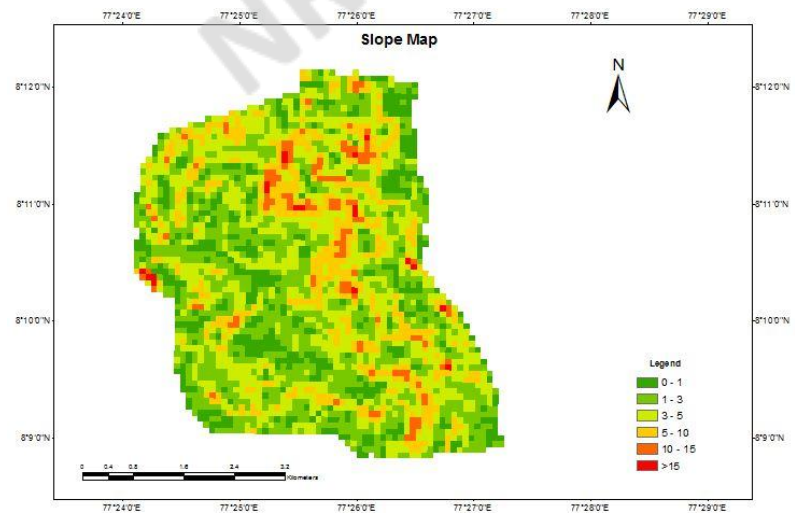


Figure.7 Slope Map

RESULTS

By integrating different thematic maps such as land use, Slope, drainage and road map in ArcGIS 9.3 software using weightage index overlay analysis, suitable site for sewage

treatment plant can be found out and classified as good, moderate and poor as shown in fig.8. The weights are assigned to various classes in the thematic layers as shown in table 1. The areas of different categories which are suitable for locating sewage treatment plant are shown in table 2.

Table 1. Criterion table for identifying suitable site

Criteria	Classes	Rank	Weightage
landuse	crop land	2	35
	builtup land	1	
	waterbodies	1	
	forest	2	
slope	0 to 5	3	25
	5 to 15	2	
	>15	1	
road	0 to 100m	1	10
	100 to 200m	2	
	>200m	3	
drainage	0 to 100m	1	30
	100 to 200m	2	
	>200m	3	

Table 2 Area of Different Categories of sewage treatment plant site

SI. No.	Suitability	Area (sq. km)
1.	High	5.53
2.	Moderate	18.06
3.	Poor	0.18

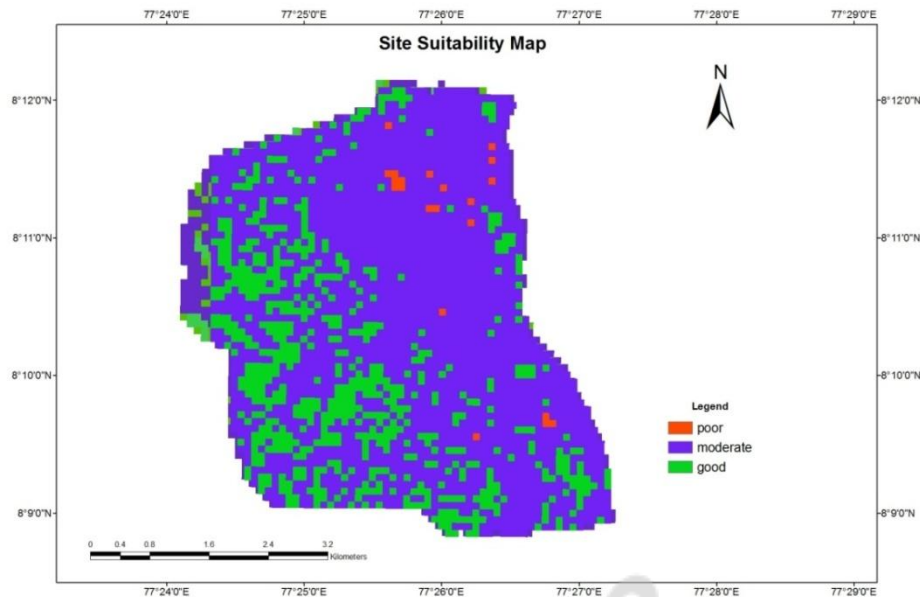


Figure 8. Site Suitability Map

CONCLUSIONS

Sewage treatment plant is great in demand due to the increasing population and urbanization. Remote sensing and GIS makes it easier to get valuable information about the study area. GIS enables us to integrate different layers and to manage large database. It gives more accurate results when compared to conventional methods. Hence GIS is proved to be a powerful tool in managing spatial and non spatial databases in suitability evaluation.

ACKNOWLEDGEMENT

The author would like to thank our Department of Civil Engineering, Regional Centre of Anna University Tirunelveli, for their valuable support to complete this work.

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