Solid Waste Dumping Site Suitability Analysis Using Quantum GIS for Thiruvallur District, Tamilnadu

K. Sindhu[1], Dr. K. Manickam[2]

[1]Assistant Professor, Department of Civil Engineering, MNM Jain Engineering College, Chennai, Tamilnadu, India

[2]Professor, Department of Civil Engineering, MNM Jain Engineering College, Chennai, Tamilnadu, India

Abstract: *Solid waste dumping is a serious problem in developed and developing countries because most solid waste are not dumped in suitable areas Thiruvallur district Tamilnadu. One of the fast developing districts in Tamilnadu has issue in dumping the solid waste generated in the district. The main objective of one study is to identify the potential dumping area for Thiruvallur using GIS tools , using Quantum GIS land suitability analysis is carried out including various data such as landuse , land cover, distance of site from road, lake, river, urban & rural settlement .the data collected are converted into raster format . Weights and ranks are assigned to the raster files based on their contribution to potential site selection. Raster calculation expression formulated to create potential site suitability map. The result map indicates that 8.95 % of total area is highly suitable for solid waste dumping, 47.28% of total area is moderately suitable for site, 21.45% of area is least suitable and 22.32% of total area is not suitable for dumping solid waste. The potential most suitable areas for solid waste dumping falls on the outskirts of the district where the effect of solid waste dumping has least effect on health and environment of the study area.*

Keywords: Solid Waste, Thiruvallur, Rsster Analysis, QGIS, Site Suitability

1. Introduction

In developing countries, the ever increasing human population and the associated anthropogenic activities have accelerated the phenomenon of urbanization in the past decade. In India, the rate of increase of urban population shot from 26% in 2001 to 31% in 2011. The census of 2011 indicates the fact that presently 30.73% of the total population resides in the urban centers, and it has been forecast that new urban population may reach 47% in next 15 years. The rapid growth rates of the cities, combined with their huge population base, has left many Indian cities lacking in basic infrastructure services like water supply, sanitation and sewerage and solid waste management. With the rising population and the associated unsustainable practices, there has been an enormous increase in the quantum as well as the in diversity of the solid waste being generated.

Domestic, Industrial and other wastes, whether these are of low or medium level, have become a perennial problem as they continue to cause environmental pollution and degradation. Poor waste management systems coupled with hot climatic conditions results in increasing environmental problems with significant local as well as global dimensions. The need of the hour is to devise an efficient solid waste management system wherein decision makers and waste management planners can deal with the increase in complexity, uncertainty, multi-objectivity, and subjectivity associated with this problem. In spite of the increasing stress towards the waste reduction at the source, as well as recovery and recycling of the solid waste, disposal of solid waste by landfilling remain the most commonly employed method.

Landfill incorporates an engineered method of disposal of solid waste on land in a manner that minimizes environmental hazards by spreading the solid waste in thin layers, compacting the solid waste to the smallest practical volume and applying a cover at the end of the operating day. However, with the increased population density and urban infrastructure, several key considerations are required to be taken into account to ensure its overall sustainability, especially those associated with its economics, optimized siting and operation.

The development of a municipal solid waste landfill requires the acquisition of large tracts of land and its suitable siting in a pre-existing urban matrix comprised of diverse competing land uses. Siting decisions are governed by the pre-existing land use dynamics of the urban area as well as the nature of potential interactions of the landfill with the pre-existing environmental, geologic, hydrological, and socio-economic parameters of the area. In the domain of the science of solid waste management, identification of landfill sites for solid waste disposal remains a critical management issue wherein the selection should be based on a number of considerations (Dipanjan et al., 1997; CPCB, 1999). Siting a sanitary landfill requires an extensive evaluation process in order to identify the best available disposal location. This location must comply with the requirements of governmental regulations and at the same time must minimize economic, environmental, health and social costs. The site selection procedure, however, should make maximum use of the available information and ensure that the outcome of the process is acceptable by most stakeholders.

Therefore, landfill siting generally requires processing of a variety of spatial data. The present study focuses on an optimized land use site selection based on multi-criteria

decision analysis and geographic information system based (GIS) overlay analysis.

The most appropriate landfill site has been identified for Thiruvallur, a typical urbanizing district of India. Several important factors and criteria were considered to arrive at the optimum siting decision including the pre-existing land use, location of sensitive sites, infiltration, water bodies, water supply sources, groundwater quality, air quality, fault line and geology. Thematic maps of the selected criteria were developed within the paradigm of standard GIS software. Subsequently, weightings were assigned to each criterion depending upon their relative importance, and ratings in accordance with the relative magnitude of impact. A GIS-based overlay analysis was performed to identify the optimum site for the landfill, one which fulfilled all of the desired attributes.

2. Study Area & Objective

THIRUVALLUR, of size 3423 sq km, consisting of 8 taluks, having Population of 56074 (as per Census 2011) As the Sub-Urban areas are growing rapidly, more wastes are produced. Overall solid waste generated in the district adds up to 422.6 tonnes with a break-up of 366 tonnes in municipalities and 56.6 tonnes in town panchayats. The solid waste generation is highest in Ambattur among municipalities and in Porur among town panchayats. The overall collection efficiency is 88 % with of 344 persons engaged in solid waste management. The primary component of the waste is compostable matter constituting 90% in the total waste. The main objective of the study is It is required to select a site for dumping the waste until the waste gets decomposed considering various parameters, so that the project is sustainable and environment friendly. FIGURE 1 shows the study area boundry.

3. Methodology

The sequence of work to be carried out throughout the project is given as flow chart in figure 2. A referenced map is created by using the co-ordinates and GCP points are created. The geo referenced map is digitized by connecting the respective points and it is later converted into digitized format. The values for the digitized map is allotted in the attribute table of the data with respect to the types and condition. The created vector layer is rasterized. With the respective raster layers the analysis is done by the raster calculator with their respective ranks and weights based on contribution for site selection. The project is analysed by using data on the basis of selecting the dump yard which is eco-friendly and transportation of the waste efficiently.

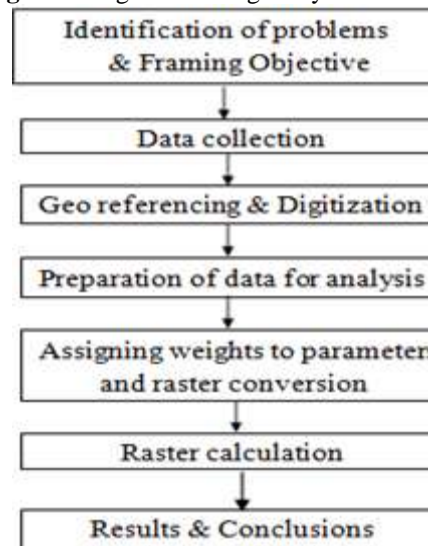

Figure 1: Figure showing study area boundry

Figure 2: Figure showing methodology flow chart

4. Data Collection and Analysis

The project is analysed by using data on the basis of selecting the dumpyard which is eco-friendly and transportation of the waste efficiently. The landuse land cover plays a major role in site selection. figure.3 Shows the landuse land cover map for the study area. Urban settlement, Rural settlement, Road, River, Lake, water bodies are identified from the landuse map as shown in figure The respective soil type is collected from the corporation and soil map is created. Figure 4 shows the soil type to the respective area in the study area. Dumping site has to be located at certain distance away from the sensitive areas to avoid pollution and disturbaces for the public and buffer analysis has been done to identify the area away from the sensitive sites so that the dumping site is identified considering the above criteria. the table 1 gives shows the weights assigned for each features in different layers based on the level of suitabilty.
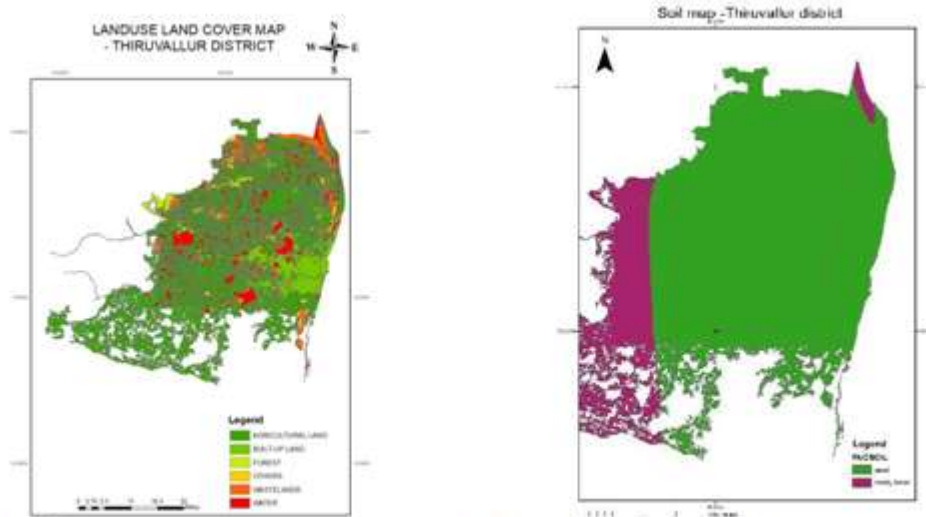
Figure 3: Figure showing land use land cover map for the study area **Figure 4:** Figure showing soil type map for the study area

Buffer usually creates two areas: one area that is within a specified distance to selected real world features and the other area that is beyond. The area that is within the specified distance is called the buffer zone. A buffer zone is any area that serves the purpose of keeping real world features distant from one another. Buffer zones are often set up to protect the environment, protect residential and commercial zones from industrial accidents or natural disasters, or to prevent violence. Fixed distance buffer is used here where the distance and segments are assigned for the buffer. In this project buffer is done for the layers:Urban settlement, Rural settlement, River,Lake & reservoirs, roads. Figure 5 showing fixed distance buffer map for various factors in the study area.
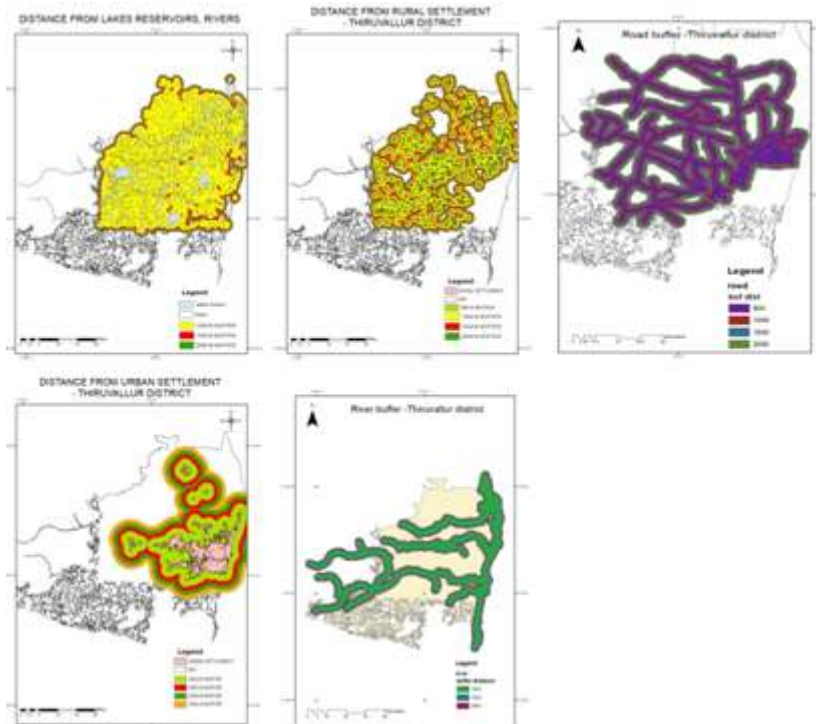

Figure 5: Figure showing fixed distance buffer map for various factors in the study area

For raster analysis the suitability levels are designated as weights in the layer and importance of criteria is designated as rank of the layer. The weighed vector layer is converted in raster layer for the analysis attributed in terms of weights.Table 1. Shows the Weights for various parameters for suitability analysis. The vector layers are converted into raster layers suitable for raster analysis .Figure 6 shows dumping site suitability map for various factors in the study area.

Table 1: Weights for various parameters for suitability analysis

Weights for land use and land cover		
Class	**Level of Suitability**	**Weight**
Water body	Very low	1
Agricultural and builtup land	Low	2
Forest and others	Moderate	3
Waste land	Highly	4
Weights for Urban settlement distance		

Class	Level of Suitability	Weight
0-2500	Unsuitable	1
2500-4000	Suitable	2
4000-5500	Moderate suitable	3
5500-7000	Highly suitable	4
Weights for Rural settlement distance		
Class	Level of Suitability	Weight
0-500	Unsuitable	1
500-1000	Suitable	2
1000-1500	Moderate suitable	3
1500-2000	Highly suitable	4
Weights for River distance		
Class	Level of Suitability	Weight
0-1000	Unsuitable	1
1000-1500	Moderate suitable	2
1500-2000	Highly suitable	3
Weights for Lake distance		
Class	Level of Suitability	Weight
0-1000	Unsuitable	1
1000-1500	Moderate suitable	2

Class	Level of Suitability	Weight
1500-2000	Highly suitable	3
Weights for Road distance		
Class	Level of Suitability	Weight
0-500	Unsuitable	1
500-1000	Suitable	2
1000-1500	Moderate suitable	3
1500-2000	Highly suitable	4
Weights for Soil type		
Class	Level of Suitability	Weight
Sand	Unsuitable	1
Sandy loam	Suitable	2

The raster analyse is done by calculating the respective raster layer with their influence in selecting the site for dumping Municipal Waste. The influence is collected from the journal published by Minale. The influence given for the various factors is given in the below table 2 Influence for various factors.
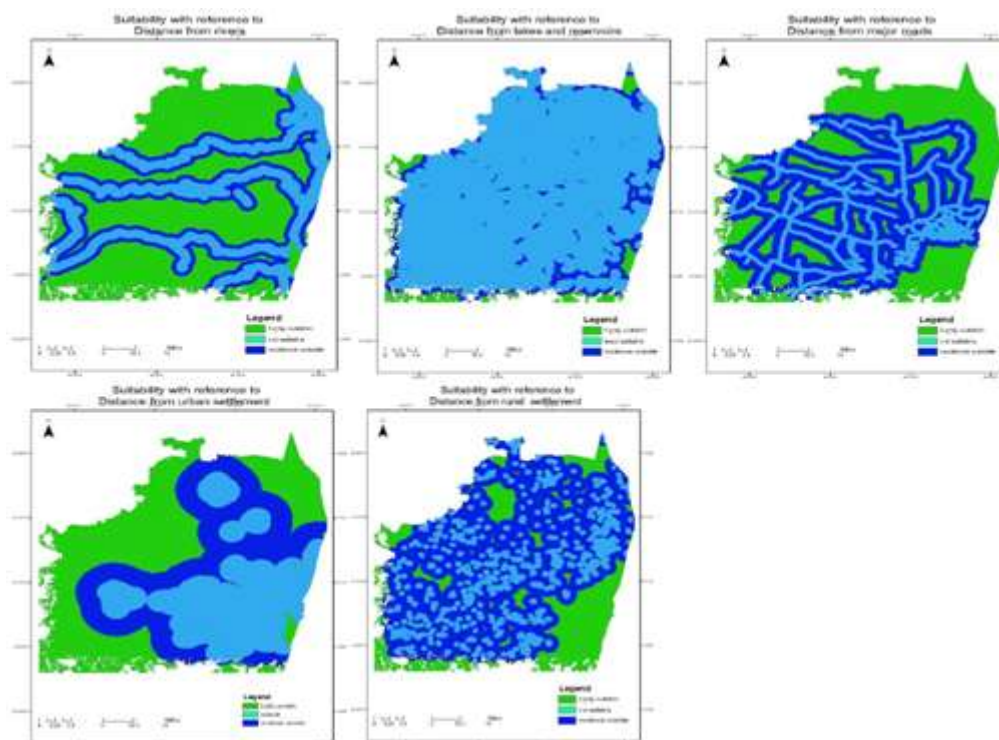

Figure 6: Figure showing dumping site suitability map for various factors in the study area

5. Results and Conclusion

The suitable site for dumping the Municipal waste is found for the Thiruvallur district. The highly suitable area has been identified by analysis. For analysing, various factors such as Land suitability and Land cover, Urban settlement ,Rural settlement , Road , River, Lake , Soil type are considered . Respective buffering and weightage are given and the result is obtained for the concerned area.

The final raster map has pixel values ranging from 0-255. Table 3 shows the condition for identifying dumping site location. The higher range pixel values shows location which is highly suitable. Figure 7 showing dumping site suitability map for the study area. From the suitability map obtained we can identify the locations where dumping sites

can be proposed and transportation& disposal of solid waste can be planned accordingly

Table 2: Influence percentage of various factors for suitability analysis

Factor	Influence (%)
Land use	32.1
Distance from Urban settlement	22.01
Distance from Rural Settlement	15.38
Soil type	13.04
Distance from Road	7.3
Distance from River	4.93
Distance from Lake	3.41

Table 3: Conditions for site suitability

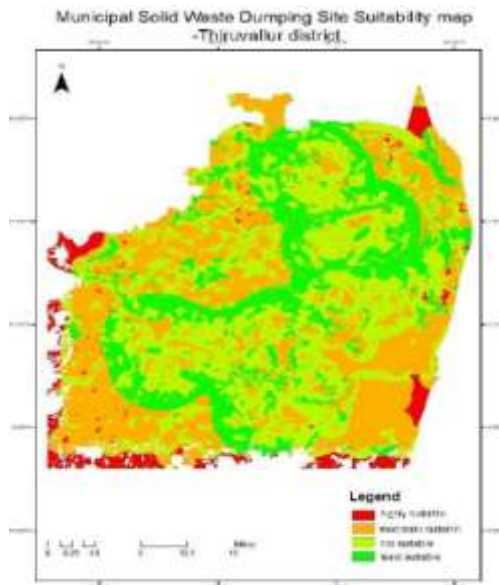| Area considered	Range
Highly suitable	180 – 255
Moderate suitable	120 – 180
Less suitable	60 – 120
Unsuitable	0 – 60

Figure 7: Figure showing dumping site suitability map for thiruvallur district

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