SELECTION OF POTENTIAL SOLID WASTE DUMP SITES FOR KAKINADA CITY USING GIS AND REMOTE SENSING TECHNIQUES

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ABSTRACT
The enormous generation, improper storage and unscientific disposal of solid waste can affect air and water quality, land use and public health. Keeping in this view, the present study is carried out with an objective of identifying a suitable site for disposal of municipal solid waste generated in Kakinada Municipal Corporation using Geographical Information System (GIS) and weighted overlay analysis. For achieving this objective, GIS is used to analyse the existing spatial relationships between various geologic, topographic, and environmental characteristics of the area as they relate to the investigation of identifying suitable landfill sites. For this purpose, various input spatial layers including settlements, roads, topography, geology, geomorphology, land use, ground water and soil are prepared using the Survey of India Toposheets and satellite data, ground data and collateral data with the help of ArcGIS. Using the Arc View GIS (Spatial Analyst) different solid waste disposal sites were selected according to the conditions given. Accordingly, sites were selected and the overall selected sites cover an area with a total area of 1058812m².

Keywords: Landfill site selection, solid waste, Kakinada, GIS, remote sensing

1. INTRODUCTION
In recent years, the urban environment has become a major subject of concern. The process of rapid urbanisation poses serious challenges to towns and cities, which are struggling to provide and maintain the already inadequate level of urban services. Among the major environmental problems faced by urban areas are air, water, and soil pollution and growing volume of solid waste. In industrial areas of many cities, the municipal solid waste is getting mixed up with hazardous waste creating a serious problem, while the accumulation of garbage has become a common site in most of the cities. Due to rapid growth of urban population, as well as constraint in resources, the management of solid waste poses a difficult and complex problem for the society and its improper management affects the public health and degrades environment. This trend can be ascribed to our changing lifestyles, economic growth, and a few changes in food habits, and living standards and at the same time changes in consumption patterns.

Solid Waste Management has been one of the neglected areas of urban management activities in India. By and large, in cities and towns hardly 50 per cent of the solid wastes generated are collected, transported and disposed off, giving rise to insanitary conditions and diseases, especially amongst the urban poor who constitute about 35 per cent of the urban population. Improper solid waste management deteriorates public health, causes environmental pollution, accelerates natural resources degradation, causes climate change and greatly impacts the quality of life of citizens. Municipal Solid Waste Management is limited to collection, transportation and disposal of un-segregated waste. The dumps are filling up faster than we can even find newer sites for them. There is a need to have an Integrated Waste Management System that would provide sustainable solutions in our country. Garbage disposal has been a long-standing problem and will continue to be a problem in the future. As the population of the world continues to increase, so will the garbage produced. It is therefore important to seek out the ways that can best be employed to minimize the amount of garbage. Shortage of land for waste disposal and inappropriate landfill site is one of the biggest problems in most of large urban areas. Therefore more efforts are needed to overcome this problem. An inappropriate landfill site may have negative environmental, economic and ecological impacts. This is not a problem of the future but a problem of today.

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2. DESCRIPTION OF THE STUDY AREA
The Kakinada city (16°57' N: 81°15' E) is the capital of East Godavari District of Andhra Pradesh on the central east coast of India. Fig 1 shows the location of the study area. The city is influenced by the semi-arid climate. The area receives an average rainfall of 1040 mm per annum, primary during the south west monsoon (June – September) and on account of cyclonic activity in the Bay of Bengal in the post monsoon (October–November).
The developing city, Kakinada is still depending on the age-old mode of garbage collection and waste management. At present, 260 tonnes of garbage a day is being collected from the households. It is being dumped at unauthorised dumping yard near saradamamba temple-cheedelapora located amidst residential areas. Construction of a permanent dumping yard in the city, one of the long pending projects. The 150 year old civic body failed to find a permanent solution to the garbage problem, as it is of the practice of identifying empty lands to dump the litter.

**METHODOLOGY**

GIS is a powerful tool for environmental data analysis and planning. It stores spatial data in a digital mapping environment. GIS is an information management system capable of providing spatial analysis tools for storing, retrieving, and manipulating georeferenced computerized maps[8]. In the process of site selection, broadly two types of database are generated. These two types of database are spatial database and non-spatial database. The spatial data is composed of land use/land cover, geomorphology, drainage, watershed, slope, geology, soil etc. The non-spatial data is composed of population details, soil type, ground water quality etc. The spatial data consists of thematic and topographic maps derived from satellite imagery and SOI toposheets. The satellite imagery LANDSAT-7 [ETM+] (Fig: 2) and SOI toposheets(65k4, 65k8&12, 65L1, 65L5) series of 1:50,000 scale.

According to municipal solid wastes (Management and Handling) Rules, 2000, some of the exclusionary criteria considered for the present study include the following.
- no landfill should be constructed within 200 mts of any lake or pond.
- no landfill should be constructed within 200 mts of any state or national highway.
- a landfill site must be at least 1000 mts from a notified habitat area.
- no landfill should be constructed within wetlands.
- no landfill should be constructed within critical habitat areas.
- a landfill should not be constructed in areas where water table is less than 5m below ground surface.

**Base map**

The base map (Fig.3) is prepared using survey of India (SOI) toposheets on 1:50000 scale and updated with the help of satellite imagery. The information content of this map is used as a baseline data to finalize all the other physical features of maps. The features included in the base map are water bodies, major settlements, canals, drains, major roads and railways.

**Road network map**

Road network plays an important role in the overall development of a region. The road network map (Fig.4) is prepared using survey of India (SOI) toposheets on 1:50000 scale. The road coverage networks from the
toposheets are updated with the latest satellite data to extract additional information on the newly developed roads.

**Geomorphology**

Survey of India toposheets and satellite imagery are used for the preparation of geomorphological map (Fig.5). The available geological and geomorphological maps, published literature and other information are used in enriching the geomorphological details.

**Soil map**

The soil map (Fig.6) for the present study area is prepared using the satellite imagery and the soil map provided and prepared by the National Bureau of Soil Survey and Land use planning (ICAR), Nagpur in co-operation with department of Agriculture, Andhra Pradesh, 2000.

**Land use/land cover map**

Land use/land cover map (Fig.7) showing the spatial distribution of various categories and their aerial extent is vital for the present study. The spatial distributions of various land uses are interpreted based on satellite data of 8-band LANDSAT-7 [ETM+]. The different land use/land cover classes existing in the study area are shown in table 1.

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>AREA (hec)</th>
<th>AREA (in %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Built up land</td>
<td>16353.2161</td>
<td>18.93</td>
</tr>
<tr>
<td>Farmland</td>
<td>40280.0899</td>
<td>46.60</td>
</tr>
<tr>
<td>Mangroves</td>
<td>12328.3918</td>
<td>14.26</td>
</tr>
<tr>
<td>Misc</td>
<td>5789.0122</td>
<td>6.70</td>
</tr>
<tr>
<td>River</td>
<td>1726.6500</td>
<td>2.00</td>
</tr>
<tr>
<td>Salt pans</td>
<td>5744.7900</td>
<td>6.65</td>
</tr>
<tr>
<td>Wastelands</td>
<td>4067.9100</td>
<td>4.70</td>
</tr>
<tr>
<td>Water bodies</td>
<td>135.2700</td>
<td>0.16</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>86425.33</strong></td>
<td><strong>100.00</strong></td>
</tr>
</tbody>
</table>

Table: 1 Land use/land cover distribution in the study area

**Ground water table map**

Ground water table map (Fig.8) is prepared based on information obtained from the state ground water department. Depending on the depth of water table below the ground level, the area is divided into two classes, areas with ground water level less than 5m below ground level and greater than 5m below ground level. The major part of the study area is occupied by ground water table less than 5m.

**Ground water infiltration map**

Ground water infiltration (Fig.9) is interpreted based on soil types and its thickness. Most of the study area is occupied by high infiltration rate.

**Buffer maps**

Buffers are generated for the exclusionary criteria. A 200mts buffer was created using the function in GIS software, which will be used to generate the buffer around all surface waters (Fig.10). The road network map with a buffer distance of 200mts (Fig.11) and a 1000mts buffer (Fig.12) was created around the settlements using buffer analysis in ARC/INFO and Arc View GIS software. All the non-exclusionary criteria considered for site selection are ranked and weighted using weighted overlay analysis for preparation of a final suitability map for selection of disposal site. [12]

3. RESULT:

![Fig. 3: Base map of the study area](image)

![Fig. 4: Road network map of the study area](image)
Fig. 5: Geomorphological map of the study area

Fig. 6: Soil map of the study area

Fig. 7: Land use/Land cover map of the study area

Fig. 8: Water table map of the study area

Fig. 9: Ground water infiltration map of the study area

Fig. 10: Buffer map of road network of the study area
3. CONCLUSIONS

Using the Arc View GIS (Spatial Analyst) different solid waste disposal sites (SWDS) were selected according to the conditions given. Accordingly, thirty sites were selected (Fig. 13) and the overall selected sites covers an area with a total area of 1058812m².

In the present study it was tried to find out the potential waste disposal sites using Remote Sensing and GIS techniques for Kakinada Municipality. Selection of suitable sites for waste disposal is based on several factors. GIS technology using weighted overlay analysis help to select the possible suitable solid waste disposal sites. The region of interest for site selection includes all area, which falls within the buffer distance of 40 kms from the centre of Kakinada city.

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REFERENCES


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