Research Paper

Volume : 4 | Issue : 8 | Aug 2015 • ISSN No 2277 - 8179

Solid Waste Management Using GIS, MIS and GPS - A Case Study of Hyderabad City

Environmental Science

KEYWORDS : Solid Waste, Geographic Information System (GIS), Management Information System (MIS) and Global Positioning System (GPS).

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ABSTRACT

The research paper explains about the experiences of developing GIS-MIS-GPS for Solid Waste Management (SWM) for a typical urban environment of Hyderabad City. The various aspects covered in this paper are the Background, Need, Methodology,GIS-MIS-GPS for Solid Waste Management (SWM) envisions a future where GIS is recognized as an integral and indispensable information tool for civic management, serving the integrated information needs of the citizens in identifying the suitability sites for dumping solid waste and optimum route analysis,The advantages of GIS include their capability to combine spatial and non-spatial information, ideal data viewing capabilities allowing efficient and effective visual examinations of solutions.

1. INTRODUCTION

Human activity, either domestic or industrial, produces waste materials to greater or lesser extent always. Each city produces tons of solid wastes daily from household, hospitals, industry, offices and market centers. By volume, municipal solid waste (MSW) is by far the largest component of overall urban waste stream and includes a variety of potentially toxic substances making its disposal a problem. However, either due to resource crunch or inefficient infrastructure, not all of this waste gets collected and transported efficiently to final dumpsites leading to an improper management and disposal, resulting in serious impacts on health and problems to surrounding environment (Rajivi Ahir 1999). The efficacy of solid waste disposal depends upon selection of proper site and there are several issues that have impact for site selection. Site selection is therefore one of the most critical areas of municipal planning involving a multidisciplinary approach and a broad spectrum of considerations. The transportation of solid waste from the source of generation to the dumping site is also a critical issue in solid waste management (BP&RD 1998).

2. STUDY AREA

Hyderabad City is situated in the Krishna basin and the river Musi, which is a tributary of river Krishna, passes through the city and bifurcates it into Northern and Southern Hyderabad. The study region covers an area of 179Km^2. The study area is situated between 78d22'30" & 78d32'30" east longitude & between 17d18'30" & 17d28'30" north latitude. The ground levels vary from 487 meters to 610 meters above mean sea level.

The region of interest for site selection includes all area, which falls within the buffer distance of 50km from the center of Hyderabad city. This area comprises of Hyderabad Urban Development Area, parts of Rangareddy, Nalgonda, Medak and Mahabubnagar districts of Telangana State. It is covered by topo sheet No. 56K on 1:2, 50,000 scale. The location map of study area is given in Fig. 1.

Fig 1: Showing location map of the study area

3. OBJECTIVES OF THE STUDY

- To study the status of existing scenario of solid waste management in Hyderabad city by analyzing the trends in population growth, waste generation, existing transfer stations and solid waste disposal sites in order to evolve a strategic plan for future years.
- To create spatial digital database comprising base map, land use/ land cover, soil, slope, physiography, geology, geomorphology, drainage pattern, ground water potential, infiltration rate, watershed, transportation network and wasteland map with the help of IRS –1D, PAN & LISS-III merged satellite imagery and Survey of India (SOI) toposheets along with ground truth analysis on ARC/INFO GIS platform.
- To carry out route optimization – shortest path analysis from collection point to the dumping site using Network Analyst module of Arc View GIS software.
- To Make GIS-MIS as a tool for making decisions on investment in infrastructure facilities.

4. MATERIALS AND METHODOLOGY

Study of the existing infrastructure with respect to the needs, here one important thing, people using the maps and the database in the disorganized way. There is a feeling among the people that, they felt the need for organized system like GIS, since most of the data they use as spatially related, not only it helps in viewing and also analyzing, it will help in decision making. (Dr.M.Anji Reddy 2001)

- Study and analysis of the Existing Conditions-maps, attribute data, reports, the monitoring mechanism
- Creation of the baseline data and the waste quantity details
- Digitizing / demarcation of the existing health ward boundaries
- Software upgradation to incorporate the details, to enter data (data entry-editing module), data viewing module (querying and the analyzing), MIS report & network compatible
- Data entry of the details – spatial and attribute – bins, routes, quantity of waste dry & wet from the city level to the health ward level
- Generation of Maps with all the existing details
- Finalization of the software and integration of the three modules GIS, MIS and GPS
- Training of the officials to handle the system and updating the data (Mather.M.Paul 1998).

a) GIS (Geographic Information System)

- To manage large amount of spatial data.
- Bins, Collection points, streets, roads, collection points, truck routes, ward/range/zonal/head offices, various levels - wards, ranges, zones and the city level data

- The locations, distance, accessibility, proximity
- Standardized coding system - Unique Ids for various elements (bins, collection points etc) (Sabinisi F.F 1987).

b) Components of GIS Data
- Base map
- Health ward boundaries - demarcation
- Details of the health ward - data to be added

c) Software
- Data entry module-updating the data
- Data viewer module-query
- MIS report generation module
- GPS module (Mishra H.C. 1998)

d) MIS (Management Information System)
- To manage large amount of spatial (attribute) data related to the 277 wards
- Quantity of waste from the bins, streets, roads, each ward, range, zone level and city level

e) Components of MIS
- Reports - Daily, weekly, monthly
- Levels - City level, Zone level, Range level, Health ward level
- Details - Quantum of waste - dry & wet

f) Types - Residential, commercial & market
- Bins, Pushcarts, Mini Tippers/Trucks
- Routing analysis - collection points in the route and the quantum of waste (Existing and the optimal route)
- Location analysis - Sorting area (ward level), Decentralized composting area (ward level), transfer station (zone level)
- Frequency of clearance and Location of dumping yards

5. RESULTS AND DISCUSSION

GIS-MIS-GPS for Solid Waste Management (SWM) envisions a future where GIS is recognized as an integral and indispensable information tool for civic management, serving the integrated information needs of the citizens. The implementation of a GIS represents a journey and not a destination. New uses, new applications and new users will continue to evolve in the foreseeable future. Major benefits will derive from opportunities currently unforeseen. As a result, for the foreseeable future, this project will have no definable end (Lillesant 2000).

The enormous generation, improper storage and unscientific disposal of solid waste can affect air and water quality, land use, and public health. As it may take years to identify improper disposal practices that affect public health and the environment, it is imperative that accurate, thoughtful methods be used to locate waste sites so that their impact on the environment and public is minimized. The major problems faced are evaluating the impact of existing facilities and identifying economically practical and environmentally safe sites for future waste disposal. In both cases, volumes of multi- disciplinary information must be collected, stored, and analyzed. One approach particularly well suited to the management of such database is the Geographic Information System (GIS). A GIS is a digital data base management system designed to accept large volumes of spatially distributed data from a variety of sources. It efficiently stores, retrieves, analyzes, and displays the accumulated information according to user-defined specifications.

Keeping this in view, the present study is carried out with an objective of identifying a suitable site for disposal of municipal solid waste generated in Hyderabad city using GIS. According to the existing records of the Municipal Corporation of Hyderabad (MCH), the total solid waste generated in Hyderabad is about 2200 MT/day of which 1500MT is disposed by land filling and the remaining 700MT is utilized for power generation. With the Autonagar dumping site being closed in 2005, there exists only one site operating at present located at Jawaharnagar for disposing this waste. Keeping in view the need for disposal sites, an attempt has been made in this study to identify potential sites for disposal of solid waste generated in Hyderabad. For achieving this objective, GIS is used to analyze the existing spatial relationships between various geologic, topographic, hydrologic and environmental characteristics of the area as they relate to the investigation of identifying suitable landfill sites. For this purpose, various input spatial map layers including settlements, roads, topography, geology, land use, geomorphology, soil, aquifers and surface water are prepared using the Survey of India toposheets, IRS-ID PAN & LISS-III merged satellite data, ground data and collateral data with the help of ARC/INFO GIS.

Siting criteria were defined using the standards related to land use, geology, watercourses, roads, etc. The adopted criteria are applied to the integrated data using if then queries, buffering capacities, and overlays. Maps satisfying the defined criteria were obtained and a composite map representing the overlay of these maps was derived. The weightage factors are estimated for each criterion using the Hierarchy Process (HP) and an overall suitability index is produced for each candidate site allowing comparison and best site selection.

Optimal route analysis in terms of travel distance from each of the three existing transfer stations to the disposal site is carried out using Network Analyst extension of Arc View GIS software. The various factors that are considered during selection of an optimal route are type of road, traffic flow, volume of traffic etc. The system is designed in Integrated Development Environment (IDE), a term commonly used in the programming world to describe the interface and environment that is used to create the application we need and can function on a desktop computer.

The significance of the project lies in the development of a coherent set of criteria for siting solid waste landfills, and establishing a robust methodology for analyzing the necessary data in a relatively quick and reliable manner using GIS.

6. CONCLUSIONS

1. Based on the above techniques the entire area is categorized into five suitability classes as excellent, good, moderate, poor and very poor with respect to landfill siting. Higher the suitability index, the more suited is the site for waste disposal and lower the value, lower is the suitability. Two suitability maps are generated in the present study based on toposheets and satellite imagery (Padmaja Vuppala 2006).
2. Attribute data is generated using GPS for evaluation viz., distance from the point of waste generation, area covered, distance to nearest road or water body, population density surrounding the site etc. of all the sites identified resulted in the short-listing of the sites. Five best sites possessing the best compromise of features were selected within excellent, good and moderate suitability class.
3. Some of the excellent sites were waste management can be done including the area with scrub forest are identified near Kuntlur and Annaram, Marpalliguda and Adilabad, Ankshahpur and Aushapur, between Pocharam and Yemnampet villages towards east of Hyderabad and near Yadawaram, Turkapallli and Masjidpur villages towards northeast of Hyderabad. Excellent sites excluding the area under scrub forest were identified near Lakdaram towards northwest of Hyderabad, near Kisara, Peddaparvatapuram and Bhogawaram towards northeast of Hyderabad and near Pratapasingaram, Koremalla and Choudariguda villages located towards east of Hyderabad.
4. Some Good sites are suggested which includes the scrub forest were identified between Nerapalli, Polkampalli and Manyaguda villages, between Seriguda and Turka Yemjal

Volume : 4 | Issue : 8 | Aug 2015 • ISSN No 2277 - 8179

and near Upparpalli and Tumukunta villages towards south-east, between Narapalli and Kachwani Singaram towards east and between Puduru, Munirabad and Yemjal towards north of Hyderabad. Apart from the above, site located between Ismailkhanguda and Pocharam villages towards southeast of Hyderabad is identified as a good site excluding area with scrub forest.

5. Sites located near Yadagiripalli and Kisara, between Kondapuram, Charlapalli and Ghatkesar villages and between Kisara, Bhogawaram and Peddaparvatapuram towards east of Hyderabad, between Srirangaram, Dablipur and Girmapuram towards north and between Wailal, Kishtaipalli and Jinnawaram villages towards northwest are few of the moderate sites (including the scrub forest) identified. Apart from the above, one site located near Madhawaram, Gandigudem and Kazipalli villages towards northwest of Hyderabad is identified as moderate site excluding the area with scrub forest.
6. The transportation analysis carried out with transfer stations as origin points and sites identified as destination points it can be concluded that the waste collected at Imliban transfer station can be transported and disposed to sites located near Kuntlur, Marpalliguda and Adilabad villages belonging to excellent class; to sites near Nerapalli and Seriguda of good category; and sites near Yadagiripalli and Kisara of moderate category. The waste from TBT can be transported to sites located near Kuntlur, Pocharam, Kisara and Marpalliguda of excellent class; to sites near Narapalli, Upparpalli, Puduru and Ismailkhanguda of good class; and to sites near Kondapuram and Srirangaram of moderate class. The waste from YZT can be transported to site near Lakdaram of excellent class; to site near Wailal and Madhawaram of moderate class.

Fig 2: Showing the thematic maps of the study area

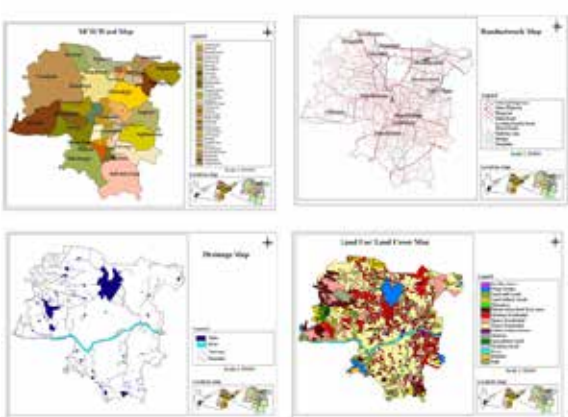

Fig 3: Showing the Site Photographs of the study area

REFERENCE

➢ Dr.AnjiReddy.M, textbook of RS and GIS, second edition, B.S.publications, | Hyderabad, 2001. | ➢ Ms.PadmajaVvuppala, report on suitability analysis decision support system for solid waste disposal sites in and around Hyderabad, 2006. | ➢ Burrough Peter A and Rachael A Mc Donnell, Principles of GIS, Oxford University press, New York, 1998. | ➢ Geography, RajiviAhir, 3rdedition, spectrum India, New Delhi,1999. | ➢ Jensen john. R, remote sensing of the environment, a earth resources perceptive, Low price edition, Keithc.clarke, series editor,Pearson education. | ➢ Lillesand M Thomas and Ralph w keiferi, remote sensing and image interpretation, John wiley and sons, New York, 2000. | ➢ Mather. M Paul, Computer Processing of Remote sensing images, an introduction | Second edition, JOHN WILEY &SONS, New York, 1998. | ➢ Mishra H.C,"Introduction To Satellite Remote Sensing", GIS India,1998. | ➢ Sabinsi F.F, Remote Sensing, Principles and interpretation , W H Freeman and | Company, Newyork,1987. |