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Municipal Solid Waste Management System by using Remote Sensing and GIS Applications: A Review

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Abstract: *Municipal solid waste is one of the very severe problems in most of the developing countries like India. Due to the rapid growth of population and industrialization, the urban population has been increased day by day, this will leads to the generation of more solid waste and there is a need to create for solid waste management particularly its effect is more in urban areas when compared to rural areas. If we are not done the proper management of solid waste then it will create several problems to the environment, human health, and natural resources, moreover the leachate(the liquid which is formed from the substances or the materials) formation under the inappropriately designed landfill leads to the contamination of groundwater along with the other consequences like foul smell, problems to stray animals, etc., In this paper, an attempt was done to give a review on importance of municipal solid waste management, Along with that in order to increase the accuracy of study here we have used software like Geographical information system (GIS) and give a piece of basic knowledge about how GIS was utilized in selecting the suitable landfill and toxic waste sites that are environmentally sustainable and socially acceptable. GIS is the sure answer to most of the waste management problems. It also helps in assessment where pollution is most likely to occur from solid waste landfills.*

Keywords: *Solid Waste, GIS, Disposal, Landfill, Pollution*

I. INTRODUCTION

Solid waste is classified as the waste that is generated from the daily activities of living species. The human actions like residential, commercial, industrial, and constructional are generating a bulk amount of solid waste in various forms. Especially in urban areas, urban areas are pinpoint locations where a huge amount of waste is generating mainly in the industrial sector, in the industrial sector, a lot of polluted waste is released, which will be considered as dangerous to the environment and natural resources.

Currently, with the generation of non-biodegradable materials, not just the soil but even the planet itself is becoming more and more toxic. Solid waste and its hazardous strength also depend on its composition of various materials which can be labeled as organic and non-organic waste, at this present situation of solid waste management it is strongly recommended that to follow green engineering principles which are mainly concentrated on reduce, reuse and recycle, the separated organic waste from the municipal solid waste is going to be treated by adopting a natural process called composting by utilizing earthworms and microorganisms such as bacteria and fungi to check the suitability of sample as a fertilizer and all non-organic waste materials are going to be used as plastic roads and creating bricks by using the energy which is released in the process of incineration (M. Satish Kumar 2020). At dumping locations, the disposal of solid waste is the main origin of leachate formation and it will leads to the contamination of groundwater, and as well as the quality of air (Duguma Erasu 2018).

Furthermore, it may not be possible to determine the effect of the landfill site on the environment for certain long standing landfill sites where data may not be available at the site. In such a case to overcome this issue there must be a scientific technology like GIS for proper monitoring and management of solid waste.

Geographical information systems (GIS) techniques have emerged as efficient and powerful tools in different fields of science over the last three decades (G. Venu Ratna Kumari 2018). The GIS can store, organize, retrieve, identify, control, analyze and present enormous spatial data and information in a simple way. Now a day's GIS Are considered important tools for groundwater studies, in particular for extended and complex systems (Asadi et al 2007).

The result in the form of integrated map could be properly analyzed using the advantage of technology like GIS as methodology, which includes analysis of many resources and their interpretation.

II. LITERATURE REVIEW

M Satish Kumar. (2020) carried out a case study on green engineering practices on municipal solid waste management. In these present situations, green engineering principles are more useful which concentrates largely on the 3R principle. Solid waste samples are going to be collected from the tenali municipality and segregated the collected waste depending upon their nature such as organic and non-organic waste. The organic waste is going to be tested for specific parameters, by considering the results, solid waste treatment is compulsory because the underground flow by waste is spoiling the groundwater aquifers. In this study to treat with chemicals of solid waste samples, a natural process called composting is used. By the process of composting, organic waste is treated with the activity of microbes and helps in the improvement of nutrients such as nitrogen, phosphorus, potassium which will be useful for the growth of crops. And finally concluded that it is the strongest way to recommend as a treatment method which will decrease the problem of land scarcity. (1)

Hetal patel., (2020), an extensive research study was undertaken using the Geographical Information System (GIS) to explain the variability in groundwater quality in the region. to study the contamination of groundwater several samples are collected and tested in the laboratory where all the samples will be examined according to the standard methods for specific physico-chemical parameters like pH, total hardness (TH), chlorides, sulphates, acidity, total dissolved solids (TDS), magnesium and calcium. From the study, it was found that places like Behrampur, Nagma Nagar, Faisal Nagar, Chhipakuva, and other places close by are highly polluted. The findings reveal that values of various parameters are very high than those of the Limits set by Indian Drinking Water Requirements (BIS 1500:991) and by the World Health Organization. But, for drinking purposes, it isn't approved. (2)

M.V.RAJU., (2018), carried out a study to assess groundwater quality in the areas of Vijayawada municipal corporation to develop living conditions with regarding to the groundwater quality .water samples are collected and tested for specific parameters such as PH, conductivity, total dissolved solids, total solids, hardness, and chlorides to estimate the quality of water. The obtained results of the Physico-chemical analysis are mapped with GIS applications. (3)

N.Rajkumar. (2010) a complete study of the geographic variability in surface water and groundwater content was performed using the Geographical Information System (GIS). Approximately forty-three groundwater samples and seven surface water samples were obtained from the research area during February 2009 and the samples were examined for specific physical and chemical parameters such as pH, electrical conductivity, total dissolved solids, alkalinity, hardness, Na^+ , K^+ , Ca^{+2} , Mg^{+2} , Cl^- , HCO_3^- , $(\text{CO}_3)_2$, $(\text{SO}_4)^{-2}$, NO_3^- and F. The analysis shows that parameters of water safety outweigh those of Allowable consumption thresholds in certain areas contributing to water unsafe for consumption.(4)

Nilofar Saifi., (2018), in this paper, the author made an attempt to consider the sustainable management of solid waste and its composition, characteristics, collection, and transport. Over the past few decades, solid waste management has become a critical environmental problem. Because of unsuitable waste disposal, several environmental issues occur, aside from the fact that the quality of the groundwater is also affected, because of which the drinking Water consistency effects and leads to the arising of several health problems. The needs of the waste management method, the bad effects of mismanagement, numerous problems are listed in several studies are mentioned in this study. Waste separation, organic and non-organic waste segregation, will be maintained via societies. Waste processing by energy recovery or composting, composting pits are a low budget, practical methods for transforming vast amounts of organic waste generated by residential people by kitchens and gardens (about 40 Percent of the overall waste created is organic) into rich organic manure/fertilizer that can then be supplied in the open market or used in terrace gardens or in local areas. (5)

Bhushan Dhamodkar.,(2014), carried out a case study of solid waste management in Malkapur city. The challenges of waste management grew with the rise of industrialization and urbanization. Based on the study results the waste characteristics show the need for regular collection and transfer of waste, SW does not stay suitable for prolonged periods of time because the percentage of moisture content is higher. Much of the waste is disposed of by landfill in low lying regions, which may create a variety of problems, to stop these complications, the sanitary and filling need to be done. When Vermiculture techniques are used in the treatment of SW solid waste disposal is simpler. Due to its dangerous nature, Biological waste can be handled separately. (6)

Maaz Allah Khan, (2015), carried out a study on solid waste management in order to determine the existing situation and to find the main issue. Solid waste is handled and disposed of using many processes, like incineration, composting, landfill, recycle, and windrow composting. Solid waste management is modified the present disposal and subsequent use of energy. Totally this study deals with the importance of solid waste management, types of solid waste, and treatment methodologies of solid waste, Quantities, and Characteristics of SWM, and collection of solid waste. (7)

Asadi et al (2007) the quality of groundwater in Hyderabad is of particular importance and requires a lot of attention because it was the main alternative source for residential, industrial, and drinking water supply. Different thematic maps for the study region were

designed on a standard scale by AutoCAD and ARC / INFO GIS software utilizing visual representation of SOI toposheets and linearly enhanced fused data of IRS-ID PAN and LISS-III satellite images. The Physico-chemical analysis details of the groundwater samples were obtained at specified locations and the attribute database was created and the spatial distribution maps of major water quality parameters were designed using the Arc View GIS software curve-fitting approach. The research region's water quality index shows that much of the study region was With > 50 standard water quality index seen as low, very bad and inadequate water quality except in locations such as Banjara Hills, Erragadda and Tolichowki, and suggested certain ways to increase water quality in the affected areas.(8)

Balakrishnan et al., (2011), spatial variations in groundwater quality in the corporation area of Gulbarga City has studied using Geographic Information System (GIS) technique. 76 Water samples from the bore wells and open wells covering the whole corporate region were taken and tested for Physico-chemical parameters such as TDS, TH, Cl^- and NO_3^- Used Standard laboratory tests and compared with norms. The groundwater quality data maps of the whole sample region are prepared for all of the above criteria by using a spatial interpolation technique from GIS. The spatial database for the study region which is established in GIS has helped track and control groundwater contamination. The mapping of potable and non-potable zones in the study region was labeled on the basis of water quality. The analysis of groundwater quality in the study region indicated that half of the city had non-potable groundwater. (9)

Mahamid and Thawaba, (2010), a suitable location for a best dumping site for the governate of Ramallah was defined with the usage of geographical information system as a method to facilitate decision making process. In order to get this purpose thematic layers and different tabular data such as topography, land usage, road network, ground and surface water, drainage, and urban areas were collected from various Palestinian institutions and government agencies. By the usage of multi criteria analysis a suitable site was chosen taking into consideration of vulnerable regions and the best place for the regional landfill site was determined. (10)

M.Vivek, (2018), deals with the utilization of GIS tools to assess the correct location for the disposal of solid waste in thanjavur. In this study to find out the position of dumping site a seven various criteria (Land use, Soil, Slope, Drainage, Lineament, Geology, and Geomorphology) are tested. The sites determined as suitable for landfill are confirmed with field checks and a detailed feasibility study should be carried out on the selected area and minimize all pollution risks with a view of environment protection.(11)

Tamilenthi.S. (2011) identified suitable waste disposal sites utilizing Remote Sensing and GIS techniques for the municipality of Karaikudi Based on the application of various criteria IRS- P6 LISS III imagery and GIS as a method are found to be very useful for analyzing and locating solid waste disposal sites. A buffer from the municipal office 5 km away is extracted. GIS software utilizing weighted overlay analysis aims to find the best locations for the management of solid waste and was classified into three groups. They are fine, bad, and moderate. The first site is the southern part of Illuppakudi and the second site can be chosen somewhere in the 4-5 km buffer range, which may be ideal for travel, environmental and economic considerations. (12)

Genemo Berisa., (2016) deals with the Selection of an appropriate site for the disposal of municipal solid waste created by the municipality of Jigjiga using GIS techniques. In the ArcGIS system, the Weighted Linear Combination (WLC) techniques were used to build the following factor maps showing three groups of suitability levels: slightly suitable, reasonably suitable, and highly suitable. Further study is also carried out in ARC GIS in order to identify an appropriate dumping site for the landfill of the town. Finally concluded that the most suitable site for municipal solid waste disposal (landfill) has been nominated for a site with 24 ha area, 4.8 km away from residences and 1 km close to the main roads. This site is located in the town's new ten kebele, northwest. (13)

G.Venu Ratna kumari.,(2018) the study was conducted in the areas of Vijayawada municipal corporation namely machavaram,labbipet, Benz circle, patamata,autonagar and ayyappa nagar .five sampling centers were selected in each region and called as L1,L2,L3,L4,L5. And the obtained results are correlated with drinking water quality norms and GIS maps are created with the obtained results for simple analysis. (14)

R. Nallusamy, Mukesh Goelr, (2017), pointed out the selection of the suitable location of a site for the transfer of Solid Waste generated by the municipality of Perambalur using GIS techniques. In this perspective, the appropriate site selection for the disposal of solid waste is defined by integrating spatial data and non-spatial data, various input map layers and attributes created for this reason. By comparing the maps generated by these two distinct methods, both techniques demonstrate similar findings. Along with that, the Use of multi-criteria analysis is a modern effort to get a suitable site. It is observed that the Perambalur Taluk is an important site known for the disposal of Solid Waste. (15)

Naser and Hajizadeh, (2011), carried out a study on the discovery of landfill sites for toxic waste disposal in Khorasan Razavi province. An improper landfill site may have detrimental environmental, ecological, and economic impacts. Potential locations for

toxic waste landfills in northeastern Khorasan were defined in the present study using the integration of geographic information system and landfill susceptibility zonation methods. Inappropriate areas were excluded from the model first, and the suitability of the remaining regions was evaluated in two stages using 15 specific criteria. Nine viable places were selected as the best locations on the basis of economical studies and environmental impact assessment. This report has shown that the Maasumabad, Kheirabad, Mayamey, and Yonsi are respectively the good landfill sites in Khorasan Razavi province. (16)

Surajit Bera.,(2016), proposed a study used the combination of GIS and Remote Sensing to find the best locations in an urbanizing area for dumping solid waste materials. A multi-criteria approach was used along with the GIS-based overlay study to determine the most suitable location for solid waste disposal in the Dhanbad block. A number of eleven (11) possible sites for solid waste disposal is found at the most appropriate locations. (17)

Ashish R. Mishra., (2014), the present study, focused on the research carried out by Yavatmal Municipal Corporation on solid waste management activities. It is also developed to study solid waste composition in Yavatmal Region. The data gathered indicate that the maximum proportion of refuse generated by food and garden waste, and a proportion of reuse caused by the food and garden waste, Paper was second highest and inert material was third highest. It seems that the dumpsite is 8 km away and smaller vehicles are used for solid waste transportation, it will be beneficial to set up a transfer station to reduce transportation expenses. That is the most effective by means of recycling and reusing products such as carbon, fabrics, glass, and rubber, etc. An annual study on the implementation of solid waste collection strategies will be formulated. (18)

Duguma Erasu.,(2018), carried out a study to measure the amount of solid waste generated and to examine factors that influence waste generation and disposal in Robe Town, Ethiopia. The outcomes of this study showed that total household waste produced was about 97,092kg /day. In addition, the analysis reveals the town's solid waste generation rate is 0.261kg /person /day. Approximately 57.5 percent of solid waste is appropriately disposed of at landfill sites, while the remaining 42.5 percent are improperly discarded at the roadside and open fields. Finally, he recommends the town will focus actively on waste disposal initiatives such as reduction, recycle, reuse and composting along with that to avoid leachate formation and landfill gas, recommends to the municipality has come forward and built a well-standardized landfill. (19)

Mufeed Sharholi., (2008), in this study an attempt was done to give a review about characteristics, collection, generation and transportation, treatment and dispose technologies of municipal solid waste implemented in India. Various adopted MSW treatment methods and their benefits and drawbacks are thoroughly examined. Composting and vermicomposting and are very common and popular in India instead of incineration, and It is best suggestible to switch from free disposal to sanitary landfills. The report is ended with a few useful ideas which may be effective in motivating the relevant authorities/researchers to work for further development of the existing system. (20)

III. CONCLUSION

Waste generation is a continuous process by humans and as well as animals. In that municipal solid waste is one of the main issue. Moreover, the disposal of solid waste is also a big problem due to insufficient land for dumping in many areas. Because of open dumping, there will be high chances of spreading diseases to nearby people and polluting natural resources. So to decrease the burden of solid waste disposal here we have recommended the natural processes like composting, vermicomposting. Due to this process, the hazardousness of the organic solid waste is removed and can be used for many purposes. In this study, I concluded that the proper management of solid waste is effectively done by means of GIS. Geographical Information System technology must be used in their assessment of pollution as it is useful to analyze & get the solution easily with more accuracy. To this end that the above strategies along with maintenance of greenbelt at solid waste dumping yards all the problems associated with solid waste can be eliminated by promoting environmental sustainability.

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