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Study of Solid Waste Management Using Geospatial Tools for Ichalkaranji City

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Abstract -*Over the last few decades rapid industrialization, rural to urban migration and high population growth have induced rapid urbanization world over and India is no exception. Consequently, the problems associated with urban solid waste management have acquired an alarming dimension. It is observed that the per capita solid waste generation rate in India has increased from 0.5 kg per day in 2011 to 0.7 kg per day in 2020.This has pressurized the existing systems resulting in adverse impacts on human health and environment. Though concerted efforts have been put in by urban administration, there is vast scope for introduction of state-of-the-art system to collect, process, dispose, or reuse the solid wastes in a cost-effective manner considering technical, geographic, socio-cultural, industrial, infrastructural, legal, and environmental factors associated with it in an integrated manner. Ichalkaranji is one of the fastest growing cities, presently generating about 110 metric tons of solid waste per day. In this study, an attempt is made to assess the present status of Solid Waste Management System (SWMS) in Ichalkaranji city and compare it with Swachh Bharat Mission's Municipal Solid Waste Management Rule 2016 clauses and finally suggest various improvements in view of future expansions. The work includes extensive use of Arc-GIS involving overlay and proximity analysis. The study covers the aspects such as region wise generation of solid waste and infrastructure for its collection, processing and disposal, or Reuse. It is concluded that better planning, management and effective implementation of solid waste management system can be achieved using these modern tools so that clean urban environment for various cities in the country is ensured.*

Key Words: ***Urban Solid Waste Management System, Geospatial tools***.

1. GENESIS

Municipal Solid Waste (MSW) consist of various types of waste like, Residential and Commercial establishment unwanted and discarded materials, street sweeping waste, construction and demolition debris, sanitation residues, trade and non-hazardous industrial waste, treated biomedical solid waste. Day by day around the globe, waste generation rates are rising. In 2020, the total waste generated by world cities was 2.24 billion tonnes of solid waste, amounting to a footprint of 0.79 kilograms per person per day. With the rapid growth of population and urbanization, the generation of waste is expected to generate ranging 3.5 - 6 million ton per day of solid waste by 2025. It observed that in developed countries generate more solid waste than developing countries. It is also reported that MSW generation in less developed cities is 0.3-0.7 Kg/Capita/day and for fast developing cities is 0.5-1.5 Kg/Capita/day while for developed cites it is greater than 1 Kg/Capita/day in Asian countries like India. Improper MSW disposal and management causes various types of pollution that in air, soil, and water. In urban places, MSW clogs drains, creating stagnant water for insect breeding and floods during rainy seasons is critical issue. There is generation of various poisonous gases from the open dumping of organic wastes in landfills and untreated leachate pollutes surrounding soil and water bodies. Numerous health issues are aroused due to improper SWM.

In Ichalkaranji city primary sources of solid waste are Household, Hotels & Restaurants, Street sweeping & Markets / commercial area. Biomedical waste and E-waste are on minor side of collection. The total quantity of waste generated per day is about 100-110 metric tons (0.34-0.38 kg/ capita/day) CPHEEO-2000. Ichalkaranji Municipal Corporation (IMC) is responsible for solid waste management components like collection, storage, segregation, transportation and disposal of all solid waste generated in the city. This work also involves future waste generation predications. This tool helps to take good decision in all aspects before any plan execution or after execution of system.

2. STUDY AREA

Ichalkaranji City, the second largest city in Kolhapur district after Kolhapur city in Maharashtra. Although Ichalkaranji city has population of 292062; its urban / metropolitan population is 325,709 of which 169,870 are males and 155,839 are females. The city's population as shown above is excludes newly growing industrial and residential areas, villages that are partly included by Ichalkaranji (known as part of the city) but having Kabnur, Yadrav and Korochi etc as a gram panchayat. Village Shahapur Village, Ichalkaranji was included in Ichalkaranji Municipal Corporation in 1985. Its literacy rate is 85.98% which is higher than the national average which is 59.5 %. The city is known as "Manchester of Maharashtra" as it has maximum number of power looms & spinning mill contributing to daily turnover of 100 Crores Rupees. The city under IMC jurisdiction covers a geographic area of 29.84 sq.km. Ichalkaranji Municipal Corporation lies between latitudes 16°42'32.4072''N and longitudes between 74°27'21.8808''E. Ichalkaranji city situated at an altitude of

538 meters (1768 ft.) above mean sea level (MSL). The entire jurisdiction of IMC is divided in to 31 electoral wards, 26 administrative wards.

3. DATABASE AND METHODOLOGY

In this research work an attempt is made to assess adminward wise waste generation its collection, segregation, transportation, treatment and disposal land fill site using geospatial tools i.e. Geographical Information System (GIS) and critically study technical, Socio economic, health and environmental effects of respective adminward, with multi-criteria analysis method have been studied to find best waste management strategy for the city based on various criteria.

The research work is divided into three components:

1. Study of existing solid waste management system using of Geospatial tools
2. Comparison of existing solid waste management system with Solid Waste Management Rule 2016.
3. Suggesting some future majors that can be carried out Future Generation of MSW.

3.1 Solid Waste Management Components

The most important parameter to be considered is population of study area. The population of each adminward is considered for this research work. Adminward wise waste generation is calculated. The components of existing waste management waste generation, collection, transportation, processing and disposal. The detail process is explained in flow chart Figure (2).

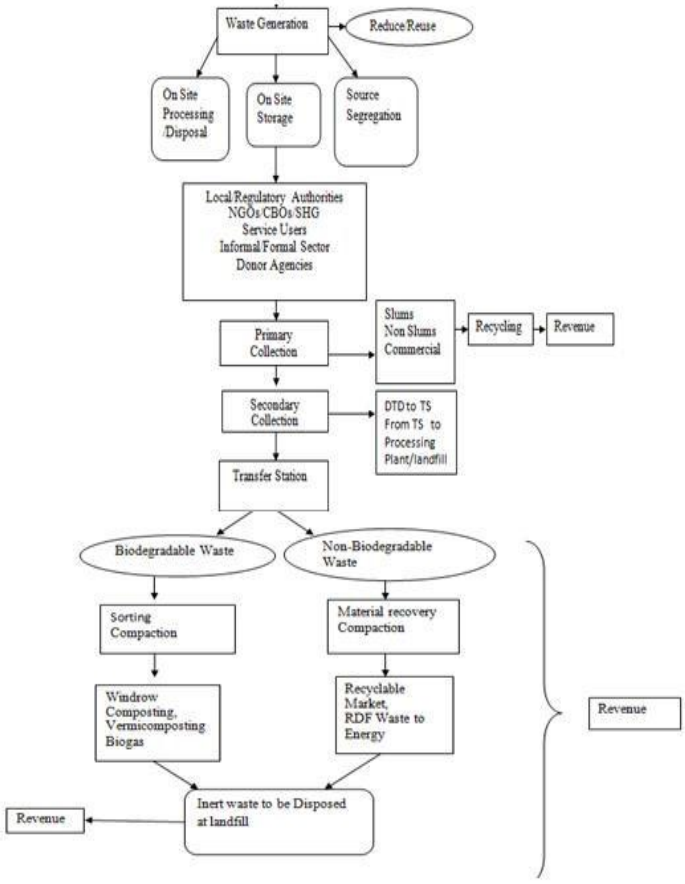

Figure 2: Solid Waste Management Flow Chart.

3.1.2 Geospatial Analysis

The main objective of this research work is to study the current solid waste system of Ichalkaranji city using Geospatial tools. The data collection involved collection of topographical maps, ward maps, satellite data and demographic details. The collection of these data and their source are shown

Data	Sources
Ichalkaranji city ward map	Ichalkaranji Municipal Corporation Documents
Google Image	Google earth pro
Satellite Imagery	bhuvan.nrsc.gov.in Carsat-1, CartoDEM all versions
Demographic details	Ichalkaranji Municipal Corporation, Census data
All Secondary data related Solid Waste Management	Solid waste department, Ichalkaranji Municipal corporation

The brief information about steps involved in implementation methodology for the present research work.

1. Data Collection: Procurement of Satellite data and related attribute data.
2. Data Processing: Geo-correction of topographical maps and image processing
3. Application of standard image processing techniques to identify the existing solid waste system of study area.
4. Creation of GIS layers: digitization of ward map, locating smaller ramps, treatment plant and administrative boundary of study area from the topographical maps and Google images using GIS software's.
5. Preparation of thematic maps: Generation of result based thematic maps.

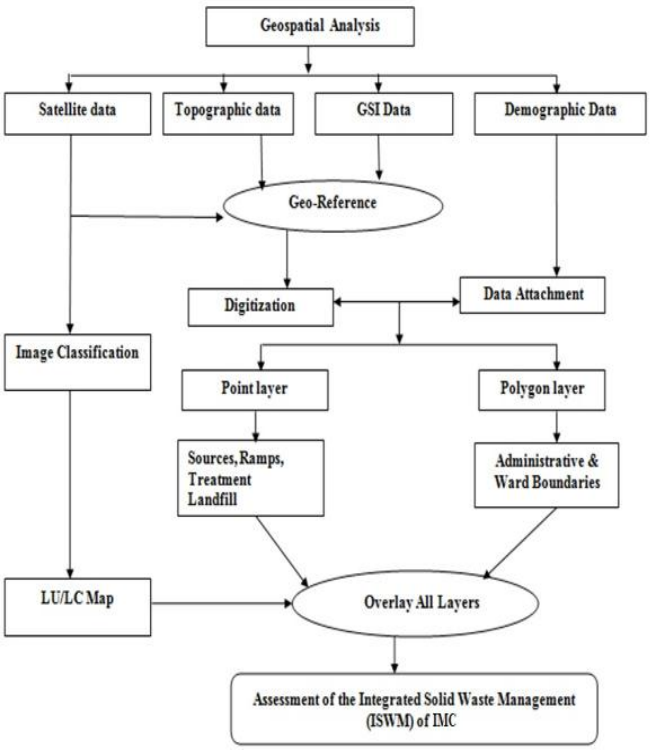

Figure 3: Flow chart of Geospatial Analysis.

4. RESULTS & DISCUSSIONS

4.1 Use of geospatial tools

The municipal solid waste management system (MSWMS) includes reduce/reuse, recycle, composting, waste to energy and finally landfill. The detail solid waste management system study is conducted using geospatial tools. Thematic maps have been generated using Arc-GIS 10.2. To study the spatial variations of the MSWMS It is seen that, Ichalkaranji generates 100-125 metric tons of waste every day from different sources in adminwards. Ichalkaranji waste composition consists 45% of organic waste 55% other waste (fig5). About 80 percent of the waste is generated from households (domestic waste), hotels, restaurants and Street sweeping & Markets / commercial area establishments which together account for over 18.5 percent of the waste generated and biomedical waste, E-waste & Hazardous waste account 0.5% generation each. (table2). Waste generation based on population. The generation rate per capita per day was considered as 0.4kg/capita/day according to World Bank. Awareness of waste reduction at source need improvement. To achieve zero garbage model it important to focus on waste segregation. Ichalkaranji city generates Dry Waste and Wet Waste almost in equal proportion (40%-40%) and 20% mixed waste. Solid Waste Collection system of IMC is projected. (In table 2)

Scientific landfill site is essential. Decentralized treatment method needs to be adopted. Other waste like C and D is processed in one plant under IMC. Special waste like hazardous waste, biomedical waste, plastic waste and E-waste special treatment plants have been established based on generation capacity. However special waste treatment awareness is needed to avoid harmful effects on environment and public health. The research work suggestions need to be implemented in SWM system of IMC for urban sustainable development.

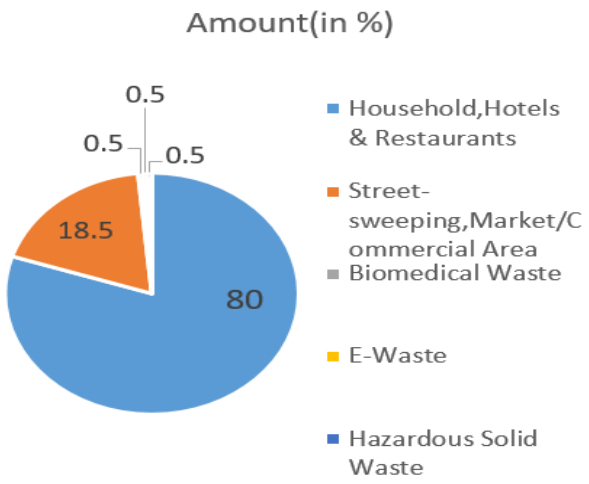

Figure 4: Composition of Waste

(Solid Waste Management Dept, IMC)

Sr. No.	Sources of Generation	Quantity (MTD)	Percentage (%)
1	Household, Hotels & Restaurants	88	80
2	Street sweeping & Markets / commercial area	20.35	18.5
3.	Biomedical Waste	0.55	0.5
4.	E-waste Waste	0.55	0.5
5.	Hazardous Solid Waste	0.55	0.5
	Total	110	100

Table 2: Sources of waste generation.

Sr.No	Type of Vehicle	Nos.
1.	Ghanta Truck	68
2.	Compactor	2
3.	Tractor	10
4.	JCB	2
5.	Loaders	2
6.	Bulldozers	1
7.	Tipper	5

Table 3: solid waste collection system-IMC secondary system.

5. FUTURE GENERATION OF MSW.

Presently IMC generated 100 to 125 tons of waste per day. Per capita per day waste generation is 380-450 gram. Since India is under lower medium income category by word bank the waste generation rate varies from 0.7-1.5kg/capita/day. Future solid waste generation for Ichalkaranji city is projected on the basis of 0.4-0.6kg per capita generation. Decade wise generation of municipal solid waste under IMC is as per Table-5 which indicates about threefold increase in quantity of SW when compared to 2011 level. Thus meticulous planning and effective implementation of MSWMS by IMC is essential.

Currently, the present SWM of Ichalkaranji satisfies with Solid Waste Management Rule 2016.But as the population is increasing there will be increase solid waste generation. So, in future there will be need to implement transfer station between collection area and landfill station.

Year	Projected Population (at rate 1.54%/yr.)	Generation Rate (Kg/capita/day)	Waste Generation (TPD)
2011	290560	0.3	109
2021	295035	0.4	118
2031	299579	0.5	150
2041	304192	0.6	182

Table 4: Future generation of solid waste

(World Bank report)

6. GIS MAP OF ICHALKARANJI CITY

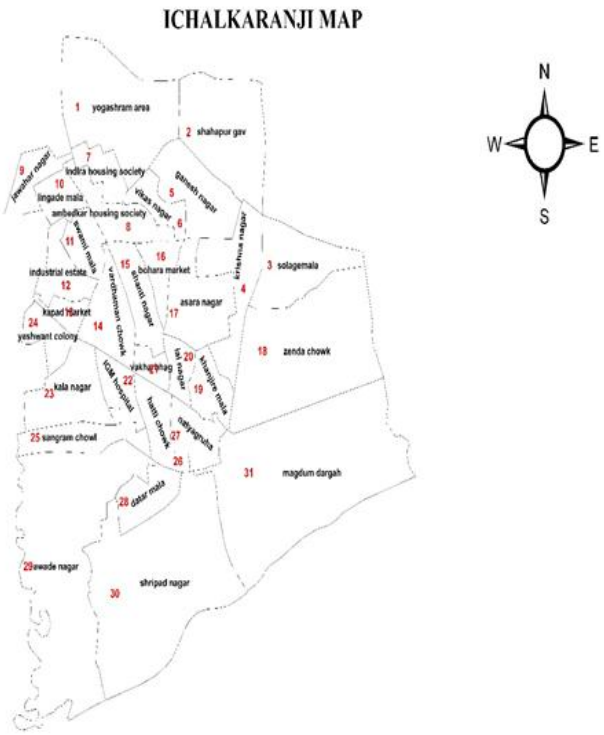

Fig: 5- Location Map of Study Area.

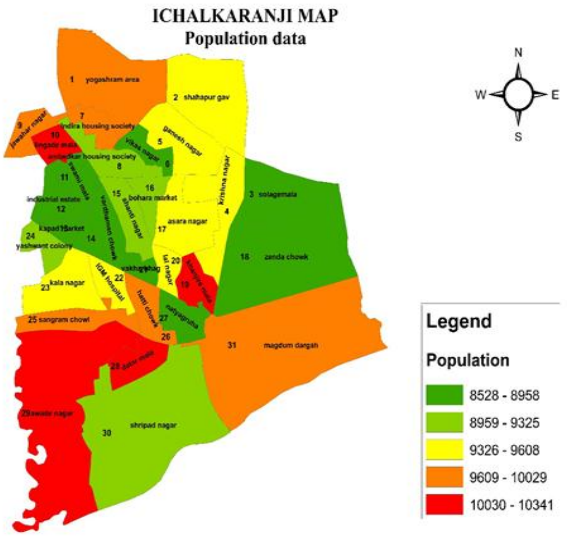

Fig: 6- Population Distribution of IMC.

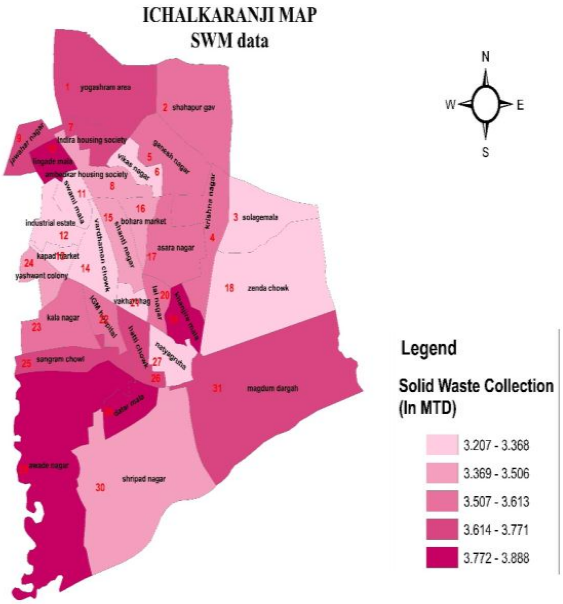

Fig: 7- Ward wise solid waste collection of IMC.

7. CONCLUSIONS

The study demonstrated that in view of the rapid urbanization, a well-planned MSWMS with its effective implementation is need of the hour for Ichalkaranji city. The detail planning and spatial status of implantation study of MSWMS considering its various components can be possible using geospatial tools for better results, minimizing the environmental impact on urban health. Various results obtained in this the study are useful in planning MSWMS for the city emphasizing the importance of the requirement of Solid Waste Management System (SWMS) for all urban establishments in the country.

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