

Vol. 11. No.2. 2022

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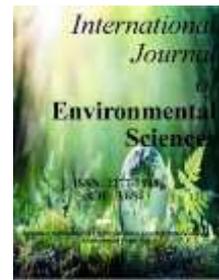
DOI: 10.13140/RG.2.2.36424

Orcid ID: 0000-0002-5529-7564

Contents available at:

<http://www.crdeepjournal.org>

International Journal of Environmental Sciences (ISSN: 2277-1948) (CIF: 3.654)
 A Peer Reviewed Quarterly Journal

**Full Length Research Paper**

Assessment of Municipal Solid Waste Management in Rani Bagh Area of Jammu City through SWOT Analysis: Prospect of Jammu Municipal Corporation towards Swachh Bharat Abhiyan and Sustainable Jammu City.

Anil Thakar^{1*} and Shashi Devi²¹ Institute of Mountain Environment, Bhaderwah Campus, University of Jammu, Jammu and Kashmir, India.² Department of Environmental Sciences, Govt. Degree College Budhal, Jammu and Kashmir, India.**ARTICLE INFORMATION****ABSTRACT****Corresponding Author:**

Anil Thakar

Article history:

Received: 20-05-2022

Revised: 24-05-2022

Accepted: 27-05-2022

Published: 28-05-2022

Key words:

Swachh Bharat Mission,
 SWOT analysis,
 Sustainable cities,
 Refused Derived Fuel,
 Vermicomposting.

From few years, the exponential population growth, high density of urban areas, diverse culture, lifestyle changes due to changing food habits and priorities have seen an ambiguous problem in terms of Municipal Solid Waste Management (MSWM) in India. The present study is a comprehensive analysis undertaken and initiated on 2nd October 2017 on the third anniversary of Swachh Bharat Mission started by Government of India summarising the municipal solid waste management status along with recognizing the associated challenges and deriving potential solutions for the MSWM in the Rani Bagh area of Jammu city. The data was collected for one year between October 2017 to September 2018 from 150 households and nine slaughter houses/ chicken shops in the vicinity, the municipal solid waste generated was weighed by volunteers deployed and the problems associated due to the non-segregation of solid waste at source, citizen's attitude, socioeconomic status of residents, inadequate potential strategies, social taboo at local level and poor implementation government policies were addressed. Study area generates 253 kg/day of MSW including 0.344 kg/capita/day; which comprises mainly of compostable organics (70-78%), inorganics (15-20%) and inert (8-10%) fraction. The discussion concludes with an urgent need for adequate treatment and recycling strategies like Refused Derived Fuel (RDF), Vermicomposting etc. required to be adopted as per the Integrated Solid Waste Management System (ISWMS). Further findings of SWOT approach (Strength, Weakness, Opportunity and Threats/challenges) as per United States Environmental protection Agency could help in developing a strategic action plan for sustainable cities involving community, NGO's, private sector and municipal authorities through Public-Private Partnership (PPP) mode

Introduction

Solid waste mentions to unwanted or waste solid materials generated from combined residential, industrial and commercial activities in a given region (Chandrappa and Das, 2012; Parvathamma, 2014). Municipal Solid Waste (MSW) comprises of all types of solid waste generated by households and commercial establishments and collected usually by local government bodies like municipality (Bhada-Tata and Hoornweg, 2011). In the developing countries the majority of substances composing MSW include paper, kitchen waste, plastics, metals, textiles, rubber and glass. Sometimes solid wastes are classified as domestic, industrial, commercial, construction or institutional and on content basis as organic material, glass, metal, plastic and in the hazard category as potential toxic, non-toxin, flammable, radioactive, infectious etc. (Festus and Omoboye, 2015). Ecologically, solid waste can be categorized into as biodegradable, non-biodegradable and inert waste (Kumar and Singh, 2013). In view of fast economic development and urbanization, the generation of municipal solid waste has rapidly increased worldwide and the composition of Municipal Solid Waste has also changed significantly leading to more pressure on the existing environment, human health and also to the management of Municipal Solid Waste system (Sinha and Rawat, 1991; Wang and Nie, 2001; Zhao *et al.*, 2011). With the increased population growth and mounting consumer choices resulted in the larger production of waste worldwide (Karak *et al.*, 2012). At present, around 62 million tonnes of solid waste is generated annually out of which 5.6 million tonnes is plastic waste, 0.17 million tonnes is biomedical waste, hazardous waste generation is 7.90 million tonnes per annum and 15 lakh tonne is e-waste (CPCB report 2016). In the Jammu city rapid urbanisation has leads to

generation of 3142 Tonnes waste per day (Action plan report J&K, 2019). Major Indian metros like Mumbai, Delhi, Bengaluru, Kolkata and Chennai generate about 10 million tonnes of garbage every day. Mumbai and Delhi have 3 major landfills each and their biggest/main landfills, Deonar in Mumbai (90 years old) and Ghazipur in Delhi (33 years old) which are functioning way beyond their lifespan. Similarly in Jammu Bhagwati Nagar landfill and Udeywala landfill are the only landfill sites allocated for the waste management. Earlier a short study in the same area has been done which shows 82.49% of Biodegradable waste generation and non-biodegradable waste composition was 16.62% followed by 0.88% Inert material category (M.Sc. Dissertation University of Jammu 2015). Hence, a similar attempt was made to study the generation and composition of municipal solid waste from Rani Bagh and its adjoining areas like Gadigarh, Ajit Nagar, Babliana others. This study will help us to place before the Jammu Municipal Corporation the problems arising out of unsegregated solid waste and its unscientific disposal applicable not only to the study area but to other areas as well. So better strategy and framework could be developed to step up towards sustainable city. It is now being realized that if waste generation continues recklessly at this very pace, then it would become rampant and alarming very soon and possibly beyond rectification. Therefore, Management of solid waste has become very important in order to minimize the detrimental and lasting aftermaths of solid waste. To mitigate the problem Swachh Bharat Mission was launched in October, 2014 by Government of India with an aim of clean India and to improve solid waste generation scenario and its proper management through scientific disposal (Figure 1). As from the long time the municipalities have been facing many issues related to the unplanned collection, treatment, and management of solid waste which is the main hurdle on SBM.



Fig 1: Solid Waste Management System

Materials and methods

Study area

Jammu and Kashmir, the north western state of India is located in between 32° 17' to 37° 06' N and 73° 26' to 80° 30' E. Jammu city lies at uneven ridges of low heights at the Shivalik hills. It is surrounded by the Shivalik range to the north, east, and southeast while the Trikuta Range surrounds it in the northwest. The Jammu region has ten districts viz. Jammu, Samba, Kathua, Udhampur, Reasi, Doda, Kishtwar, Ramban, Poonch and Rajouri. Jammu city has an area of 112 sq. km with population of approximately 5.2 lakhs. The present area of investigation Rani Bagh is situated at distance of 5 km from Jammu University Campus towards Jammu South (Figure 2). The area does not come under municipal limit of Jammu city but recently some portion was included in municipal limits. Presently, Jammu has seven council and thirty-six municipal committee and Jammu city is divided into 75 wards. A minimum of 150 houses and butcher houses were randomly selected for the purpose of study.

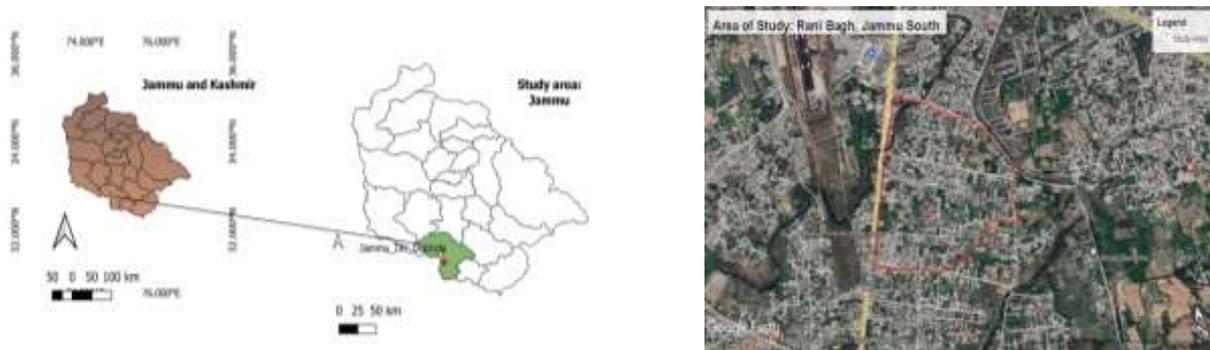


Fig 2: Study area- Rani Bagh, Jammu

Methodology

The households were demarcated into categories like High Income Group (HIG), Low Income Group (LIG) and Medium Income Group (MIG) on the basis of income and their socioeconomic status the samples were collected using quartile method (Tchobanoglous and Kreith, 2002) and the variation in waste composition with respect to different socio-economic groups was studied. The solid waste generated from the households were collected and weighed on seasonal basis for a year between October 2017 to September 2018 from 150 households as stratified random sampling on the basis of their categorization into different groups (Tchobanoglous and Kreith, 2002) and nine slaughter houses/ chicken

shops in the area. Volunteer students of the area and workers from Urban Local Bodies (ULB) were deputed for the collection of waste materials which were collected from different economic groups living in the area and the variation in waste composition with respect to different socio-economic groups was studied. Physical composition of MSW was determined without removing moisture from the waste. The wet waste collected were segregated, weighed and classified into various categories according to the Solid Waste Management Rule, 2016.

SWOT (Strengths, Weaknesses, Opportunities and Threats/Challenges) Analysis

An important approach given by USEPA (United States Environmental protection Agency) regarding waste management practices of an area is SWOT model. This model helps to identify the positive and negative factors that could help to identify the effect on management practice of an area (Srivastva *et al.*, 2005). This approach was used to analyze the opportunities and threats associated with solid waste management practices in Chandigarh city (Mor *et al.*, 2015). In the SWOT technique various factors are used for identifying their impacts like strengths, weaknesses, opportunities and threats of programme or other associated activity. For conducting SWOT analysis, the questionnaires and other interviews were conducted to gather information on waste management practices in the area and Jammu city and the observation made during field visits were recorded. It could help Jammu Municipal Corporation in developing concrete strategic action plans in J&K to improve MSW management practices along with their already adopted IEC (Information, Education and Communication) Strategy.

Results and Discussion

Per capita waste generation in Jammu and Kashmir is around 0.23 kg per day and overall, it generates approximately 350 tons per day (TPD) of MSW with highest composition of biodegradable waste 70-80% (State action plan, 2018). Previously work has been done in nearby areas of Jammu like Gandhinagar, Rehari, Janipur, Bohri (Slathia 1999, Sharma 2001, Pandita 2011) in which higher composition was of biodegradable waste followed by non-biodegradable waste and inert material. In the present area the major components of MSW included degradable organics (~78%), inert (~10%), plastic, paper, cloths (~12%), glass (~0.1%) and other. In the developing nations organic matter is higher (Khajuria *et al.*, 2010). Among the three income groups, higher portion of biodegradable materials was observed in LIG (Low Income Group) 74%. The non-biodegradable waste segment was in the range of 12-18% on average basis and were reported to be higher in HIG (High Income Group) due to the use of plastic and other allied products (Table 1). Similarly, Sharholly *et al.*, 2008 observed higher fraction of degradable materials in LIG among the three income groups and reported increase in organic fraction in MSW with decrease in socio-economic status of the area. In summer season food waste generation from the locality is higher followed by vegetable waste, paper and textile waste whereas in winter season generation of food waste is higher followed by textile, vegetable and paper waste (Figure: 3)

Table 1: Physical Composition of MSW in three income groups on wet weight basis % in Rani Bagh Jammu

Components	HIG*	MIG*	LIG*	Average± SD
Compostable/Organic	61.3	70.6	74.0	68±3.1
Plastic/Polythene	8.2	6.9	5.8	6.9±2.0
Paper	8.1	6.4	4.1	6.2±0.6
Glass	6.5	3.4	2.0	3.9±2.3
Rubber/Leather	5.1	4.9	4.2	4.7±1.7
Inerts	5.3	6.4	9.4	7.0±0.8
Clothes	5.5	1.4	0.5	2.4±1.1

HIG*- High Income Group; MIG*- Medium Income Group; LIG*- Low Income Group; SD Standard Deviation

Municipal Waste management Practices with SWOT analysis

Jammu Municipal Corporation (JMC) is the government body responsible for the MSW management of the city including storage, collection of waste and transportation to disposal site and processing plant. Although Jammu has Bhagwati Nagar and Udheywalla landfill sites but they are prone to get overburdened despite of their carrying capacity in coming years. The existing solid waste management system of Jammu city is shown in Fig. 2. Our study aims to identify gaps in the existing MSW management practices followed in the municipal committees and councils of Jammu Province using SWOT analysis.

Strengths

The study suggests the best management practices and ways to improve them in future times. Door-to-door collection of waste is practiced by JMC and residents pay fixed monthly charges thereby, leading to less dumping of garbage on the open field and in the drains. Various organizations like Resident Welfare Association (RWA), and other civil society volunteer groups are also involved in the management of MSW in some posh area of city. The MSW characterization showed that ~12% of the MSW is combustible in nature. JMC need to make the provision of processing waste and converting it into fuel termed as Refuse Derived Fuel (RDF) at some areas of Jammu (particularly in the outskirts). This public-private venture can reduce the pressure on the landfill. As Bhagwati Nagar landfill site is disposed to get leaching of some toxic waste into groundwater because hospital and other toxic waste are also being dumped there. Location of separate waste collection stations i.e. Sehaj Safai Kendra's (SSKs) like Chandigarh city could play an important role in reducing the diversion of combustible waste fraction through informal picking or burning.

Weakness

Lack of waste segregation at source affects the composition of MSW because the organic and fuel capabilities of waste could get reduced. Lack of composting facilities at local scale also leads to mixing and dumping of cumulative waste on the road. Physical composition of MSW showed that more than 70% of the waste fraction was organic in nature and were dumped unscientifically at gadigarh, coloniel colony, karan bagh areas. E-waste, hazardous waste and biomedical wastes of the area still ended up in landfills as a part of municipal waste. But recently from last two years JMC has been actively involved with SPCB for the proper and scientific disposal of biomedical wastes.

Opportunities and Threats

Jammu city can act as role model for 100% compliance of MSW Rules, 2016 of India. Based on MSW characterization, the present study inferred that composting and bio-methanation plant for organic waste (e.g. hotel, restaurant, dhabas etc waste) should be established. JMC could come up with In-house composting facilities at the collection points and the capacity could be identified based on different economic group sectors according to the generation of waste. The landfill leachate could be used as fertilizer by SKUAST agricultural university and for irrigating the agricultural field like RS Pura, Chatha and Miran Sahib areas. Active involvement of media, Universities, NGO's, schools and other educational institutes could play an important role. The only threat of open landfill and dumping is the seeping down of leachate into soil which could lead to loss of nutrients in soil ultimately leading to agricultural loss. Moreover, the possibility of air crash due to hovering of crows, vultures and other raptors on the garbage dump and butcher house wastes of the area is also there because the Jammu Airport runway is near to the study area.

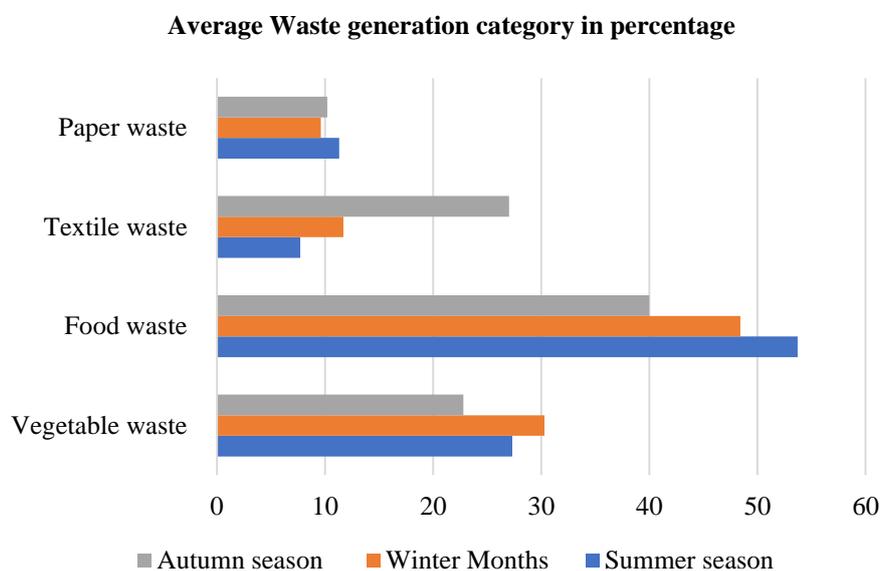


Fig 3: Seasonal MSW generation from the study area

Conclusion

Economic development, unplanned urbanization patterns and material consumption considerably enhances the MSW generation rate in any city. The poor waste management strategies, and unscientific disposal system were responsible for increasing open dumping of MSW in Jammu Province and city. It could lead to the perpetual degradation of soil and overall environmental quality. From the study it was concluded that although the present method of Solid Waste Management in the area is viable but in the longer run it could not prove to be efficient in terms of sustainable city point of view. The solid waste generated in the study area and whole Jammu city could be utilized in the production of manure and energy which will help to reduce the volume of solid waste and to some extent also reduce the increasing stress on natural resources. Substitutes to the current practices could be made feasible only if the community also get involved with the government. Hence PPP mode should be involved in making strategic decisions regarding effective implementation of Solid Waste Management Rules, 2016 under Environment Protection Act, 1986. Hence Jammu Municipal Corporation may setup an inhouse high-capacity plant for involvement of waste to energy methods like RDF, Bio methanation, Vermicomposting etc according to the suitability of the region to achieve the target of smart city, sustainable development and renewable energy target 2030 so that Jammu could be developed as model city in terms of Intelligent Waste Management System.

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