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Generation and Management of Municipal Solid Waste in Uttarakhand: a Geographical Insight

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Abstract

Waste and municipal solid waste management are not new concepts but are the essentials of human civilization. Humans generate waste by their actions and do the management may be appropriate or inappropriate. In the recent past, solid waste management (SWM) has become a concept of universal apprehension as growing industrialization, urbanization, and more and rigorous resource utilization by the modern societies generating phantom of waste in different forms. Himalayan states are not the exception of the fact. In Uttarakhand population is increasing slowly but steadily so the urban centers too. The fragile ecosystem of the Himalayas has different solid waste management systems, but all are proving inadequate, ineffective, and unsustainable; overflowing roadsides, hill slopes, river valleys, and uncollected waste bins are the evidence of facts. We can't stop waste generation, but reduce, reuse, and recycle the waste and minimize the adverse consequences. Geographical perspectives may prove helpful in overall solid waste management studies and find solutions to them. This study focuses on the geographical distribution,patterns of solid waste, and amount of solid waste generated and processed in Uttarakhand and India. Rethinking the pattern of waste generation and spatial pattern of waste distribution is the important approach and will be the first step in renovating the whole solid waste management process and facilitating a more sustainable and inclusive environment of the urban centers.

Keywords: Himalayas, municipal solid waste (MSW), solid waste management (SWM), urbanization, Uttarakhand

Introduction

Municipal Solid Waste (MSW)

Municipal solid waste is a genius mixture of household, industrial, commercial and biomedical establishmentswhich originates from people whom paper, cloth, metal, glass, organic matter. The waste from season to season and one place to another place, depending on the food, the standard of living and depending on the lifestyle and so on.

The municipal solid waste consists of household waste, construction, and demolition debris, sanitation, industrial and Hospital waste (Planning Commission, 1995).

World Bank (1994) has defined municipal solid waste as the wastes that include refuse from households, hazardous solid waste from industrial and commercial formations, and refuse from institutions, market waste, yard waste, and street sweeping.

Types of Municipal Solid Waste (MSW)

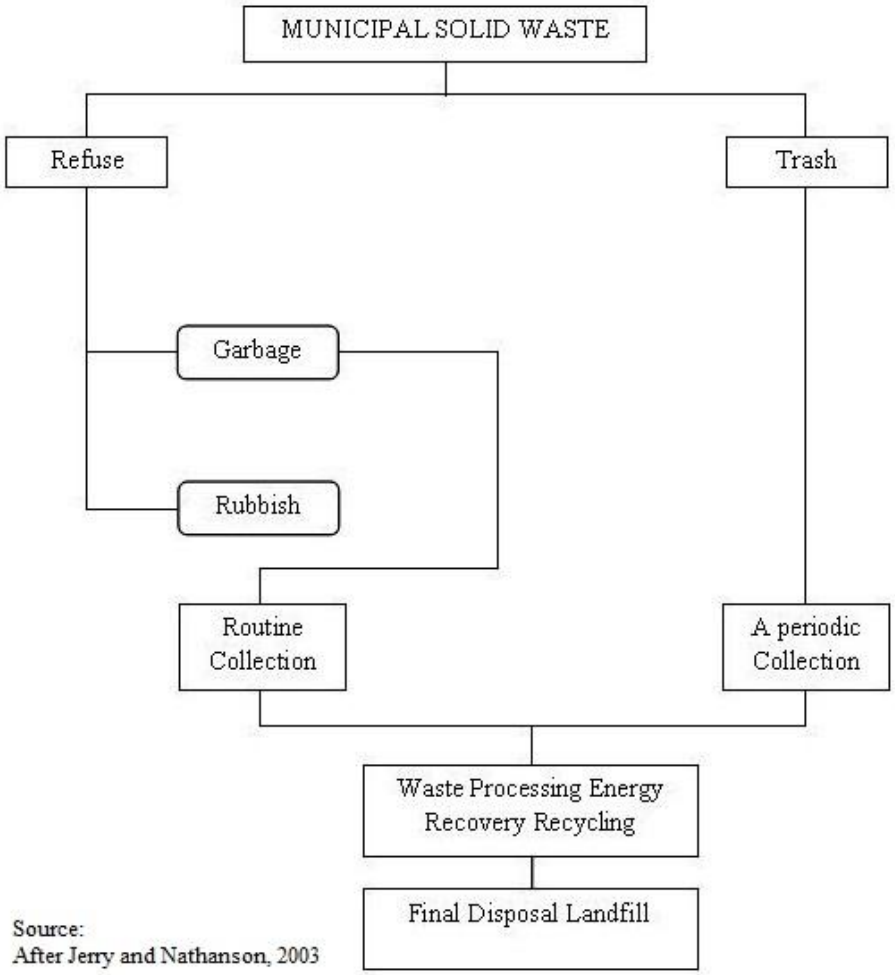

Fig. 1: Classification of Municipal Solid Waste

Solid wastes are solid and semi-solid material, resulting from human and animal activities that are useless, unwanted hazardous. Classification of Municipal Solid Waste could be as follows:

Classification of waste according to their properties

1. Bio-degradable
2. Non-biodegradable

Classification of waste according to their Sources and their generators

Household Generators

Vegetable waste, food waste, plastic bags, bottles, discarded electronic waste, newspaper and magazine, wood, clothes.

Agricultural/Horticultural Generators

Food processing, animal manure and chemical fertilizer.

Industrial Generators

Chemical solvents, sludge, metals, ash, waste water, manufacturing process

Commercial and Institutional Generators

Hotels waste, hospital waste (Biomedical waste), restaurants

Construction and Demolition Generators

Dust, debris, concrete, building martial

Review of Literature

Every human activity creates waste (Tchobanoglous et al., 1993). India is the second-most populous nation in the world; the uncontrolled growth of urban areas has led to a deficiency in infrastructural services such as water supply, sewage and municipal solid waste management (MSWM). The growth in the generation of municipal solid waste (MSW), in recent years, has been exponential due to the booming Indian economy. There has been increased change in the standard of living in the urban areas of the country, which has left the civic authorities in a tight spot. The waste quantities are estimated to increase from 46 million tones in 2001 to 65 million tones in 2010 (Kumar and Gaikwad, 2004). Most urban areas in the country are suffering from a lack of solid waste management (SWM) problems, despite the fact that large sums of municipal expenditure are earmarked for it. MSW misuses have moved to the fore of the public agenda, with levels of concern and activity by citizens and governments worldwide reaching unprecedented levels (Read et al., 1997). Therefore, it is vital that efficient and

suitable programs should be developed and explored for the improvement of a solid waste management system in the urban areas of the countries. For effective MSWM the various factors that are taken into consideration while formulating a scheme should be identified correctly and should be given due importance for the plan to be a success. Otherwise, the most inventive schemes also turn useless. The primary measure of success of a designed scheme is the degree to which it meets the purpose for which it is intended (Khan et al., 2008).

Asnani et al.; 1992, solid waste management is an integral part of urban and environmental management of each city with more than 65% of India's 250 million population living in class I towns. According to the study of Nguyen, P. T. and Yasuhiro, M. (2013), most of the municipal solid waste (MSW) in Vietnam is often disposed of at open dumping and landfill site and the methane gas comes out from this waste which is the unignorable source of greenhouse gas (GHG) emission. So, it is crucial to explore the possibility of GHG mitigation in MSW management. To develop a suitable technology for the effective management of waste within the framework of environmental protection and energy and manure generation with reference to sustainable development in India and composting of waste is also one of the effective means of waste management (Aggrawal, 1997). Composting is a method of converting organic material into a drier non-odoriferous form through bacterial action, primarily to supply humans to soil (Mantill, 1995). Collection and disposal are the two most important problems of municipal solid waste management while treatment and recycling have their limitations in developing and technology deprived countries like India. Inherent dangers of disposing of solid waste materials in open dumps are many. These dumps attract rodents, create a breeding ground for flies and insects and raise the possibility of groundwater pollution with air pollution (Kirov, 1975). Improper disposal of waste has an adverse effect on the landscape and on the surrounding environment (Ali, 1991 and Aggrawal, 1997). Municipal solid waste management has come under great stress, as considered low priority areas, and solid waste management was never taken up seriously either by the public or by concerned agency or authorities and now the piled up waste is threatening our health, environment, and well-being (Chouhan and Reddy, 1996; and Mazumdar, 1994). According to Ram, & Kumar (2021), major challenges associated with the MSW are the proper waste collection, segregation, and further disposal problems. In spite, improper MSW management and unscientific waste disposal lead to serious environmental hazards that directly affect public health in the developing world.

Inappropriate management of solid waste pollute water both ground and surface water, land, and air thus all three spheres viz. lithosphere, the hydrosphere, and the atmosphere; important for human survival and running ecosystem accurately. Ultimately the whole biosphere gets polluted by solid waste. Such problems are very common in cities and towns and areas surrounding towns and cities as the collection and disposal facilities are inadequate with the considerable amount of waste being generated daily in these places. So large heaps of garbage can be seen in a disorganized way at every corner of the cities and towns most importantly at the outer boundaries of cities and towns. The municipal solid waste should not be considered simply as residue to be thrown away, rather it should be recognized as resource; would be usedfor the production of energy, compost and fuel depending upon the techno-economical viability, local condition and sustainability of the project on a long-term basis (Yadav and Devi, 2009).It is agreed that the waste from municipal solid waste (MSW) can be considered a renewable energy resource due to its potential of being converted from "waste" into useful products and energy (Al-Ghouti et al., 2021). Gas like methane and Co2 can also generated from open landfill sites. In order to evaluate energy recovery potential from solid waste in Kakia open dumpsite landfill, the Gas Generation Model (LandGEM) was used. Kakia open dump has a methane potential of 83.52 m3 per ton of waste (Osra et al., 2021).

Objectives of the Study

Main objectives of the present paper are as:

1. To study the geographical distribution of generated and processed municipal solid waste in India and Uttarakhand.
2. To assess the lacking of municipal solid waste management in Uttarakhand.
3. Suggest measures to sustainable municipal solid waste management.

Study Area

Uttarakhand, 27th state of India; located in the mighty Himalayas; lies between $28^0$43' and 31^0 27' North latitudes and $77^0$34' and $81^0$02' East longitudes having a total geographical area of 53,483 sq. km. The state of Uttarakhand comprises 13 districts and the relief of the state varies from about 200m to 7800m of height from mean sea level. The state comprises two divisions, namely Kumaun and Garhwal, spread in about 53,483 sq.km of geographical area. The state has a population of 10,086,292, and a population density of 189 persons per Sq.km which stands less than the national average population density of India 382 persons per Sq.km (Census, 2011). Physio-graphically, the state comprises three parallel zones of Himalayan mountains are:

The Higher Himalayan Zone

Huge line of snowy peaks with an average height of 6100m. Districts of Rudraprayag, Uttarkashi, Chamoli, Pithoragarh, and Bageshwar fall in this region.

The Middle or Lesser Himalayan Zone

District Tehri-Garhwal, Garhwal, Almora, and Champawat, and some part hill area of Nainital and Dehradun come in this region witness mixture of forest-covered ranges and narrows but productive river valleys, plentiful gorges and uneven mountains

Foothills, Tarai and Bhabhar Plain Zone

Also called outer Himalaya or Siwalik ranges and foothills; smooth valleys in them neighborhood called as 'Duns'. Tarai and bhabhar plains lie in the

south of the foothills. District Haridwar, Udham Singh Nagar and the remaining area of Nainital & Dehradun fall in this region.

Methodology

The present paper is based primarily on secondary data which have been collected from census, Sankhiki Patrika, websites of Global Development Research Centre, Ministry of environment, forest and climate change and different required sources. Explanatory and analytical approaches have been adopted to discuss the data. District-wise solid waste in Uttarakhand categorized and includes the waste of municipalities, nagar palikas and nagar panchayats of that corresponding districts and further calculations have been done to find out the per annum municipal solid waste generated in Uttarakhand.

Result and Discussions

Table 1: Geographic region-wise municipal solid waste generated and processed in India

Geographical Regions	Total Waste Generation MTPA	Total Waste Processing Percentage
1. Himalayan Mountain Region		
Arunachal Pradesh	66065	20
Assam	413910	35
Himanchal Pradesh	124830	40
Jammu and Kashmir	501510	8
Manipur	64240	50
Meghalaya	97820	58
Mizoram	73365	4
Nagaland	124830	52
Sikkim	32485	66
Tripura	153300	45
Uttarakhand	513190	38
Total	**2165545**	
2. The Northern Plain Region		
Bihar	828915	43
Haryana	1647610	17
Jharkhand	849335	42
Punjab	1496500	33
Rajasthan	2372500	33
Uttar Pradesh	6132000	57
West Bengal	2810500	5
Total	**16137360**	**-**
3. Peninsular and Coastal Region		
Andhra Pradesh	2330160	29
Chhattisgarh	601885	84
Goa	94900	65
Gujarat	3702925	57
Karnataka	3650000	32
Kerala	227760	60
Madhya Pradesh	2344760	65
Maharashtra	8238050	44
Orissa	992800	12
Tamil Nadu	5601655	55
Telangana	2690415	73
West Bengal	2810500	5
Total	**33285810**	**-**
4. Islands and UTs		
Andaman Nicobar	26500	52
Chandigarh	172280	85
Daman &Diu, Dadra &Nagar Haveli	24455	65
Delhi	3832500	55
Jammu and Kashmir	501510	8
Lakshadweep	N.A.	N.A.
Pondicherry	127750	10
Total	**4684995**	**-**

Source: Ministry of environment, forest and climate change, 2018

Table shows that most solid waste producing state lies in the northern plain and peninsular and coastal regions of India which is obvious as these states are among the most populous, urbanized and industrialized states of India. The states of the peninsular and coastal region are not much far from them as they are also highly industrialized states of India as most industrial and urban centres lie in this region. All the bigger states process only its 30 to 60 percent waste while smaller states and union territories generate lesser amount of municipal solid waste and process more than 60 percent of its waste generated with few exceptions. States like Telangana process its 73 percent solid waste (Table: 1).

Table 2: Geographic region wise status of municipal solid waste generated in Uttarakhand

Region (District Municipalities, Nagar Palika, nagar panchayats)	**Waste Generation (MTPD)**	**Waste Generation (MTPA)**
1. Higher Himalayan Region		
Rudraprayag	6.11	2230.15
Uttarkashi	12.99	4741.35
Chamoli	24.51	8946.15
Pithoragarh	26.39	9632.35
Bageshwar	4.33	1580.45
Total	**74.33**	**27130.45**
2. Central and Lesser Himalayan Region		
Almora	15.40	5621.00
Champawat	13.38	4883.70
Tehri Garhwal	26.41	9639.65
Nainital	105	38325
Pauri Garhwal	25.57	9333.05
Total	**185.76**	**67802.40**
3. Foothills and plains Region		
Dehradun	276.13	100787.50
Haridwar	164.39	60002.35
U S Nagar	155.98	56932.70
Total	**596.50**	**217722.55**

Source: Based on Urban MSW action plan for Uttarakhand, 2017

Table 2 depicts that highest amount of the municipal waste come from only three districts of Dehradun, Haridwar and U S nagar; situated in the foothills and plains which is about 217722.55 MTPA while, district municipal and nagar palika of central and lesser Himalaya generate lower amount of solid waste as compared to foothills and plains which is 67802.40 MTPA. Only 27130.45 MTPA of solid waste is generated by the municipalities and nagar palika of Higher Himalayan districts. Over all municipalities and nagar palika of Uttarakhand state are generating 312655.40 MT per year with an average of 65. 89 MT of solid waste per day (Table: 2 and Fig. 2).

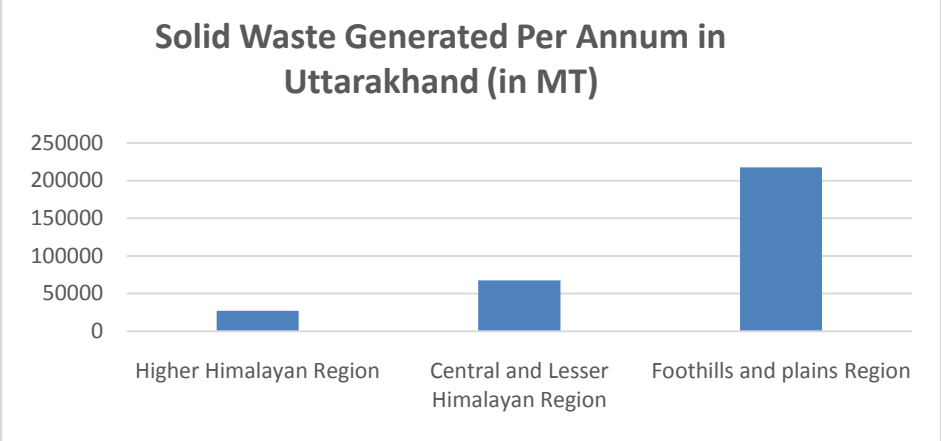

Fig. 2: Solid Waste Generated Per Annum in Uttarakhand

Suggestions and Recommendations

Global Development Research Centre in the year 2013 estimated the duration of waste degeneration provided in the table 3. The table also clarifies the nature of waste. Knowledge would prove helpful in the segregation of waste at various levels means domestic and municipal levels and further at decomposition sites.

As per the table 1; Uttarakhand process its only 38 percent municipal solid waste. Most of the waste processing units are located in the districts of plains. Here lots of scope is open for Uttarakhand to process higher amount of municipal solids waste. This can be done with the help and infrastructure developed by the Government and Local administrative bodies at local levels. People's active participation is also needed. For proper disposal of

municipal solid waste, it is inevitable to have a clear understanding of waste type and its duration of decomposition and degeneration and also the nature of solid waste, i.e., waste falls in which category; whether it is biodegradable or non-biodegradable

Table 3: Rate and Time of Degeneration of Waste Items

Category	Types of Waste	Time Needed to Degenerate
Biodegradable	Organic wastes (food, fruits and vegetable peels etc.)	7 - 15 days
	Paper	10 - 13 days
	Cotton clothes	2 - 5 months
	Woolen clothes	12 months
	Wood and wooden Furniture	10 - 15 years
Non - Biodegradable	Metal items such as aluminum, tin etc.	100 - 500 years
	All Plastic items	One million years
	Glass, and glass bottles	Undetermined

Source: Based on Global Development Research Centre, 2013

Conclusion

Four R's i.e., Refuse, Reduce, Reuse, and Recycle are the obvious factors in sustainable municipal solid waste management. All depend mainly on the awareness, cooperation and understanding of the situations and problems due to solid waste whether; social, health, environmental or economic. Active people participation and institutional support and guidance may help a lot in sustainable solid waste management practices. For the proper management of municipal solid waste in the countries like India who have more than 1.211 billion population; the distribution pattern of municipal solid waste, knowledge of the type of waste, its duration of decomposition and degeneration is a must. Bigger states in India produce more solid waste and process less as compared to states having less population and areal extent. Thus, there is huge scope open for such states those are processing less. When we come to Uttarakhand that is more sensitive, environmentally; the trend is the same as plain districts of Uttarakhand are generating more amount of waste as compared to states of higher altitude due to higher population pressure, higher consumption of resources and products, but are processing less waste which is leading to various environmental and social problems as soil, water, and air pollution with severe health and sanitary problems to the society. A very few municipalities and nagar palikas have their own processing units in the state and the remaining are collecting and decomposing waste in open and by traditional methods. The need of the time is to collect, segregate and process municipal solid waste at the domestic and municipal level, chalk out the distribution pattern of municipal solid waste, its types, selection of proper sites for disposal, use of environment friendly decomposition tools and techniques are also valuable. Waste from municipalities in recent time of technological developments can be converted into energy and useful artefacts and would prove a good source of economic benefits and can open new dimensions in municipal solid waste management.

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