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Solid waste management processes and problems in Almora municipal area of Uttarakhand

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Abstract
Municipal solid waste is a serious hazard to the whole world but more hazardous to the developing countries like India where urbanization is very fast and industrial development is still gaining speed. Almora municipal area of Uttarakhand where the growth of urbanization is high and population is continuously increasing. As a district headquarter Almora provides sites for different administrative, educational, trade, tourism, health and recreational activities. In Almora city, municipal body provides solid waste collection and management services to a great extent. Though, it is an essential service, but not attaining adequate priority, which it deserves in the fast growing city. In general, solid waste collection and management services are deprived and insufficient in Almora municipal area. This situation has created many problems in urban environment also to the public health of Almora municipal area. Huge interventions in natural settings by humans are the main cause of environmental and social hazards in urban areas. Incineration of municipal solid waste is producing black carbon, emitting harmful toxins like mercury, carbon dioxide, and sulfur dioxide, etc. and also adding particulate matters in the urban environment. All these are collectively creating problems to the precious plants, wildlife and also to the human beings. Present study focuses on the municipal solid waste collection, management and disposal system and related lacking in Almora municipal area and provides measures to organize up with the problems.

Keywords: Almora municipal area, urban environment, sustainable waste management, pollution, Uttarakhand

1. Introduction
Every human activity creates waste (Tchobanoglous *et al*., 1993) [13]. 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. According to Kumar and Gaikwad (2004) [8], there is a continuous change in the standard of living of people living in the urban areas of the country, has left the municipal authorities in a tight spot, and the quantities of waste are estimated to increase from 46 million tons in 2001 to 65 million tons in 2010. Most urban areas in the country are suffering from a lack of solid waste management (SWM) related services, despite the fact that large sums of municipal expenditure are earmarked for it. *Solid waste causes ground and surface water contamination; besides GHG emission as when water filters through any material, chemicals in the material may dissolve in the water. This process is called leaching and the resulting mixture is called leachate (McMichael, 2000)* [9]. According to Hoornweg *et al*., (1999) [7]; illegal disposal of wastes in water bodies is a common practice that not only causes toxins to get dispersed in the environment but also often ends up coagulating the water bodies and destroying the whole ecosystem of the area. According to Blenkharn (2008) [2], safe management and disposal of wastes is an essential component in the maintenance of adequate hygiene standards, safe working conditions and effective risk reduction. Hassena Hashia and Javeed Ahmad Rather (2008) [6], in their study 'Human Induced Ecological Problems: A case study of Dal lake hunt out the various ecological problems caused due to tourism activities and suggest various measures to solve them. Jagbir Singh and AL. Ramanathan (2011) [12], in their edited book named 'Solid Waste Management: Present and Future Challenges', discussed about the various aspects of solid wastes; its sources,

Processing, management and challenges faced with their probable solutions. Findings of (Dhokhikah *et al*., 2012) [5], shows that most of the Asian developing countries are still following the landfill system for the solid waste dumping. (Cucchiella *et al*., 2014) [4] Proposed the waste management framework to achieve the sustainability in waste management. 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). SVS Rana (2006) [10], classified solid waste into various categories as garbage, rubbish, sewage sludge and miscellaneous material and discussed about the water pollution caused by the dumping of these materials. Various studies related with solid waste management are in operations throughout the world.

2. Objectives of the Study

Main objectives of the present research are as:

- To find out the different sources and generators of solid waste in Almora municipal area.
- To study the solid waste disposal and management system used by population and Almora municipality.
- To investigate the lacking of the solid waste disposal process in Almora municipal area and find out the appropriate measures to sustainable municipal solid waste management.

3. Study Area

The district Almora is situated between $29^0$37’ North to 29^0 62’ North latitude and $79^0$40’ East to $79^0$67’ East longitude. Almora municipal board came into existence in the year 1864. Almora city is the head quarter of Almora district and is spread over an area of about 7.54 km^2. Presently Almora city as a municipal board is selected for the proposed study and the whole municipal area is divided into 13 wards and diverse *Mohallas*. Presently, Almora municipal area comprises *Shailakhola, Ramshila, Badreshwar, Murli Manohar, Baleshwar, Vivekanandpuri, Rajpura, Nanda Devi, Narayan Tiwari Dewal (N.T.D.), Tripura Sundari, Lakshmeshwar, Railapali* and *Dugalkhola* wards. The study area is located in the Lesser Himalayas and established over a ridge with a population of 38364 persons according to the census of the year 2011; among which 19730 persons are males and 18634 persons are females. Maximum population is in the *Baleshwar* ward which is 4619 persons with 2374 males and 2245 females whereas minimum populated ward is *Sailakhola* which has 1437 persons with 737 males and 700 females (Census, 2011). The study area is highly rough terrain, marked with steep and high ridges and deep and narrow valleys located between the *Kosi* and *Suyal* Rivers. The elevation of the region is high ranging from about 1500 meters to 3000 meters.

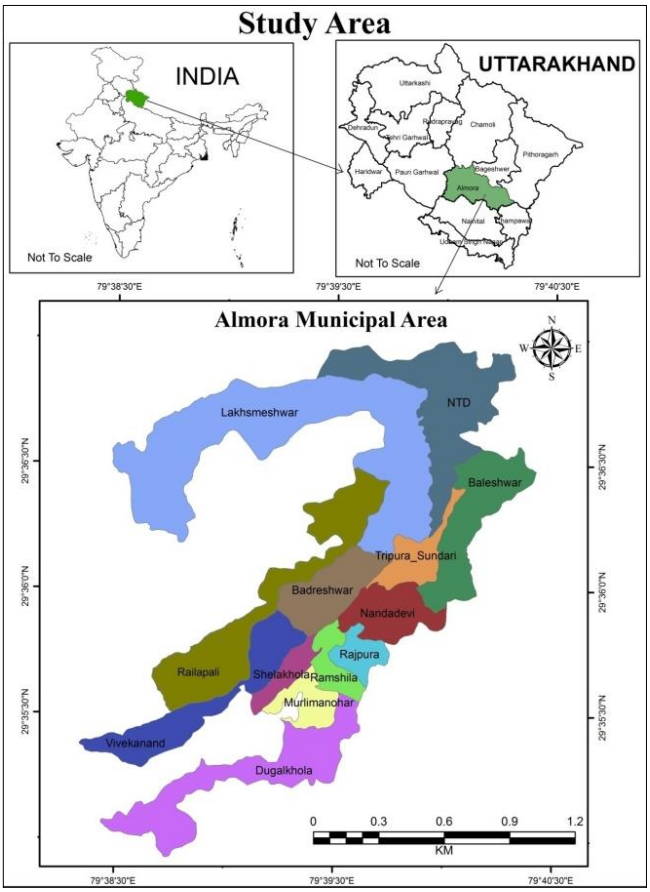

Fig 1: Location Map of Study Area

4. Methodology

The present paper is based both on primary and secondary data. Secondary data has been collected from census of India, and office of Almora municipal board. A survey-based study was conducted in Almora city for gathering primary data; field observation, interviews, questionnaires, and schedules etc. were used for that. Purposive and random sampling methods have been adopted to select the sample respondents. A total of 195 respondents were selected from the whole study area. Municipality presently has 13 wards i.e., 15 respondents from each ward were selected for primary data collection, among them 104 were females and 91 were males. Further calculations have been done to find out the results.

5. Result and Discussions

5.1 Production of Solid Waste

Table 1: Solid Waste Generated in Almora Municipal Area

Sl. No.	Types of Solid Waste	Quantity Generated Per Day (in Tons)
1.	Household Waste	5.8
2.	Waste from Vegetable and Fruits	0.32
3.	Waste from Hotels and Restaurants	0.114
4.	Waste from Commercial Shops	0.36
5.	Roadside Waste	0.621
6.	Waste from Drains (*Nallas)*	3.36
	Total	**10.57**

Source: Almora Municipal Board, 2020

Table 1 shows the daily waste generated from the Almora municipality, the waste generated under the municipality is the waste generated out of residential places like vegetables, peels of fruits, newspaper and other types of household garbage, waste from shops, hotels, restaurants, hospitals etc. Table demonstrates that total waste generation in Almora municipal area is 10.57 tons per day. Out of which 5.8 tons of waste is extracted in the form of household waste, the amount of waste from the drains is 3.36 tons per day. There are 0.114 tons of waste from hotels and restaurants, 0.36 tons from commercial shops, 0.621 tons from and around the roads and 0.32 tons per day of organic waste released from the vegetables and fruits markets.

5.2 Problems Associated with Solid Waste Management System and Infrastructure Available

Solid waste management system exists in most of the urban centers since last few decades. However, these systems have yet to emerge as well as organized practices although; the solid waste characteristics in different urban centers vary significantly (Kumar and Gaikwad, 2004) [8].

There is a major deficiency associated with the workers in Almora Municipal area which is described in the following section:

Table 2: Sweepers and Other Workers

Sl. No.	Category of Workers	No. of Workers
1.	Sweeper (Safai Karmchari)	179
2.	Supervisor (Nayak)	9
3.	Chief Supervisor (Chief Nayak)	1
4.	Health Observer (Swasth Nirikshak)	1

Source: Almora Municipal Board, 2020

Table 2 shows the workers and sweepers engaged in the work of sweeping, collection, segregation, monitoring and disposal of solid waste generated in the Almora municipal area. One health observer, one chief supervisor, 9 supervisors and 179 sweepers are engaged in the municipal work.

Table 3: Ward wise Allocated Dustbins in Almora Municipal Area

Sl. No.	Ward Name	Population	Allocated Dustbin
1.	Sailakhola	1437	5
2.	Ramshila	2259	2
3.	Badreshwar	3469	7
4.	N.T.D.	3475	7
5.	Tripurasundari	2459	2
6.	Lakshmeshwar	3307	8
7.	Murlimanohar	2949	3
8.	Baleshwar	4619	5
9.	Vivekanandpuri	2402	8
10.	Rajpura	3904	2
11.	Nandadevi	3839	2
12.	Railapali	2063	3
13.	Dugalkhola	2182	3
	Total	**38364**	**57**

Source: Almora Municipal Board, 2020

From table 3 it can be seen that the proportion of dustbins in Almora municipality is very less as compared to the population requirements; according to the census of 2011, Almora municipality has a population of 38364.The whole study area is divided into 13 wards out of which the highly populous wards are *Baleshwar* (4619 person) and *Rajpura* (3904 person) but the number of dustbins allocated here are only 5 in *Baleshwar*ward and only 2 dustbins are in *Rajpura* ward. In *Nandadevi* ward (2 dustbins), *Murlimanohar* (3 dustbins), *Sailakhola* (5 dustbins), are allocated by the municipal board. The *Railapali* (3 dustbins), *Dugalkhola* (3 dustbins), *Ramshila* (2 dustbins), and in *Tripurasundari* ward only 2 dustbins are available. The *Badreshwar* ward has 7dustbins, *Lakshmeshwar* has 8dustbins, whereas *N.T.D.* keeps 7dustbins, on the other side in *Vivekanandpuri* ward allocated dustbins are 8. So, the overall allocated dustbins in the study area are only 57, according to the municipal data of year 2020. Thus, it is clear that most of the wards has insufficient number of dustbins as compared to its population so the waste materials remain spread here and there on the streets, roads, and drains of the Almora municipal area. Most of the cases waste remain thrown outside and nearby to the dustbins due to smaller size of dustbins.

Table 4: Duration of Emptying Dustbins in Almora Municipal Area

Sl. No.	Duration of Empty Dustbin in Days	No of Sample Respondents	Percentage
1.	1	23	11.79
2.	2	21	10.77
3.	3	35	17.95
4.	4	77	39.49
5.	One Week	39	20.00
	Total	**195**	**100.00**

Source: Field Survey, 2021.

Table 4 illustrates that there are higher number of respondents 77 (39.49 percent) emptying garbage after 4 days. Whereas 35 (17.95 percent) respondents after 3 days, 21 respondents after 2 days while 39 (20.00 percent) respondents emptying their dustbins on is a week and only 23(11.79 percent) respondents emptying waste every day.

Table 5: Available Public Toilets in Almora Municipal Area

Sl. No.	Ward Name	Population	No. of Public Toilets		Waste Disposal System
			Male	Female	
1.	Badreshwar	3469	01	00	Open Drainage
2.	Baleshwar	4619	01	00	Open Drainage
3.	Dugalkhola	2182	00	00	Open Drainage
4.	Lakshmeshwar	3307	03	00	Septic Tank
5.	Murlimanohar	2949	02	00	Septic Tank
6.	N.T.D.	3475	01	01	Septic Tank
7.	Nandadevi	3839	06	06	Septic Tank

8.	Railapali	2063	00	00	Open Drainage
9.	Rajpura	3904	01	01	Septic Tank
10.	Ramshila	2259	02	00	Open Drainage
11.	Sailakhola	1437	00	00	Open Drainage
12.	Tripurasundari	2459	00	01	Open Drainage
13.	Vivekanandpuri	2402	02	02	Septic Tank
	Total	**38364**	**19**	**11**	

Source: Almora Municipal Board, 2020

From table 5 it is clear that numbers of public toilets are very less as per population pressure. Wards like *Dugalkhola*, *Railapali*, *Sailakhola* and *Tripurasundari* have no any public toilet available. Where there public toilets are available; are in very poor condition due to lack of proper care and cleaning. Among 13 wards of Almora municipal area only 6 wards have septic tanks for wastewater disposal while 7 wards have open drainage for wastewater disposal. It depicts that wastewater disposal system is in very poor condition in the study area. Only 3 wards namely; *Tripurasundari*, *Baleshwar*, and *Rajpura* are covered under wastewater management and sewerage treatment in whole Almora municipal area. Sewer lines are available for only 656 houses (Almora Municipal Board, 2020). In other municipal wards of Almora, the waste and septic waste is disposed of on private land lying vacant by the building owner, on the side of the motor roads, in desolate and invisible places, for which user charges, grievance redressed mechanism is still not fixed (Table 5).

Table 6: Waste Transportation Infrastructure

Sl. No.	Type of Vehicle	Vehicle Capacity (in Quintal)	No. of Vehicles
1.	Mahindra Tipper (Big)	90	1
2.	Mahindra Tipper (Small)	40	1
3.	Mahindra Pickup (Small)	10	2
4.	Side Bin Lifter	8	1
5.	Container	60	1
6.	Truck	60	1
	Total	**268**	**7**

Source: Almora Municipal Board, 2020

From table 6 it is clear that only 7 vehicles of different size are available to the municipality to transport the solid waste from different wards of the city with total capacity of only 268 quintals which is very low as compared to waste produced in the municipal area of Almora.

Table 7: Condition of Public Dustbins by Sample Respondents

Sl. No.	Condition of Public Dustbin	No. of Sample Respondents	Percentage
1.	Rusted	54	27.69
2.	Too Small	106	54.36
3.	Good Condition	12	6.15
4.	Broken	23	11.79
	Total	**195**	**100.00**

Source: Field Survey, 2021

Table 7 demonstrates the responses of sample respondents about the condition and sufficiency of public dustbins. From the table, it is clear that a major number of respondents are not fully satisfied with the condition of dustbins. About the public dustbins; 106 (54.39 percent) respondents respond that they are of too small size hence that waste remains spread around them, around 54 (27.69 percent) respondents confirmed that the dustbins are rusted, 23(11.79 percent) respondents accepted that they dump domestic garbage in the broken dustbins hence the garbage comes out and remain spread here and there on the streets and roads. Only 12 (6.15 percent) respondents admit that around them public dustbins are in good condition.

Table 8: Separation of Household Solid Waste by Sample Respondents

A).	Separation of Waste Solid & Liquid	No. of Sample Respondents	Percentage
1.	Yes	41	21.03
2.	No	154	78.97
Total		**195**	**100**
B).	**Medium Used to Store Waste**	**No. of Sample Respondents**	**Percentage**
1.	Old Basket & Bucket	142	72.82
2.	Plastic Bag	53	27.18
Total		**195**	**100**

Source: Field Survey, 2021

Table 9: Methods Used to Disposal of Household Waste:

Sl. No.	Disposal of Solid Waste	No. of Sample Respondents	Percentage
1.	Public Dustbin	89	45.64
2.	Water Streams and Water Bodies	5	2.56
3.	Road Side	35	17.95
4.	In Open Space	23	11.79
5.	In Pit	13	6.67
6.	Others	30	15.38
	Total	**195**	**100.00**

Source: Field Survey, 2021

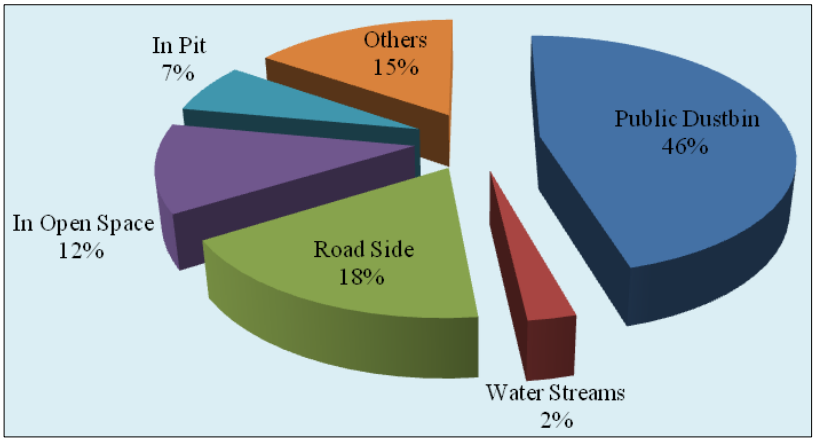

Fig 2: Disposal of Solid Waste in Almora Municipal Area

Table 8 is showing that only 41(21.03 percent) respondents separate solid and liquid waste while 154 (78.97 percent) respondents not separate. The 142 (72.82 percent) respondents use to old basket and buckets shove garbage and 53 (27.18 percent) respondents use to plastic bag to fling waste. Out of 195 respondents 89 (45.64 percent) respondents dispose to waste public dustbin while 5 respondents (2.56 percent) dispose to water streams like near *Dharas*, *Naulas*, 35 respondents (17.95 percent) dispose road side streets, 23 (11.79 percent) respondents liquidate in open space, only 13 (6.67 percent) respondents dispose to oneself made pit and the 30 respondents (15.38) percent dispose to other side dispose to solid waste (Table 9 and Fig. 2).

6. Suggestions and Conclusion

Almora municipal area in present is facing the problem of poor solid waste management, lacking infrastructure and poor workforce. Waste remains scattered here and there in the markets, on streets and roads; no any fixed mechanism of solid waste disposal is applied. People are also not aware about the adverse environmental, health and social impacts of solid waste here in the municipal area.

Modern urban living brings on the problem of waste which increases in quantity and changes in composition with each passing day. An adequate understanding of the problem both of infrastructural requirements as well as its societal dimensions; solid waste management in Almora municipal board has been a neglected area. Rapid urbanization and resultant solid waste often accounted for severe urban health problems.

6.1 Rapid Urbanization to be severed and Quantity of Municipal Waste

Almora municipality is by now feeling the burden of residents and therefore municipal services and waste management is coming as a challenge in the area. Waste is increasing day by day with increase in population and per capita waste generation rate due to altering lifestyles and rising income. The increasing solid waste quantities and area to be served strain the existing integrated solid waste system.

6.2 Old Equipments and Technology

A secondary collection system is not well harmonized with the transport system. The municipal area cannot be properly serviced due to an insufficient number of vehicles, this results in the under utilization of the existing resources and the lowering of the efficiency. Modern tools and machines are not available for proper waste collection, segregation, transportation, disposal and incineration. Solid waste overloaded manually in a truck without using the protective gears is unsafe to the health of workers. Problems occur when a transport fleet is updated because waste at a secondary storage system is still dumping ground.

6.3 Awareness Design of Appropriate Waste Management

Collection of Waste

- Properly designed collection bins and implements should be used for the collection.
- Door to door collection system can be introduced regularly to ensure eco-friendly collection practices.
- Provision of separate bins for biodegradable and non biodegradable matter.
- Segregate the waste according the source and properties.
- The daily collection of garbage both at the primary and secondary level should be initiated so that there is no overflowing of the bins and littering of the area.

6.4 Segregation and Transportation of Municipal Waste

- The municipal authority and citizens should be encourage for the segregation of waste municipal

authority should organize awareness programs to ensure that community participates in waste segregation.
- The selection of properly designed vehicles used to transport the municipal waste is also important.
- Municipal authority should attend daily for the clearing of waste from the beans or containers where ever placed and should cleaned before they start overflowing.

6.5 Disposal of Waste
- Sanitary landfill techniques should be adopted for the disposal of waste
- Composting and vermi-composting is the process of decomposition and stabilization of organic matter under a proscribed circumstance in a study area waste minimization through segregation of recyclable materials like glass, metals, plastics etc waste pickers should be trained for segregation of recyclable substance can be done in a more prepared and organizing way at their source.
- Proper financial as well educational support should be provided to the Almora municipal Board.
- Proper guidance, awareness instruction as well should be prearranged for municipal board as well as people.
- Providing essential infrastructure, tools and equipment to all urban local bodies for effective SWM. management Capacity building, societal awareness, Community Education and Implement disposal bans on materials that limit opportunities to achieve reuse, recycling or energy recovery**.**

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