



Assessing the Socio-Economic and Health Impacts of Solid Waste Management in Nagar Palika Parishad, Rudraprayag (Uttarakhand)

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Abstract: Effective solid waste management is crucial for maintaining a healthy environment, yet it remains a growing challenge in urban areas. This study examines the current waste management practices in Nagar Palika Parishad (NPP) Rudraprayag, Uttarakhand, highlighting key issues such as waste accumulation, inadequate disposal infrastructure, and associated health risks. Data were collected through surveys, face-to-face interviews, scientific literature, official reports, and informal documents. Findings indicate that Rudraprayag generates 5.92 metric tonnes of waste per day, with residential waste contributing the most. Despite being a religious city, Rudraprayag faces significant sanitation challenges, including the absence of dustbins in key market areas due to aesthetic concerns. Addressing these issues requires strategic dustbin placement, regular waste collection, increased street cleaning, and community engagement. This study underscores the need for sustainable waste management strategies tailored to the unique challenges of developing regions, ensuring both environmental and public health improvements.

Key words: Solid waste • Waste Disposal • Waste Management • Sanitation

Introduction

Solid waste management basically means collection, transportation and disposal of waste. It refers to non-liquid, non-gaseous materials that people produce and no longer need (Leton and omotosho 2004). Different approaches to waste management are used in developed and developing nations, in urban and rural settings, and for various industries that produce different kinds of garbage. Management of waste is now on high priority because It may pose health issues and impact on the socio-economic condition of the people. Rudraprayag is a district and also a city which is now becoming a centre of attraction for tourists, so therefore the officials over there should be more indulged in maintaining the waste management issue. Solid waste production is influenced by a number of variables, including population expansion, waste-generating technology, use and throw lifestyles, etc. The management of non-hazardous waste is often the job of local

authorities, whereas the generator of that specific waste is responsible for managing non-hazardous garbage (Kuniyal et al 2003).

Waste is the major source of vector-borne diseases. These types of unhealthy practices create serious health and environmental issues for local residents. Maintaining solid waste management in developing nations is a difficult task as effective management is expensive, which is why many steps are being taken to address this kind of issue. In order to manage this issue, an integrated, sustained, and socially supported system is necessary for the municipal network (Kurane 2024).

Waste can be a valuable resource if managed properly. However, waste management remains a major challenge, especially in hilly regions where steep slopes make incineration and landfill site selection difficult. Leachate from waste contaminates freshwater streams, affecting water quality. While waste generation cannot be stopped, it can be reduced through better infrastructure and



lifestyle choices (Gupta et al. 2023). Uttarakhand generates approximately 3,000 metric tonnes of waste daily, but only 40% is managed. This study examines solid waste management challenges, municipal waste handling practices, and the effectiveness of existing policies in addressing these issues.

Objectives

1. To find out the different sources and generators of solid waste in Rudraprayag, Garhwal, Uttarakhand.
2. To investigate Rudraprayag's present methods for handling solid waste.

3. To find out the aftereffects of the disposal of waste, such as illnesses or other health problems, among the locals.

Study area

Rudraprayag, a district in Uttarakhand, is nestled in the Himalayan range. Formed by merging parts of Chamoli, Tehri, and Pauri Garhwal, it shares borders with Pauri in the south, Tehri Garhwal in the west, Uttarkashi in the north, and Chamoli in the east and northeast. Located between latitudes 30°12'N–30°45'N and longitudes 79°E–79°25'E, the district spans 1,984 km², with its headquarters in Rudraprayag town (Fig 1).

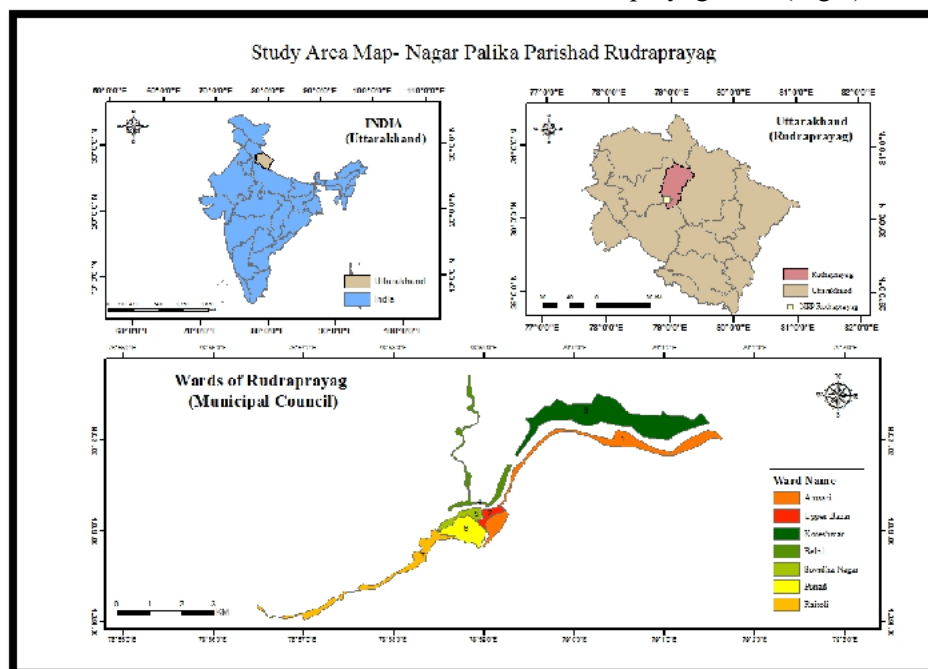


Fig. 1: Location Map of the Study Area

Kedarnath, a renowned Lord Shiva shrine, is situated here. According to the 2011 census, Rudraprayag has a population of 242,285, comprising 127,696 women and 114,589 men, with a density of 120 people per km². Between 2001 and 2011, the population grew by 4.14% (Kumar et al., 2019). The district consists of three sub-divisions—Rudraprayag, Jakholi, and Ukhimath—and four tehsils. It features steep hills, narrow valleys, and some flat areas along riverbanks, and is divided into lower and upper Himalayan zones physiographically.

The district's higher Himalayan zone has glaciers that are permanently covered in snow and ice all year round. This region is included in the main or outer upper Himalayas. This area contains the majority of the district's notable peaks and glaciers. This zone contains the majority of the district's population. There is a lot of forest cover here. This region can be categorized geomorphologically into dissected hills, valleys, river terraces, etc. There are several recent and older landslides seen in the region. A number of major places



of district like Guptakashi, Okimath, Jakholi etc. are situated in this region. The major township of the area like Tilwara and Agustmuni situated on the river Mandakini. Rudraprayag municipal council consists of 7 wards. There are 2,363 families living in the municipality as of the 2011 Census. There are 9,313 people living in Rudraprayag overall, 4,073 of them are female and 5,240 of whom are male. Rudraprayag has an average sex ratio of 777. (DEP Rudraprayag; 2020).

Methodology

The research conducted in the study area in order to understand the socioeconomic impact

on health due to improper management of waste, alongside additional social issues that cause hardship for the locals. The goals of the research work were created using the New Ecological Paradigm (NEP) as a foundation. Primary and secondary both type of data is collected from the study area. Information about waste management in the study area was gathered by conducting surveys and interviews with participants, including managers, shopkeepers, important stakeholders, sanitation workers, etc. Additionally, a portion of the data is being collected via government and official records (Fig 2).

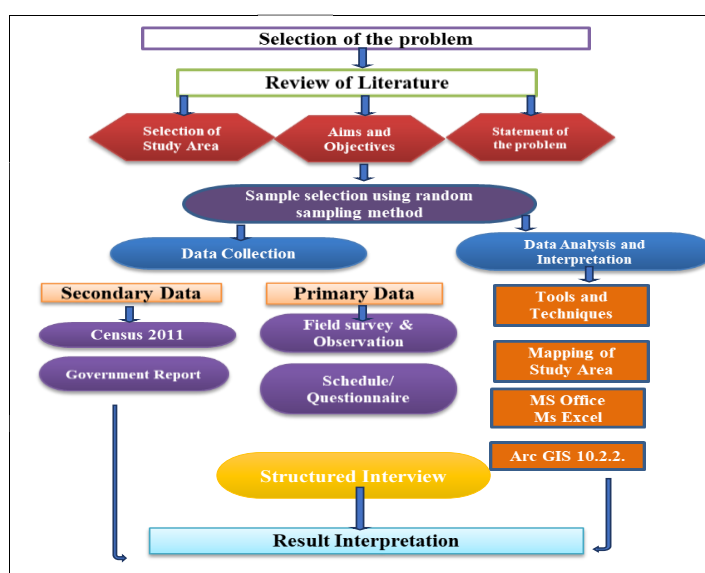


Fig. 2: Flowchart of Methodology

A ground-level survey is essential to bridge the gap between government records and on-ground reality. Random sampling was used to collect data from different wards of ULB Rudraprayag, selecting a sample of 210 households, with 30 from each ward. Information on health and community facilities related to waste management was gathered from small clinics and Primary Health Centers (PHCs) (Urooj et al 2024). The local council completed a questionnaire covering solid waste inventory, physical characteristics, transportation, and sanitation workers. Simultaneous field testing was conducted, inspecting new devices for waste

management in hilly areas. Both quantitative and qualitative data were analyzed using semi-structured questionnaires. Qualitative data was gathered from semi-structured questionnaires, while open-ended questions collected quantitative data from households, business owners, ASHA workers, municipal authorities, and ward representatives. The collected data was represented through pie charts to illustrate household social characteristics, environmental impacts of waste, and the management, disposal, and treatment of infectious and household waste.



Result and Discussion

Information regarding the management of waste was collected from Municipal council Rudraprayag, who is responsible for waste collection from point sources, its transportation, and disposal of solid waste.

Quantification of solid waste

Trend for the solid waste generation and population growth is different in every region

Table 1: Quantification of the Total Production of Municipal Solid Waste

Municipal Councils	Population (2011 census)	Total Number of wards	Solid waste generation Metric Tonne Per Day (MTPD)			
			Dry	Wet	Other Waste	Total
Rudraprayag	9313	07	3.4	2.1	0.42	5.92

Source: Municipal Council of Rudraprayag

The quantity of waste generation is not much in Rudraprayag, but still, it is a lot for the locals to manage, as there is no proper facility to manage the waste as compared to the plain areas. The transportation of waste is quite easy in plain areas and the less availability of land for waste is another major issue in hilly regions.

Segregation of waste

The improper disposal of waste leads to many inconveniences like degradation of environment, human health hazard, and resource depletion. Systematic ways of segregation of waste can address this issue, which involves different ways of segregating the waste into various categories like bio-degradable and non-biodegradable waste at the

of India. At world scale the trend shows that there is positive correlation with economic development in terms of solid waste generation. detailed questionnaire some of the questions were asked from the authorities of municipal council Rudraprayag. According to official record total waste generation in Rudraprayag is 5.92 metric tonne per day (Table 1).

source. This waste can be transferred into valuable composting waste by doing composting process. In NPP Rudraprayag waste segregation is operating by categorizing the waste into 20 different categories like plastic bottles, cardboard sheets etc. which are packed in different rack sacks. Non-recyclable dry waste after segregation is sold to Cement factory at Rajasthan and rest is sent to waste to energy plant in Gajipur (by NEPRA Group). KK Traders is managing the recycling of dry waste, from 2019 till now 5 lakh rupees has been earned by selling the recyclable waste. The process of segregation of solid waste is very important part as it will be helpful in final disposal of solid waste and also it can have positive impact on generating the income.



Fig 3: Picture showing segregation of solid waste in different categories



Composition of solid waste

There are multiple sources of waste generation like commercial, institution/offices/ colleges, daily market, residential, wholesale/

vegetables, others. But the maximum amount of waste generation is coming from residential areas (Table 2).

Table 2: Major Sources of MSW Generation in Rudraprayag

No. of holdings and waste quantities	NPP Rudraprayag
	Waste Quantity (MTPD)
Residential	2.2
Institution/offices/ schools/ Colleges etc.	0.2
Commercial complex	1
Daily market	1.8
Wholesale/vegetables	0.5
Hostels/ Pg	0.1
Restaurants	0.1
A Ceremony house/ Banquet Hall	0.02
Others	-
Total	5.92

Source: Municipal Council of Rudraprayag

Additionally, kitchen garbage accounts for the majority of waste production in that category. Most residents are aware of solid waste management, with green dustbins designated for biodegradable waste and blue for non-biodegradable waste. The municipal council has provided these color-coded bins in the town, but some residents have not received them. A major issue is the absence of public dustbins in the market, affecting the aesthetic appeal of Rudraprayag, a holy town. During the yatra season, the influx of tourists significantly increases waste generation. Some respondents cited the lack of suitable locations for dustbins in the market, as shopkeepers are reluctant to place them nearby. Consequently, waste is often discarded on roads, piled in specific spots, or thrown into the river, leading to severe environmental concerns.

Another major challenge is the inefficient waste management system at NPP Rudraprayag. In several higher-altitude wards, waste collectors, particularly women, do not regularly collect waste, resulting in accumulation near houses. Collection timing is also problematic, as most residents are asleep between 4 and 6 am when waste is picked up,

leading to missed collections. Many households mitigate kitchen waste issues by feeding scraps to their cows.

The Namami Gange project is active in the area, with community-driven initiatives like Nukkad Nataks and cleanliness drives. However, its effectiveness is limited as most participants are sixth- to eighth-grade students, who lack the capacity to drive meaningful change. Greater involvement of youth and adults is essential for achieving substantial improvements in waste management and environmental conservation in Rudraprayag.

A new waste cleaner machine has been introduced in Rudraprayag, and it has been tested on the ground. Roots RSB 6000 Truck Mounted Road Sweeper is the machine's name (Fig 4). This is a 6 cubic meter truck-mounted city sweeper that performs exceptionally well. The auxiliary engine drives the vacuum and broom attachments. Road sweeping was made simple by the two side brushes, central main broom, strong vacuum, and other tools. It is used to clean major cities; municipalities and it is even suitable in hilly areas wherever anybody gets benefit from truck mounted sweepers versatility. Even for the beginner



user, it is very simple to use. Additionally, it is made to survive the challenging working conditions in India. This machine's straightforward design makes it practically maintenance free. And as a result, less labour and ownership would be needed. The sweeper kit is appropriate for any foreign truck. Controllers from the driver's cabin. A 1000-liter water tank built right in. Even under difficult operating circumstances, the machine provides exceptional sweeping performance.

Health issues

Large public gatherings and events often generate significant amounts of waste, particularly food waste, which can attract pests such as flies and rodents. The accumulation of waste in open areas creates unhygienic conditions, increasing the risk of vector-borne diseases. Ineffective waste disposal practices and delayed cleanup efforts further contribute to public health concerns, exposing residents to infections like typhoid and diarrheal diseases.



Fig. 4: Plates representing Roots RSB 6000 Truck

Additionally, sanitation workers and ragpickers, who are frequently in direct contact with waste, face heightened health risks due to inadequate protective gear. Prolonged exposure to contaminated materials increases their vulnerability to respiratory infections, skin disorders, and other occupational hazards. Without proper safety measures, these workers are at risk of contracting serious illnesses, including tuberculosis, which can also affect their families and communities.

Addressing these health risks requires efficient waste management, timely cleanup efforts, and better protective measures for sanitation workers. Strengthening hygiene awareness and public responsibility can help mitigate the

spread of diseases and ensure a healthier living environment.

Conclusion

The study highlights the improper management of solid waste in NPP Rudraprayag, an environmentally sensitive zone facing increasing waste-related challenges due to ineffective disposal practices by residents and tourists. The research, based on semi-structured questionnaires from municipal authorities, local residents, and shopkeepers, identifies key issues affecting waste management in the town.

A significant portion of the waste generated is either transported to landfill sites or dumped on hilly slopes, leading to environmental pollution and the spread of diseases in nearby



areas. Open burning of waste is also a common practice, further deteriorating air quality. The lack of infrastructure, limited awareness, improper disposal methods, and weak implementation of solid waste management (SWM) rules pose serious health risks to people and wildlife. Currently, the town generates 5.92 metric tonnes of waste per day (MTPD), with the majority originating from residential areas. This highlights the need for better waste management strategies, particularly for household waste.

There is also an urgent requirement for a more effective workforce, as current sanitation workers are reportedly not functioning efficiently. During the peak yatra season, waste generation increases significantly, necessitating an expansion of worker shifts and improved waste management practices to handle the additional load. Although some measures have been taken to address these challenges, their implementation has been inadequate, reducing their effectiveness.

To tackle these issues, strict enforcement of waste management plans emphasizing recycling, reuse, and proper disposal is essential. Open dumping and burning of waste should be strictly prohibited, with legal measures in place to prevent such practices. Restricting access to certain areas and implementing targeted awareness programs can help in changing public attitudes toward waste disposal.

This study attempts to provide practical solutions for improving waste management in Rudraprayag. While there are limitations, adopting the suggested strategies can significantly enhance waste management efforts in the future. Proper implementation of these methods can lead to waste reduction, improved collection efficiency, and overall cleanliness of the town.

Suggestions

The proper management of waste demands facilities to manage the waste so that there is a

clean and well-maintained environment in the city. Therefore, there are some suggestions which will further help in maintaining the waste which are as follows: -

1. The lack of dustbins in the market is contributing to multiple environmental and health issues, including waste accumulation, pollution, soil contamination, clogged drains, and the potential outbreak of diseases.
2. Poor sanitation can deter tourists from visiting the area, negatively impacting the local tourism industry. Therefore, effective waste management should be ensured.
3. The timing and efficiency of waste collection should be monitored, as irresponsible collection practices can severely affect sanitation in residential areas.
4. The municipal council should focus on managing waste during public gatherings to prevent environmental pollution. Authorities must take proactive measures to ensure hygiene in surrounding areas.
5. Recycling and remanufacturing not only reduce waste but also generate employment and contribute to economic growth. The government should actively promote such sustainable practices.
6. Awareness programs on waste management and proper disposal practices should be organized to encourage community participation and ensure effective implementation of waste management strategies.

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