Journal of Forestry and Natural Resources
Jour.For.Nat.Reso (JFNR) (2026).5(1).59-71 | ISSN: 3005-4036
Web link: https://journals.hu.edu.et/hu-journals/index.php/jfnr

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Land use land cover analysis for sustainability in waste management optimization in the Durgapur municipality and surrounding area

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ARTICLE HISTORY
Submitted: 25 July, 2025
Accepted: 30 June 2026
Published Online: 30 June 2026

CITATION
Ghosh et.al (2026). Land use land cover analysis for sustainability in waste management optimization in the Durgapur municipality and surrounding area. *Journal of Forestry and Natural Resources*, 5(1), 59-71.
https://doi.org/10.20372/gxjnqq09

KEYWORDS
Industrial waste; Waste Management; Land Use and Land Cover; Analytical Hierarchy Process; Durgapur Municipality Corporation.

Abstract

India's largest industrial complex, the Durgapur Steel Plant, is suffering from sanitation and health problems due to the unwanted disposal of solid waste. The West Bengal plant is trying to convert trash into something worthwhile and minimize pollution in the environment. The disposal of industrial waste is governed by environmental protection. However, uncontrolled waste collection, illegal dumping, and poor public awareness are challenges in developing nations such as India. India needs to focus on recycling, regionalized solid waste treatment, and green technology to overcome these challenges. Smart cities need various strategies for implementation. The study designs open-ground waste facilities, maximizes vacant land space utilization for green waste management, examines the relationship between residential land use and the generation of waste, and minimizes pollution. Comparison and evaluation are two elements of the multicriteria decision-making methodology referred to as the analytical hierarchy process (AHP). It simplifies the problematic task by attributing normalized weights to each groundwater prospecting factor theme tier. The consistency ratio (CR), which should be no more than 0.1, informs one about how reliable the judgment is. In this research, the CR value was 0.089, which is no more than 0.1. GIS is employed to delineate land use and land cover classes, such as bare land, settlement, dense vegetation, cultivated land, sand, and water bodies, from expert judgment. Different land use and land cover categories of different waste management suitability scores were grouped by the AHP analysis of the Durgapur Municipality Corporation. Scatter land and,barren land and ground is highly suitable (15-22%) for waste management, followed by agricultural land and dense vegetation are suitable (12-14%). Settlement, sand and waterbody is medium suitable (5-11%) for waste management, next to the ground. The research highlights the importance of considering such factors in ascertaining whether waste management is appropriate.

1 Introduction

Unwanted solid, liquid, and gaseous wastes from industrial processes must be collected, transported, processed, disposed of, and monitored as part of the crucial process of industrial waste management (Prakash et al., 2019). Because industrial waste has a detrimental effect on the air, water, and land, as well as on human health, proper management of this garbage has become increasingly crucial (Geetha & Rajalakshmi, 2020; Prakash et al., 2019). Numerous approaches have been developed for effective industrial waste management, including end-of-waste, cradle-to-cradle, circular economy, sustainable materials management, zero waste, and environmental design (Mohamed et al., 2023). Although waste management practices differ by area, wealthy nations such as Japan have extensive rules and regulations that emphasize proper treatment, disposal standards, and generator accountability (Hirota,

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1986). However, issues including erratic garbage collection, unlawful disposal, and low public awareness continue to exist in developing nations (Muiruri et al., 2020). Waste management requires a systems approach that integrates the five functional components of generation, reduction, collection, recycling, and disposal with more general environmental, social, and economic considerations (Sushil, 1990). India produces over 90 million tons of solid trash a year, making waste management extremely difficult due to the country's rapid industrialization, urbanization, and population expansion (A. Singh et al., 2021). India's trash generation rate ranges from 0.12 to 0.60 kg/capita/day (S. Singh & Singh, 2021). Hospital solid waste is composed of glass (3–5%), plastics (7–10%), disposable syringes (0.3-0.5%), infectious waste (30–35%), and general garbage (40%–45%), including food (Patil & Shekdar, 2001). Concern over e-waste is also growing, since India is the world's fifth-largest producer. India's current waste management methods are mostly unscientific, with a considerable amount of solid garbage being carelessly disposed of on the outskirts of cities without first being treated (Das, 2020). Increased air pollution and groundwater contamination result from this. With disorganized units handling 95% of e-waste, the informal sector controls the recycling of e-waste (Borthakur & Sinha, 2014).

Recent rules have increased the awareness of biomedical waste management, but execution is still difficult (Patil & Shekdar, 2001; S et al., 2019). Rapid urbanization, population expansion, and rising per capita trash generation rates have made municipal solid waste management (MSWM) a major environmental concern for Indian towns (A. Kaur & Deswal, 2019). There are serious threats to the environment and public health because almost 90% of India's municipal solid waste is unscientifically dumped in open landfills and dumps (Sharholy et al., 2007). By working with self-help organizations like SWaCH and the informal garbage industry, Pune has attained a 95% waste segregation rate (Saifi & Jha, 2024). In conclusion, effective waste management in Indian smart cities requires a multifaceted approach (Fig 1). This includes the implementation of IoT-based solutions, smart bins, and integrated systems that involve various stakeholders. Additionally, sustainable planning, waste characterization, and the development of waste-to-energy potentials are crucial for long-term success (Cheela et al., 2021).

Major landfill location criteria consist of settlement distance, land cover, slope, road pattern, wind direction, geology, soil category, and water bodies (Mussa & Suryabhagavan, 2019). The Analytical Hierarchy Process (AHP) is commonly used to assign weights to these criteria based on their relative importance (Fagbohun & Aladejana, 2016; Wijesinghe & Fernando, 2023). GIS analysis then combines the weighted factors into suitability maps ranking locations as highly favorable, favorable, moderately favorable, less favorable, or unfavorable for waste disposal (Mussa & Suryabhagavan, 2019; Wijesinghe & Fernando, 2023). Studies suggest that while most focus on landfilling locations, some emphasize increasing waste management facilities, as demonstrated in Ethiopia where 20.8% of solid waste is recyclable (Doboch Wanore et al., 2023). Additionally, the availability of land for landfills is a major challenge in highly urbanized areas, sometimes necessitating compromises between environmental concerns and waste management needs (Ali & Ahmad, 2020). GIS-MCDA is a cost-effective solution for determining landfill locations, promoting sustainable urban waste management and improving public health and environmental protection in cities (Mondal et al., 2014; Usman Kaoje, 2016).

Indian cities face environmental challenges due to improper municipal solid waste management, with the daily waste generation in Lucknow causing public health hazards and potential groundwater contamination (Archana et al., 2014). Similarly, about 90% of MSW in Indian cities is disposed of unscientifically in open dumps and landfills (Sharholy et al., 2007). It is interesting to note that only a small portion of Mumbai's 17.20% recyclable waste is recovered by rag-pickers, underscoring the unrealized potential in the informal waste sector (Yedla & Kansal, 2003). Ranchi's waste management issues underscore the need for improved strategies, as common practices in developing nations like Nigeria are inefficient and harmful to the environment and public health (Omole et al., 2016). This suggests that Ranchi's waste management challenges are part of a broader global concern. Ranchi could benefit from introducing more modern technology, educating the general public, and successfully enforcing laws to overcome these problems (Aman & Srivast, 2020). Additionally, implementing cutting-edge solutions such as mobile applications, artificial intelligence (AI), and the Internet of Things (IoT), as suggested for Rajshahi City Corporation in Bangladesh, could greatly increase Ranchi's waste management effectiveness (Hossain et al., 2024). Groundwater pollution from open MSW disposal is a result of the landfill leachate. Water quality fluctuated throughout time and space, according to a study of groundwater samples taken near Ranchi's open MSW disposal site (Chakraborty & Kumar, 2016).

This research proposes a systematic approach to select an alternative MSW dumping ground in the city of Mumbai, keeping in view all the aspects of MSW management as a whole. The absence of uniform site evaluation procedures due to a mix of complex factors and parameters is tackled by the proposed MCDM-based approach (Khan et al., 2016). MCDM uses a hierarchical multi-level framework for organic waste management decision support, enabling comparison and analysis of competing criteria for effective conclusion-making. Social justice and environmental health movements place importance on sustainable waste management and recognize how to build cross-sector and cross-class alliances for alternative sustainable practices (Randhawa et al., 2020). In developing countries such as Turkey, economic development, population expansion, and industrialization have led to municipal solid waste management issues due to water resource pollution and climatic alteration (Yildirim et al., 2021).

By combining quantitative and qualitative factors and applying weights based on relative importance, MCDM methods chiefly consider and prioritize potential landfill locations while providing spatial information for land choice (Ghobadi, 2024). As per research, it is those families that had rightful area/society waste collectors that recorded greater log probabilities of garbage segregation, and hence, they know more about the practice. The gap effect is not strong, however (P. Kaur et al., 2023). Based on a survey, 60% of middle-class and upper-class households are financially and physically ready to adopt municipal solid waste management methods, while 30% of poor families are equally ready (Kumar & Anand, 2017). Failure to manage waste in an appropriate manner and going against national waste management codes in most large metropolitan cities due to poor infrastructure and services create economic and environmental issues. India is estimated to produce 5% more MSW each year.

Serious health risks of injury and infection are posed by biomedical waste, and unsound waste management is highly likely to have a negative impact on public health, especially among medical students who are exposed to it during hospital training (A. Singh et al., 2022). According to the survey, the more educated dealers and the higher socioeconomic status dealers are more concerned about the dangers of radioactive waste (Makkar et al., 2014). India, one of the most populous countries in the world, also has a significant waste disposal problem because of its urbanization, emerging economy, and shifting consumer trends (Poddar, 2023).

In several industries, including plumbing, toys, furniture, packing, and interior design, plastic items have supplanted conventional materials due to their low manufacturing costs, simplicity of manufacture, and water resistance. In India, packaging accounts for around 42% (Rode, 2015). Although medical professionals' knowledge and awareness of biomedical waste management are limited, regular education can improve procedures and keep medical workers from becoming discouraged. With the help of other groups, the ALM program, which started out as a local project, has grown into a city-level initiative. Critics claim that because ALMs are mostly found in affluent neighbourhoods, they have an elitist and middle-class bias. Through creative communication techniques, music, talk programs, lectures, ads, and pledges, the Residents Association ALM runs a radio station that addresses social, educational, and environmental issues in the community (Mukherjee Basu & Punjabi, 2020).

Figure 1: Planning of a Smart City (**Shahab2022**)

To guarantee that waste is managed within the facility, biomedical waste produced during diagnosis, treatment, and immunization as well as radioactive and laboratory waste require minor revisions to the Biomedical Waste Management Rules of 2016. Because of poor and disorganized waste disposal procedures, hospitals' current biomedical waste management is subpar, leading to the dangerous mixing of hospital and general garbage (Balaji, n.d.). The disposal of hospital waste, which is divided into hazardous and general wastes, presents significant issues. Hazardous wastes are more dangerous and are more likely to become polluted than general wastes, which are always clean. This research proposes a new method of market verification of recycling machines based on qualitative and quantitative parameters. A fuzzy pairwise comparison matrix and fuzzy AHP are used in the model, and factor weights are provided with predetermined linguistic terms ("the Market Validation of Device Recycling Motor Oils," 2016). Apart from examining the economic advantages and on-site and off-site recycling activities, this study tries to quantify, account for, and assess the likely scale of these activities. It also discusses the environmental and public health hazards (Muisa Zikali et al., 2022). Building demolition, renovation, and repair generate low-risk and low-volume solid waste that is referred to as construction and demolition waste (C&D). Effective management, cleaning, and screening in the industrial crushing plants can facilitate recycling and reuse because of increasing environmental and public health concerns. Enviro-Vigil is treating biomedical waste for Thane Municipal Corporation and the surrounding districts for over 3500 customers. They treat 2000 g/day, out of which 1200 kg is incinerated at 8500C as anatomical and contaminated waste (Iyer, 2016).

2 Materials and methods

2.1 Study Area

The coordinates of Durgapur are-Latitude Range: Approximately 23.4° N to 23.6° N, Longitude Range: Approximately 87.3° E to 87.5° E. Despite being a part of the Faridpur-Durgapur block, DMC is managed independently due to its significance. Within 15 km, Kanksa is located in the eastern part of the DMC, Faridpur Block is located in the northern section, and Andal is located in the western portion. It is 65 meters (213 feet) above sea level on average. The districts of Asansol Sadar to the west, Purba Bardhaman to the east, Bankura to the south over the Damodar, and Birbhum to the north across the Ajay River encircle the Durgapur subdivision. West Bengal, India's Durgapur Municipality Corporation (DMC) is a lowland area with a variety of land cover and land use. The Damodar River is one of several tiny rivers and bodies of water that are located within the city. There are sizable residential, business, and industrial areas in Durgapur, a significant metropolitan center. The complexity of waste management is increased by the abundance of sand, dense vegetation, and woods in the surrounding areas. To field investigate some site are found for waste disposal Site-1: (Latitude: 23.529075°, Longitude: 87.35033°), Site-2:(Latitude: 23.530673°, Longitude: 87.350479°), Site-3: Latitude: 23.530116°, Longitude:87.350236°), Site-4: (Latitude: 23.541007°, Longitude:87.359212°), Site-5: (Latitude: 23.541373°, Longitude: 87.359491°), Site-6: (Latitude: 23.538258°, Longitude: 87.299657°), Site-7: Latitude: 23.538097°, Longitude: 87.299549°) (Fig. 2).

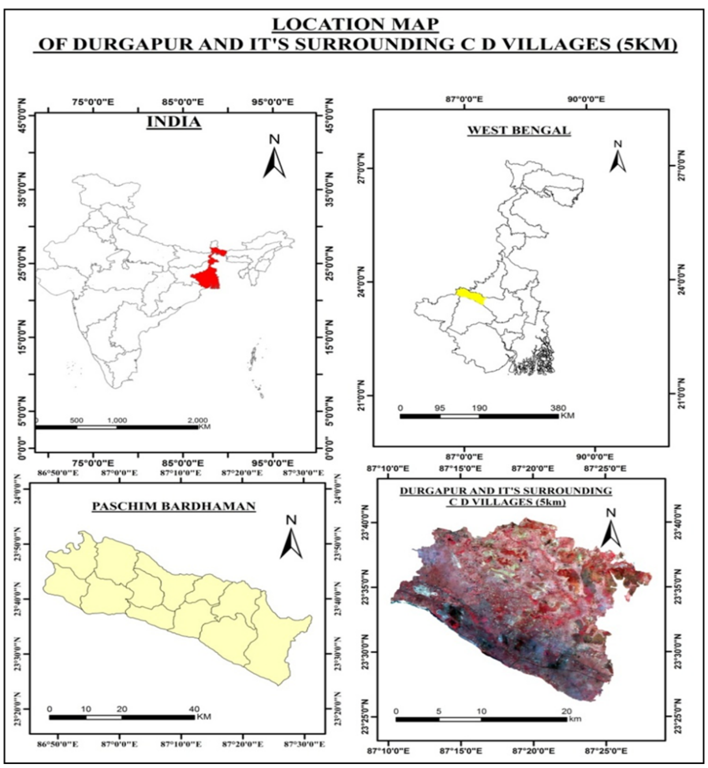

Figure 2: Map of study area

2.2 Methods

2.2.1 Field Observation

Field visits to a sample of DMC locations have shown open dumping to be extensive and pervasive. The photos below are a typical city street garbage dumping scene. areas where there is rubbish from home and market as in Plate- A to R these include plastic and other trash along streets and surrounding environments (Fig. 2).

2.2.2 Maximum likelihood method for collecting data of LULC

To address these challenges, several studies have proposed using Geographic Information Systems (GIS) and multi-criteria decision-making (MCDM) methods for selecting suitable MSWD sites. These approaches consider various factors such as elevation, slope, permeability, distance from water bodies, roads, and settlements (Bilgilioglu et al., 2021). Integrating the Analytical Hierarchy Process (AHP)-based MCDA with geospatial techniques can help identify suitable waste dumping sites, as demonstrated in studies from other developing countries (Wijesinghe & Fernando, 2023). Adopting these cutting-edge methods and putting smart city ideas into practice can help Indian towns create waste management systems that are more effective and ecologically friendly. In order to solve growing problems in emerging nations, GIS and AHP are useful tools for locating appropriate landfill sites for the disposal of solid waste in Indian cities (Dara & Reddy, 2018; Sk et al., 2020). The integration of GIS and AHP allows for the consideration of multiple criteria in landfill site selection. Common criteria include land elevation, slope, soil, geology, land use, distance to surface water, roads, industrial belts, sensitive places, and land cost (Sk et al., 2020). Some research has broadened these standards to incorporate elements such as protected areas, groundwater level, and the distance to tube wells (Dara & Reddy, 2018; Fatima et al., 2021). It is interesting to note that some research has used variants of the AHP approach, including fuzzy AHP, to overcome the imprecise nature of language evaluations in landfill site selection (Fatima et al., 2021; Islam et al., 2020). Furthermore, some academics have created environmental decision support tools, such EDSS-MSWI, to offer a comprehensive strategy for managing municipal solid waste in India (Nas & Singh, 2013).

In Indian cities, GIS and AHP techniques work well for analyzing the suitability of urban dumping sites while taking social, economic, and environmental aspects into account. By improving the site selection accuracy, fuzzy logic integration offers a methodical, data-driven approach to solid waste management. Mumbai, the financial hub of India, produces an astounding 6256–9000 tonnes of municipal solid waste (MSW) every day, making waste management extremely difficult (Yedla & Kansal, 2003).

The Saaty method, commonly known as the analytical hierarchy process (AHP) method, is a multicriteria decision-making approach that combines comparison and evaluation (Stofkova et al., 2022). (Saaty, 1987). AHP is a widely accepted model used to assign a normalized weight for each thematic layer of groundwater prospecting factor (Melese & Belay, 2022). The pairwise comparison matrix simplifies the complex decision-making process between criteria, allowing for the derived comparative relevance values. The reliability of the judgment is dependent on the Consistency Ratio (CR), and its value must be less than or equal to 0.1 (Sajil Kumar et al., 2022).

Plate 1. *Plate: A-Scatter forest distance from 4 km to Durgapur Municipal Corporation, B-Open dumping site, C- Systematic waste disposal container at Scattered Forest, D- Areas maintained for green cover within urban planning (Dumping site near dense forest area), E-This area includes both crop fields and orchards (Waste disposal at agricultural land area), F- Waste disposal at agricultural land area, G-Waste island type, H-Dumping site at open ground and sand area, I- Areas not covered by vegetation or structures (Open ground) (Source-The Authors)*

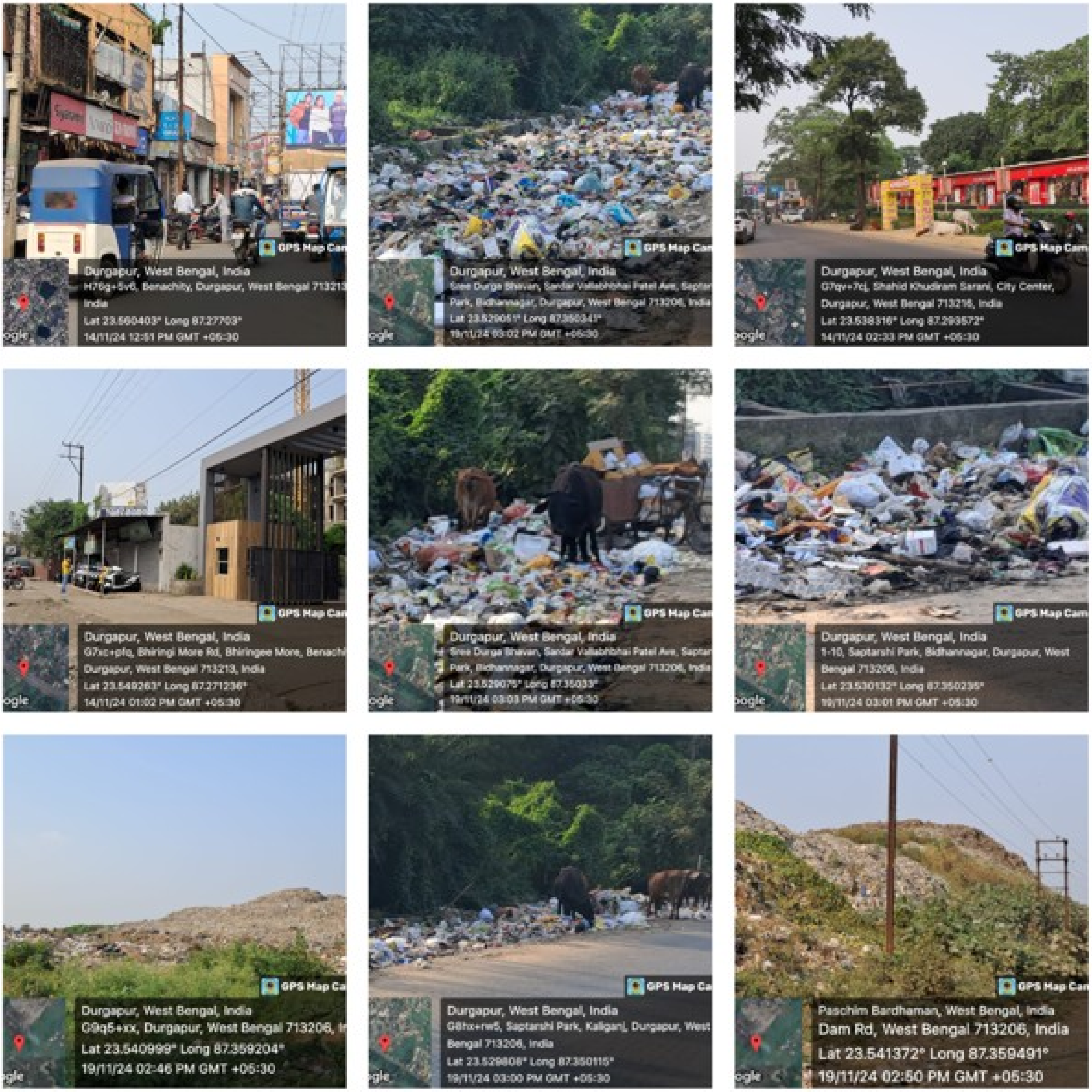

Plate 2. *Plate: A-Scatter forest distance from 4 km to Durgapur Municipal Corporation, B-Open dumping site, C- Systematic waste disposal container at Scattered Forest, D- Areas maintained for green cover within urban planning (Dumping site near dense forest area), E-This area includes both crop fields and orchards (Waste disposal at agricultural land area), F- Waste disposal at agricultural land area, G-Waste island type, H-Dumping site at open ground and sand area, I- Areas not covered by vegetation or structures (Open ground) (Source-The Authors)*

The authors provided the judgment the pairwise comparison matrix was derived. The AHP model involves defining thematic layers, generating a pairwise comparison matrix using Saaty's 1-9 scale, and determining the final weight of the layers using normalized eigenvalues. The consistency ratio (CR) is calculated using a formula. CR = CI/RI where, RI indicates the random consistency index whose value depends on the order of the matrix (Table 2) and CI indicates the consistency index, which can be obtained from the following formula: CI = λmax-n/n-1. Where, i principal eigenvalue of the matrix, n = number of groundwater prospecting factors. The value of CR must be <0.1. Table 1.

Table 1: Saaty's 1-9 scale of relative importance

Scale	Importance
1	Equal importance
2	Weak
3	Moderate importance
4	Moderate plus
5	Strong importance
6	Strong plus
7	Strong importance
8	Very strong importance
9	Extreme importance

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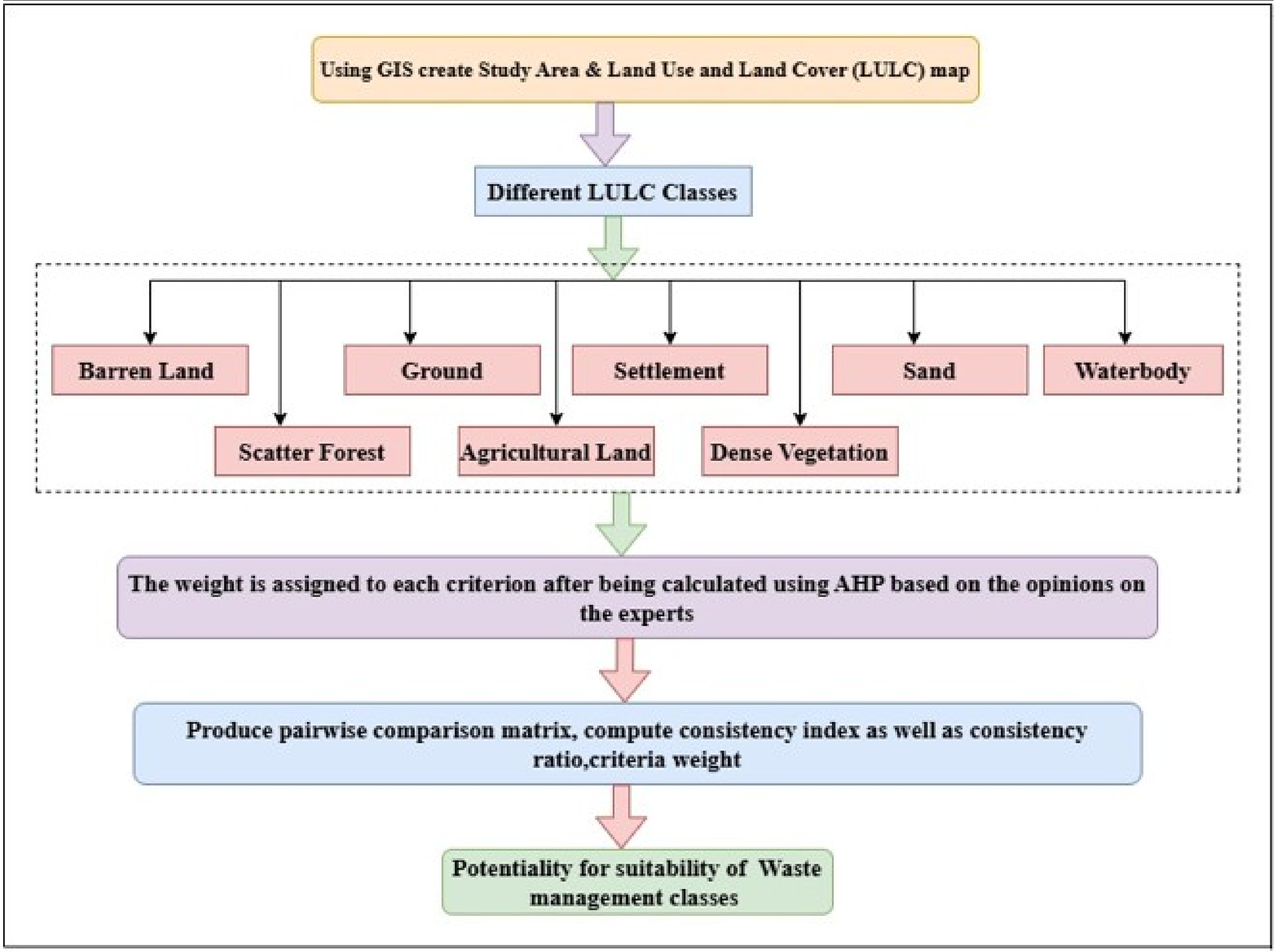

Figure 3: Methodology

2.2.3 *Sources of waste in the Durgapur Municipal Corporation*

Waste can come in a variety of forms, including food processing waste, biomedical waste, nuclear waste, construction waste, industrial waste, oil factory waste, e-waste, household waste, trash, home waste after slaughter, etc. Waste can be categorized as follows (Agarwal Professor et al., 2015):

- Solid waste, which includes home, kitchen, and vegetable waste.
- E-waste: abandoned electronic equipment, including computers, TVs, and music players systems, etc.
- Liquid waste: water used in tanneries and various industries, distillation facilities and thermal power plants
- Plastic garbage, such as buckets, bottles, and bags.
- Metal waste, such as scraps and unwanted metal sheets.
- Unused materials from nuclear power facilities are known as nuclear waste.

Additionally, we can classify all of these types of waste as wet waste (biodegradable) and non-biodegradable dry waste.

a) Household Waste: One of the main sources of MSW is household garbage, which includes food scraps, paper, plastic, rags, metal, and glasses from residential areas (Fadhullah et al., 2022). Domestic garbage from residential areas varies according to cultural and socioeconomic circumstances. Waste production is higher in low-income areas and lower in developed areas. Waste production is higher in commercial areas and prosperous towns.

b) Waste from shops/vegetable/fruit market: Sixty percent of the municipal solid trash is made up of biodegradable materials, such as food waste. Food waste in Delhi amounts to 2700 MT every day, and because of insufficient collection and monitoring, it causes eutrophication and choking. To enhance municipal solid waste management (MSW) services, municipalities lack the necessary infrastructure, management techniques, and resources. The optimization of MSW disposal is hampered by significant issues such as door-to-door garbage collection, a shortage of containers, ineffective collection, and ineffective disposal techniques. Degradable trash, such as polythene, paper, and dried plantain leaves, is produced by stores and fruit and vegetable markets and is used to wrap agricultural

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products.

c) Waste from hospital/nursing home/medical stores: Significant amounts of solid waste, including leftover medication, saline bottles, and non-biodegradable medication covers, are produced in DMC by hospitals, assisted living facilities, and medical stores.

d) Waste from hotels/restaurants/eating stalls: Both biodegradable and non-biodegradable garbage are produced by hotels and restaurants; household rubbish needs to be removed every day and collected in separate receptacles.

e) Waste generated by street hawkers: Large amounts of waste are produced by street food vendors and hawkers, especially food waste and plastic paper plates.

f) Waste from slaughterhouses/fish markets: Fast-decomposing garbage from slaughterhouses and fish markets causes rot and unpleasant odors in the area because proper procedures for collecting and removing paper are not followed.

g) Industrial Waste: Waste produced in factories, mines, or mills during the processing of raw materials for new products is referred to as industrial waste (Amasuomo & Baird, 2016).

3 Results

Table 2: Different types of Land Use and Land Cover (Full study area was not covered by the LULC analysis) in DMC (Source-The Authors)

Class Name	Area (sq km)	Percentage (%)
Barren land	54.886134	12.61867
Settlement	149.734103	34.42481
Ground	8.1482	1.873323
Dense vegetation	37.445503	8.608957
Agricultural land	77.933911	17.9175
Scattered forest	6.633421	1.525065
Sand	5.969817	1.372499
Water body	12.452264	2.862854

Table 3: Land use class and change detection of 2001-2011

Land Use Class	Percentage Change (2001-2011)
Barren land	6.573249% (Increase)
Settlement	13.71964% (Increase)
Ground	-17.9083% (Decrease)
Dense vegetation	1.819068 % (Increase)
Agricultural land	0.07346% (Increase)
Scattered forest	-7.34066% (Decrease)
Sand	1.155663% (Increase)
Water body	1.503805% (Increase)

Increase Classes (2001-2011)- Barren land (6.573249%), Settlement (13.71964%), Dense vegetation (1.819068 %), Agricultural land (0.07346%), Sand (1.155663%), Water body (1.503805%) Decrease Classes (2001-2011)- Ground (-17.9083%), Scattered forest (-7.34066%)

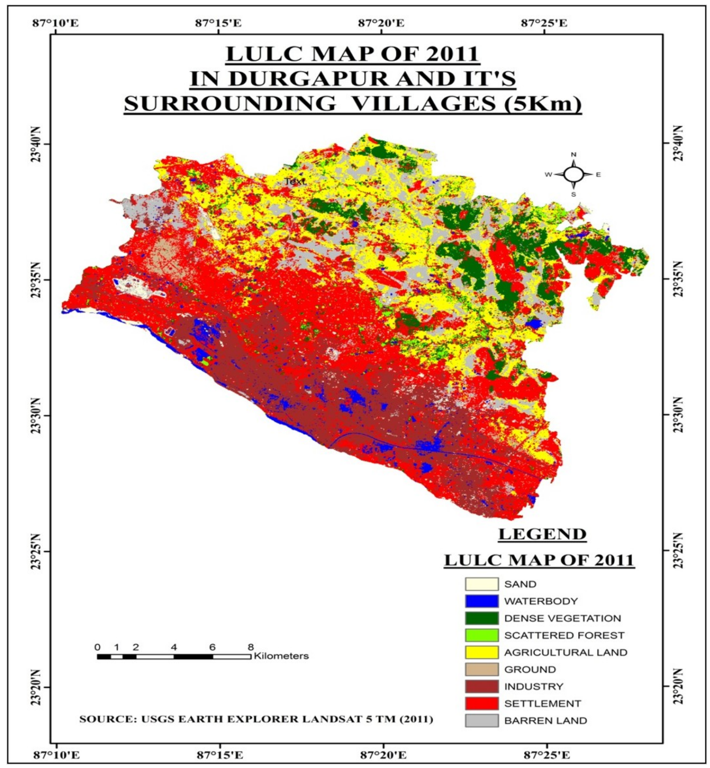

Figure 4: LULC pattern and change detection (Source-The Authors)

Table 4: Different types of LULC and waste management suitability class using AHP methods (Highly suitable: 15-22%, Suitable: 12-14%, Medium suitable: 5-11%)

LULC Type	SF	BL	DV	G	AL	S	Sa	WB	Percentage	Rank	Suitability Class
Scatter forest	1	1	2	1	2	3	3	2	18.1	2	Highly Suitable
Barren land	1	1	3	2	2	2	3	3	21.1	1	Highly Suitable
Dense Vegetation	1/2	1/3	1	1	1	3	2	3	12.3	5	Suitable
Ground	1	1/2	1	1	3	3	1	2	15.0	3	Highly Suitable
Agricultural land	1/2	1/2	1	1/3	1	4	2	3	12.4	4	Suitable
Settlement	1/3	1/2	1/3	1/3	1/4	1	3	3	8.7	6	Medium suitable
Sand	1/3	1/3	1/2	1	1/2	1/3	1	2	7.2	7	Medium suitable
Water body	1/2	1/3	1/3	1/2	1/3	1/3	1/2	1	5.2	8	Medium suitable

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Figure 5: LULC pattern and change detection (Source-The Authors)

4 Discussion

The best land use category for disposing of solid waste is open land, which includes grazing and nonagricultural regions. Evidence from Plate-A to Plate-R and discussed below:

1. Barren Land (12.62%)–Waste Management Suitability Rank 1: The most suitable land for waste management is barren land, which comprises 12.62% of the entire area. Because these plots of land lie vacant most of the time, there is a potential in constructing landfills, recycling plants, or units of wastage treatment (Evidence from Plate-P).

2. Scattered Forest (1.53%) – Waste Management Suitability Rank 2: In terms of suitability for waste management, the scattered forests that occupy an area of 1.53% in Durgapur fall under rank (evidence from Plate-C) 2. Due to their sensitive ecosystem, these forests can prove to be waste management difficult despite being central to managing biodiversity and ecological equilibrium.

3. Ground (1.87%) – Waste Management Suitability Rank 3: Ground lands at rank 3 of suitability for waste treatment occupy 1.87% of Durgapur. Open spaces containing parks, fields, and lots are among the areas that can be used for the dumping and collection of wastes (evidence from Plate-H).

4. Agricultural land (17.92%)–Waste Management Adaptability Rank 4: Durgapur has 17.92% agricultural land as part of its geography, ranking fourth in waste management adaptability. Such places have the scope to convert organic waste into compost, which can be used to enhance the fertility of the land. Irresponsible dumping of garbage, particularly from urban areas, also pollutes agricultural land.

5. Dense Vegetation (8.61%)–Waste Management Suitability Rank 5: Dense vegetation ranks fifth in suitability for waste disposal at a cover of 8.61%. Although these areas have numerous environmental benefits, including water and air purification, the dense vegetative cover is not well-suited for trash dumping.

6. Settlement (34.42%)–Waste Management Suitability Rank 6: Based on the study, in order not to cause pollution, waste-related diseases, and social disturbance, solid waste dumpsites should be situated far away from urban settlements. For waste disposal, residential areas–which constitute most of Durgapur at 34.42% rank number six. Most of the population resides there, and hence it generates a lot of waste. In urban neighborhoods, efficient garbage collection systems, such as door-to-door collection and segregation bin points–are important.

7. Sand (1.37%) – Waste Management Suitability Rank 7: Sand areas cover only 1.37% of the area in Durgapur and are ranked number six in suitability for garbage disposal (evidence from Plate-H).

8. Water Bodies (2.86%)–Waste Management Suitability Rank 8: Water bodies covering 2.86% of the land are the most inappropriate for garbage management. Solid waste management regulations and antipollution measures need to be followed so that garbage does not enter water bodies. The protection of water quality and minimization of pollution must be the top priority of waste management in these areas.

5 Conclusions

The study explores the impact of residential land use on waste output, optimizes underutilized land for sustainable waste management, develops open ground waste processing infrastructure, and changes land use detection. The suitability analysis clearly identified scattered land, barren land, and ground surfaces as the most advantageous areas (15–22%) for setting up waste management facilities. These land types present few ecological or socio-economic disputes, making them perfect for enduring infrastructure development. Agricultural areas and thick vegetation (12–14%) demonstrate moderate suitability but necessitate careful management owing to their ecological and productive significance. Settlements, sandy regions, and water bodies (5–11%) show only moderate suitability, suggesting that these areas should be steered clear of significant waste management activities due to possible environmental hazards, conflicts with human activities, and sensitivity to hydrology. Safeguard and Rank Extremely Appropriate Unused and Dispersed Land Lots Promptly identify and officially protect the recognized high-suitability barren and dispersed lands for upcoming waste management facilities. This measure will deter swift settlement expansion and guarantee the lasting availability of low-conflict areas. Create Safeguard Buffer Areas Around Delicate LULC Categories. Establish a compulsory 500-m buffer zone surrounding all areas with dense vegetation and agricultural land to safeguard ecological integrity and reduce human–environment conflict when locating waste facilities.

Acknowledgments

The First, second and third authors are grateful for the support to complete this research article. We also thank the local people and local guide for their field support.

Funding statement

There is no funding of source.

Conflict of interest

The author declare that no competing interests

Data availability Statement

Data can be made available on the behave of the request

Ethical considerations:

All ethical considerations were fully adhered during data collection, analysis and writing.

References

Agarwal Professor, R., Chaudhary Associate Professor, M., & Singh, J. (2015). Waste Management Initiatives in India for Human Well Being. Sustainable Redevelopment by the Reuse and Recycle of C&D Waste in Mumbai. *International Journal of Innovative Science and Research Technology (IJISRT)*, 937–944. https://doi.org/10.38124/ijisrt/ijisrt24may1373

Ali, S. A., & Ahmad, A. (2020). Suitability analysis for municipal landfill site selection using fuzzy analytic hierarchy process and geospatial technique. *Environmental Earth Sciences*, *79*. https://doi.org/10.1007/s12665-020-08970-z

Aman, A., & Srivast, P. (2020). Design and study of Solid Waste Management in Ranchi, Jharkhand. https://doi.org/10.21203/rs.3.rs-32222/v1

Amasuomo, E., & Baird, J. (2016). The Concept of Waste and Waste Management. *Journal of Management and Sustainability*, *6*(4), 88. https://doi.org/10.5539/jms.v6n4p88

Archana, A., Dutta, V., Ali, D., & Yunus, M. (2014). Assessment of the status of municipal solid waste management (MSWM) in Lucknow–Capital city of Uttar Pradesh, India. *IOSR Journal of Environmental Science, Toxicology and Food Technology*, *8*. https://doi.org/10.9790/2402-08524149

Balaji, T. (n.d.). A Cross-Sectional Study on the Awareness on the Bio-Medical Waste Management among Medical Students in a Tertiary Care Hospital Chennai. *20*(2).

Bilgilioglu, S. S., Gezgin, C., Orhan, O., & Karakus, P. (2021). A GIS-based multi-criteria decision-making method for selecting potential municipal solid waste disposal sites in Mersin, Turkey. *Environmental Science and Pollution Research*, *29*. https://doi.org/10.1007/s11356-021-15859-2

Borthakur, A., & Sinha, K. (2014). Electronic Waste Management in India: A Stakeholder's Perspective. *Electronic Green Journal*, *1*. https://doi.org/10.5070/g313618041

Chakraborty, S., & Kumar, R. N. (2016). Assessment of groundwater quality at a MSW landfill site using standard and AHP-based water quality index: a case study from Ranchi, Jharkhand, India. *Environmental Monitoring and Assessment*, *188*. https://doi.org/10.1007/s10661-016-5336-x

Cheela, V. R. S., Ranjan, V. P., Goel, S., John, M., & Dubey, B. (2021). Pathways to sustainable waste management in Indian Smart Cities. *Journal of Urban Management*, *10*. https://doi.org/10.1016/j.jum.2021.05.002

Dara, P. K., & Reddy, T. B. (2018). Municipal Solid Waste Landfill Site Selection for Visakhapatnam City under Vision 2020 Using GIS and AHP. *International Journal of Contemporary Research and Review*, *9*. https://doi.org/10.15520/ijcrr/2018/9/06/513

Das, P. K. (2020). Present Scenario of Waste Management in India. *American International Journal of Social Science Research*, *5*. https://doi.org/10.46281/aijssr.v5i1.481

Doboch Wanore, T., Abera Angello, Z., & Menberu Fetanu, Z. (2023). Optimized landfill site selection for municipal solid waste by integrating GIS and the multicriteria decision analysis (MCDA) technique, Hossana town, southern Ethiopia. *Helicon*, *9*. https://doi.org/10.1016/j.heliyon.2023.e21257

Fadhullah, W., Imran, N. I. N., Ismail, S. N. S., Jaafar, M. H., & Abdullah, H. (2022). Household solid waste management practices and perceptions among residents in the East Coast of Malaysia. *BMC Public Health*, *22*(1). https://doi.org/10.1186/s12889-021-12274-7

Fagbohun, B. J., & Aladejana, O. O. (2016). Integrating knowledge-based multi-criteria evaluation techniques with GIS for landfill site selection: A case study using AHP. *Materials and Geoenvironment*, *63*. https://doi.org/10.1515/rmzmag-2016-0016

Fatima, S., Ash'Aari, Z. H., Chaudhry, M. N., Sharaai, A. H., & Ramli, M. F. (2021). Comparison of the Landfill Site Suitability Assessment Using the Ahp and Fuzzy Ahp Methods. *The Journal of Solid Waste Technology and Management*, *47*. https://doi.org/10.5276/jswtm/2021.746

Geetha, R., & Rajalakshmi, S. (2020). Problem Faced by the Public Due to the Improper Waste Disposal and Behavior of Waste Disposal. *International Journal of Social Sciences and Management*, *7*. https://doi.org/10.3126/ijssm.v7i2.28593

Ghobadi, M. (2024). Environmental capability assessment for the MSW landfill site using a geographic information system and multi-criteria evaluation. *Advances in Environmental Technology*, *10*(1), 29–40. https://doi.org/10.22104/aet.2023.6210.1712

Hirota, Y. (1986). Present state of industrial waste management in Japan. *Journal of the Air Pollution Control Association*, *36*. https://doi.org/10.1080/00022470.1986.10466189

Hossain, I., Ullah, S. M. A., & Haque, A. K. M. M. (2024). Assessing sustainable waste management practices in the Rajshahi City Corporation: an analysis for local government enhancement using IoT, AI, and Android technology. *Environmental Science and Pollution Research*. https://doi.org/10.1007/s11356-024-33171-7

Islam, M., Kashem, S., & Morshed, S. (2020). Integrating spatial information technologies and the fuzzy analytic hierarchy process (F-AHP) approach for landfill siting. *City and Environment Interactions*, *7*. https://doi.org/10.1016/j.cacint.2020.100045

Iyer, H. (2016). Case Study of Mumbai: Decentralized Solid Waste Management. *Procedia Environmental Sciences*, *35*, 101–109. https://doi.org/10.1016/j.proenv.2016.07.054

Kaur, A., & Deswal, S. (2019). Sustainable Solid Waste Management in Indian Cities. https://doi.org/10.1007/978-981-13-7017-5_26

Kaur, P., Kaur, H., & Aggarwal, A. (2023). Waste Management through Waste Segregation: Survey Analysis of a North Delhi Locality. https://doi.org/10.48001/jbmis.2023.100200610

Khan, D., Kumar, A., & Samadder, S. R. (2016). Modeling landfill site selection using an integrated fuzzy MCDM approach. *Modeling Earth Systems and Environment*, *2*(2). https://doi.org/10.1007/s40808-016-0106-x

Kumar, A., & Anand, S. (2017). Community Perception toward Solid Waste Management in NCT of Delhi, India. *International Journal of Research & Review*, *4*, 47. www.ijrrjournal.com

Makkar, N., Chandra, T., Agrawal, P., Bansal, H., Singh, S., Anand, T., Gupta, M. K., & Kumar, R. (2014). Evaluating awareness and practices of radioactive waste management among scrap dealers in Delhi, India. *PLoS ONE*, *9*(3). https://doi.org/10.1371/journal.pone.0091579

Melese, T., & Belay, T. (2022). Groundwater Potential Zone Mapping Using Analytical Hierarchy Process and GIS in the Muga Watershed, Abay Basin, Ethiopia. *Global Challenges*, *6*(1). https://doi.org/10.1002/gch2.202100068

Mohamed, A.-M. O., Hameedi, S. M., Paleologos, E. K., & El Gamal, M. (2023). Chapter 1-Emerging carbon-based waste management sustainable practices. In *Sustainable use of Carbon Dioxide in Waste Management*. https://doi.org/10.1016/b978-0-12-823418-1.00015-9

Mondal, A., Tesfay, M. S., Rulinda, C. M., Gebresilassie, M. A., & Kahsay, G. H. (2014). Application of Geographic Information System and Remotesensing in the effective selection of solid waste disposal sites in Wukro town, Tigray, Ethiopia. *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, *XL-2*. https://doi.org/10.5194/isprsarchives-xl-2-115-2014

Muiruri, J., Karatu, K., & Wahome, R. (2020). Assessment of methods practiced in the disposal of solid waste in Eastleigh Nairobi County, Kenya. *AIMS Environmental Science*, *7*. https://doi.org/10.3934/environsci.2020028

Muisa Zikali, N., Chingoto, R. M., Utete, B., & Kunedzimwe, F. (2022). Household solid waste handling practices and recycling value for integrated solid waste management in a developing city in Zimbabwe. *Scientific African*, *16*. https://doi.org/10.1016/j.sciaf.2022.e01150

Mukherjee Basu, A., & Punjabi, S. (2020). Participation in solid waste management: Lessons from the Advanced Locality Management (ALM) program of Mumbai. *Journal of Urban Management*, *9*(1), 93–103. https://doi.org/10.1016/j.jum.2019.11.002

Mussa, A., & Suryabhagavan, K. V. (2019). Solid waste dumping site selection using GIS-based multi-criteria spatial modeling: a case study in Logia town, Afar region, Ethiopia. *Geology, Ecology, and Landscapes*, *5*. https://doi.org/10.1080/24749508.2019.1703311

Nas, B., & Singh, P. K. (2013). GIS-based environmental decision support system for municipal landfill site selection. *Management of Environmental Quality: An International Journal*, *24*. https://doi.org/10.1108/meq-08-2012-0056

Omole, D. O., Ndambuki, J. M., & Isiorho, S. A. (2016). Waste management practices in Nigeria: Impacts and mitigation, 520. https://doi.org/10.1130/2016.2520(33)

Patil, A. D., & Shekdar, A. V. (2001). Healthcare waste management in India. *Journal of Environmental Management*, *63*. https://doi.org/10.1006/jema.2001.0453

Poddar, A. K. (2023). A Sustainable Path Forward: Remedying the Flaws in the Basel Convention and India's Waste Management. *Environmental Claims Journal*, *35*(3), 282–296. https://doi.org/10.1080/10406026.2023.2267491

Prakash, A., Priyadarshini, R., Misra, R., & Agarwalla, N. (2019). A Novel Approach Toward Industrial Waste Management Using Q-Learning. https://doi.org/10.1109/icicrs46726.2019.9555893

Randhawa, P., Marshall, F., Kushwaha, P. K., & Desai, P. (2020). Pathways for Sustainable Urban Waste Management and Reduced Environmental Health Risks in India: Winners, Losers, and Alternatives to Waste-to-Energy in Delhi. *Frontiers in Sustainable Cities*, *2*. https://doi.org/10.3389/frsc.2020.00014

Rode, S. (2015). IMPROVING PUBLIC HEALTH AND ENVIRONMENT THROUGH PLASTIC WASTE MANAGEMENT IN MUMBAI METROPOLITAN REGION.

S, K., M, N., Abinaya, N., & Venkatesan, A. (2019). Bio-medical waste disposal in India: From paper to practice, what has been effected. *Indian Journal of Health Sciences and Biomedical Research (KLEU)*, *12*. https://doi.org/10.4103/kleuhsj.kleuhsj_112_19

Saaty, R. W. (1987). The analytic hierarchy process—what it is and how it is used. *Mathematical Modeling*, *9*(3-5), 161–176. https://doi.org/10.1016/0270-0255(87)90473-8

Saifi, N., & Jha, B. (2024). An Overview of Solid Waste Management Practices in Pune, Maharashtra, India. *Nature Environment and Pollution Technology*, *23*. https://doi.org/10.46488/nept.2024.v23i02.027

Sajil Kumar, P. J., Elango, L., & Schneider, M. (2022). GIS and AHP Based Groundwater Potential Zones Delineation in Chennai River Basin (CRB), India. *Sustainability*, *14*(3). https://doi.org/10.3390/su14031830

Sharholy, M., Trivedi, R. C., Mahmood, G., & Ahmad, K. (2007). Municipal solid waste management in Indian cities: A review. *Waste Management*, *28*. https://doi.org/10.1016/j.wasman.2007.02.008

Singh, A., Sharma, P. K., & Singh, G. S. (2021). Waste Management in India. https://doi.org/10.1201/9781003007579-5

Singh, A., Singh, N., Chellaiyan, V., Martolia, D. S., Bedi, R. S., & Mishra, C. M. (2022). A Comparative Study on the Perception of Biomedical Waste Management among Undergraduate and Postgraduate Students in a Tertiary Care Teaching Hospital in South Delhi. *Journal of Communicable Diseases*, *54*(4), 1–6. https://doi.org/10.24321/0019.5138.202295

Singh, S., & Singh, J. (2021). Solid waste management in India: a review. *International Journal of Engineering, Science and Technology*, *13*. https://doi.org/10.4314/ijest.v13i1.8s

Sk, M. M., Ali, S. A., & Ahmad, A. (2020). Optimal Sanitary Landfill Site Selection for Solid Waste Disposal in Durgapur City Using Geographic Information System and Multi-criteria Evaluation Technique. *KN-Journal of Cartography and Geographic Information*, *70*. https://doi.org/10.1007/s42489-020-00052-1

Stofkova, J., Krejnus, M., Stofkova, K. R., Malega, P., & Binasova, V. (2022). Use of the Analytic Hierarchy Process and Selected Methods in the Management Decision-Making Process in the Context of Sustainable Development. *Sustainability*, *14*(18). https://doi.org/10.3390/su141811546

Sushil, .-. (1990). Waste Management: A Systems Perspective. *Industrial Management & Data Systems*, *90*. https://doi.org/10.1108/02635579010140584

the Market Validation of Device Recycling Motor Oils. (2016). *Procedia Environmental Sciences*, *35*, 381–390. https://doi.org/10.1016/j.proenv.2016.07.018

Usman Kaoje, I. (2016). Site Suitability Analysis for Municipal Solid Waste Disposal in Birnin Kebbi, Nigeria. *IOSR Journal of Humanities and Social Science*, *21*. https://doi.org/10.9790/0837-02107030110

Wijesinghe, W. M. D. C., & Fernando, P. W. S. (2023). Optimal Urban Waste Dumping Site Selection in the Kalutara DS Division of Sri Lanka using GIS-based Multi-Criteria Decision Analysis. *Journal of Asian Geography*, *2*. https://doi.org/10.36777/jag2023.2.2.7

Yedla, S., & Kansal, S. (2003). Economic insight into municipal solid waste management in Mumbai: a critical analysis. *International Journal of Environment and Pollution*, *19*. https://doi.org/10.1504/ijep.2003.004329

Yildirim, V., Uzun, B., Baykal, T. M., Terzi, F., & ATASOY, B. A. (2021). Odor-aided Analysis for Landfill Site Selection: Study of DOKAP Region, Turkey. https://doi.org/10.21203/rs.3.rs-223168/v1