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Surajit Mahalanobis
Institute of Social Sciences
Pooja Sharma
University of Delhi
Md Nawazuzzoha
nawazuzzoha21@gmail.com

Institute of Social Sciences

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Assessment of waste management practices and environmental implications in Minicoy Island, Lakshadweep

Surajit Mahalanobis[1], Pooja Sharma[2], Md Nawazuzzoha[3*]

1. Principal Investigator. Senior Research Fellow, Institute of Social Sciences, Delhi, India.
2.Co-Principal Investigator. Associate Professor (Economics), Daulat Ram College, University of Delhi, India.
3. Research Assistant in this Research. Currently Senior Project Scientist at the Indian Institute of Technology Delhi

* Corresponding author ; email; nawazuzzoha21@gmail.com

Abstract

Small island communities face significant challenges in managing solid waste due to limited land availability, fragile ecosystems, and increasing consumption of packaged goods. This study assesses household waste generation and management practices on Minicoy Island, Lakshadweep, using household surveys, geo-tagged field observations, and spatial mapping. Data were collected from 40 households across the inhabited areas of the island and supplemented with field observations and satellite imagery to identify waste disposal practices and accumulation zones. The results indicate that household waste generation is relatively low in quantity, but the waste stream is dominated by non-biodegradable materials, particularly plastic. Open dumping and open burning of mixed waste are commonly practised, raising concerns for environmental quality and public health. Spatial observations show that improperly managed waste is present in residential, roadside, and coastal areas. The analysis of awareness and willingness suggests that while awareness of waste-related issues varies among households, there is a generally high willingness to participate in improved waste management practices. The study provides baseline information on waste management conditions on Minicoy Island and highlights the need for improved planning, community participation, and monitoring to support sustainable waste management in small island environment aligned with the UN Sustainable Development Goals (SDGs).

Keywords: Solid waste management; Small Island environments; Waste disposal practices; GIS-based spatial analysis; Community participation; Minicoy Island

1. Introduction

Small islands face unique waste challenges due to their isolation, limited land area, fragile ecosystems, and logistical constraints. These territories often struggle with importing materials and exporting waste, leading to local environmental degradation if waste is mismanaged (Singh et al., 2023). Effective waste management is therefore essential for protecting marine biodiversity, maintaining public health, and sustaining local economies, especially in tourism-dependent areas (Mohee et al., 2015). Remote islands generate high volumes of organic waste and imported packaging materials. These regions often rely on outdated collection systems, backyard burning, and unregulated land-filling (Mohee et al., 2015). Seasonal population changes from tourism cause spikes in waste generation that overwhelm existing infrastructure (Fontaine et al., 2022). Limited public awareness, inadequate policy enforcement, and geographic constraints further exacerbate the problem (Rozikin et al., 2024). Minicoy, a part of India's Lakshadweep archipelago, is a remote coral atoll with a dense population and limited freshwater availability. Its isolation magnifies challenges in waste transport, treatment, and disposal. Groundwater vulnerability due to porous coral substrates makes leachate from waste particularly hazardous (Joji, 2016). Studies show that household waste generation is strongly influenced by demographics, seasonal variations, and income levels. In Visakhapatnam, India, organic matter constituted the bulk of waste, with clear seasonal fluctuations and income-based differences in volume and composition (Cheela et al., 2021). Similarly, in Stellenbosch, South Africa, waste quantities varied based on household income and size, suggesting strong demographic links (Nell et al., 2022). Composting success depends heavily on household behaviour, seasonal conditions, and public perception. Community-level composting has also been advocated as a scalable alternative to landfill overflows in India (Gupta, 2022). Public understanding and participation remain crucial challenges. In Tamil Nadu, India, attitudes toward disposal were shaped by socio-economic factors, though awareness was uneven across practices (Indhira et al., 2015). In Pune, Bharat, even households familiar with recycling showed a mismatch between belief and actual action (Tadpatrikar& Rathod, 2024). There is a notable gap in studies applying GIS at the household or ward level. While GIS tools were used for city-wide modelling in Githunguri Town, Kenya, fine-scale mapping for residential-level planning was still lacking (Kung'u, 2024). This presents an opportunity for future research, especially in remote or smaller geographies. Socio-economic indicators like household size, income, and lifestyle play a significant role in shaping waste generation and segregation

behaviour. A review in South Africa found that higher-income households produced more recyclable and less organic waste, showing how income affects composition and disposal methods (Nell et al., 2022). Similarly, socio-economic predictors were key to understanding food waste behaviour in European households with children (Tonini et al., 2023).

The Circular Economy (CE) encourages the continuous use and repurposing of resources, reducing dependence on imports and minimising landfill use especially critical for resource-scarce islands. CE strategies are viable and necessary for islands that experience high import-to-waste ratios and face export barriers for recyclables (Elgie et al., 2021), (Mohammadi et al., 2021). Integrated Solid Waste Management (ISWM) considers the environmental, economic, and social dimensions of waste handling from generation to disposal. When applied to small islands, ISWM must be adapted to decentralised and context-specific infrastructures, often supported by community involvement and stakeholder collaboration (Shu et al., 2024). Material Flow Analysis (MFA) quantifies the inputs and outputs of materials within an island system, revealing inefficiencies and guiding resource use policies. MFA has proven useful even in data-poor environments to model key waste streams like plastics and e-waste (Noll et al., 2021). GIS (Geographic Information Systems) and remote sensing are increasingly used to spatially analyse waste generation, transportation, and disposal sites. These tools are crucial in remote island settings for identifying illegal dumps, monitoring land use changes, and optimising waste collection routes. A regional study using GIS with MFA in Northern Ireland showed the value of spatially resolving plastic waste streams and their hotspots (Mehta et al., 2022). Participatory mapping, involving local communities in data collection and mapping, enhances trust and accuracy in small-scale island contexts. It also supports community-driven interventions aligned with socio-cultural values (Bahers et al., 2022). Small islands often lack large-scale waste infrastructure and depend on imports that turn into unmanaged waste. MFA combined with CE provides tools for identifying internal circularity potentials and reducing reliance on external systems (Mohammadi et al., 2021b).

Socio-metabolic research frameworks offer a holistic lens for assessing how economic, social, and ecological variables intersect in waste generation and disposal (Singh et al., 2023). In the Maldives, mapping waste flows led to targeted waste-to-energy solutions in urban vs. rural islands (Wang et al., 2023). Similarly, integrating data from life-cycle assessments, material flow analysis, and local behavioural patterns can help tailor low-cost, eco-friendly strategies (Castellani et al., 2022). The integration of MFA with stakeholder engagement, as done in

Samothraki and South Tyrol, illustrates the importance of combining data and community knowledge for effective planning (Noll et al., 2021). In the Seychelles, land-filling dominates disposal, posing risks due to limited space and groundwater vulnerability. A trans-disciplinary case study recommended transitioning to circular strategies, improving collection networks, and diverting biogenic waste streams to reduce landfill pressure (Meylan et al., 2018). In Mauritius, over 480,000 tonnes of waste are disposed of annually in a single landfill, with limited recycling or composting. Studies advocate for integrated solid waste management (ISWM) with composting and anaerobic digestion based on the high organic content in municipal waste (Kowlesser, 2020).Tourism-driven islands like the Maldives face surges in plastic and food packaging waste. Waste-to-energy (WTE) systems are proposed for dense islands like Malé, while anaerobic digestion suits scattered islands (Wang et al., 2023).A household segregation trial in the Maldives found strong community willingness to sort waste, but highlighted spatial and logistical challenges (Mohamed et al., 2023).Caribbean islands like Aruba, Jamaica, and Barbados are generating increasing e-waste with poor recycling infrastructure. Circular economy models could yield over $500 million in recoverable materials from stored e-waste (Mohammadi et al., 2021a). In the Maldives, combining centralised incineration for urban areas with decentralized anaerobic digestion on smaller islands maximises coverage and energy recovery (Wang et al., 2023). The FaafuMagoodhoo Island study emphasised blending formal infrastructure with informal community-driven practices to enhance waste compliance and context-fit solutions (Malatesta et al., 2015). In the Maldives, modelling revealed that waste management improvements alone can backfire if tourism demand isn't also regulated. Policies that balance growth and waste control showed the best long-term sustainability outcomes (Kapmeier& Gonçalves, 2018). Studies show plastic is the most dominant component, especially in remote and tourist-heavy islands like the Andaman and Nicobar Archipelago and the Seychelles (Krishnakumar et al., 2020), (Duhec et al., 2015). Seasonal fluctuations due to tourism are well-documented, with significant increases in waste volume during peak travel months (Hidalgo, 2016). Organic waste, while heavy, makes up a smaller percentage of total debris count, especially in coastal zones where plastic dominates (Idrus et al., 2023). Household behaviour and improper waste segregation at the community level are major contributors to marine pollution, particularly in areas lacking adequate municipal waste systems (Seeruttun et al., 2021). Remote islands face logistical barriers such as difficult transportation routes, limited road infrastructure, and high dependency on shipping waste to mainland facilities. These significantly increase management costs (Zis et al., 2013). High operational costs and low economies of scale make it difficult for municipalities to invest

in long-term waste solutions (Hidalgo et al., 2017). Environmental sensitivity of these regions, especially coral reefs and marine biodiversity, makes waste mismanagement especially damaging. The accumulation of plastic and debris is a growing threat to ecosystems even in uninhabited islands (Lavers & Bond, 2017). A case study of litter across three beaches in Lakshadweep (Kadmat, Suheli Par, and Minicoy) showed that fishing (45%) and public activity (34%) were the major contributors to marine litter. The study suggested that although Minicoy was relatively clean (CCI 3.15), other islands faced moderate litter levels and lacked adequate waste control measures (Kaviarasan et al., 2020). Socioeconomic monitoring using the SocMon tool integrated marine debris as a metric in Minicoy. This participatory approach allowed for the inclusion of community insights in managing waste and created a local baseline for future interventions (Hoon & Padgett, 2023). Swachh Bharat initiatives elsewhere in India have successfully involved decentralised composting, awareness campaigns, and community-led segregation practices. While not specific to Minicoy, these practices provide models for adaptation (Subha, 2019).

GIS and participatory mapping are emerging as critical tools for waste management. In Minicoy, mapping marine debris helped identify critical hotspots and develop data for policy and community awareness (Hoon & Padgett, 2023). Technologies such as smart sensor-based garbage bins and the Internet of Things (IoT) have been proposed to support Swachh Bharat by monitoring bin usage and improving collection efficiency in dense areas potentially adaptable to smaller, remote island contexts (Solomon et al., 2022). Cultural practices heavily influence waste behaviours. In Ambikapur, a case study showed that women-led waste management initiatives achieved full household participation in segregation and collection, emphasising the importance of gender and community roles in sustainability (Dutta et al., 2021). Community willingness to participate in waste segregation and recycling increases when awareness campaigns are combined with infrastructure support, such as provision of bins (Anonymous, 2019). Although the Union Territory of Lakshadweep falls under national missions like SBM, implementation gaps persist due to limited local data and infrastructure challenges. A key limitation is the absence of robust local governance frameworks and coordination between Panchayat bodies and district administration (Behera et al., 2024). Funding, data availability, and lack of technical support are major bottlenecks, although prototype digital systems have been proposed to improve transparency and fund tracking at the local level (Renuka & Challa, 2016). Most studies in Lakshadweep use macro-level assessments of marine litter or land-based waste without spatial resolution (e.g., beach litter

surveys) (Kaviarasan et al., 2020). GIS-based micro-mapping of waste flows within Minicoy, including hotspots and route optimisation, is absent. While participatory tools like SocMon have been piloted in Minicoy (Hoon & Padgett, 2023), most waste mapping studies rely on technical data and overlook community-driven insights and local knowledge for mapping and planning. Literature rarely explores how waste practices intersect with Minicoy's unique culture, including gender roles, fishing livelihoods, or religious customs. As noted in broader Bharatiya (Indian) contexts (Dutta et al., 2021), culturally informed interventions are effective, but have not been localised for Lakshadweep. Very few studies in the region assess long-term waste impacts on coral reefs and marine biodiversity, despite Lakshadweep's ecological sensitivity. The focus has been on visual litter assessments, with little integration of ecological or marine health metrics (Lavers & Bond, 2017).

Minicoy Island continues to face significant gaps in waste management research and planning. There is an urgent need for localised solutions suited to its remote island geography, where limited waste transport and treatment systems pose persistent challenges (Hoon & Padgett, 2023). Few studies have examined how seasonal tourism influences waste generation or the capacity of local infrastructure to manage fluctuating loads. Similarly, there is no detailed analysis linking household demographics with waste composition, disposal behaviour, or community-level composting practices. The absence of fine-scale GIS-based waste mapping and route optimisation has further restricted effective waste collection and hotspot identification (Hoon & Padgett, 2023). Moreover, the movement of marine litter from land-based sources remains inadequately assessed, and absence of coordinated governance, tailored to small islands, continues to hinder efficient waste management in the Lakshadweep administration. In response to these gaps, the present study aims (1) to identify the key challenges and barriers in existing waste management practices and community awareness, (2) to map waste generation systems on Minicoy Island using geo-tagged images and spatial analyses, and (3) to assess the environmental impacts of improper waste disposal, with particular attention to marine ecosystem degradation and pollution pathways (Hoon & Padgett, 2023).

2. Material and methods

2.1 Study Area

Minicoy Island, locally known as *Maliku*, is the southernmost atoll of the Lakshadweep archipelago, situated in the Arabian Sea close to the Maldives. Crescent-shaped and encircled by sandy beaches and coral reefs, it encloses a large lagoon of approximately 30.6 km²(Figure1).

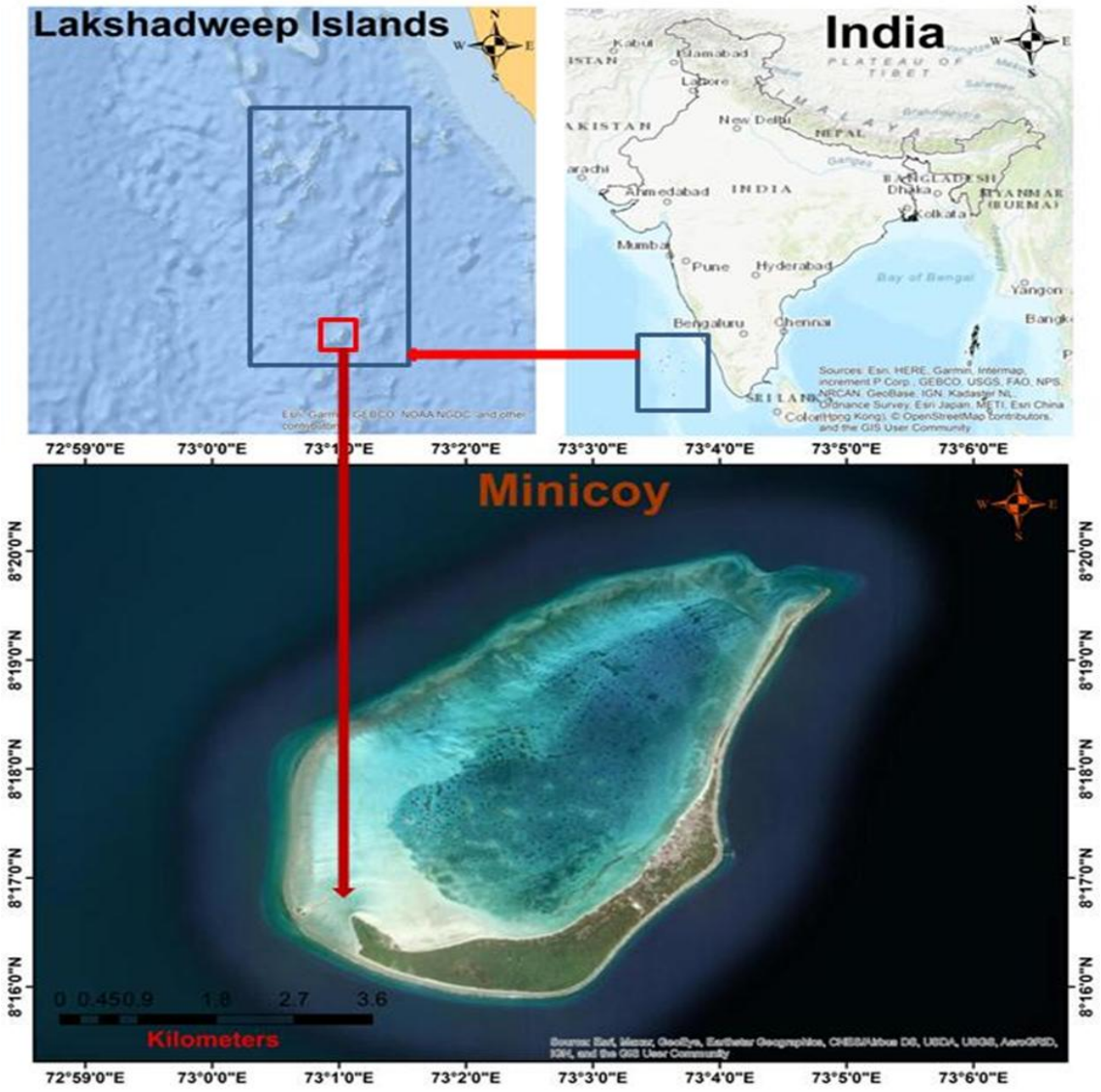


Figure 1. Study area

With an elevation ranging from 2 to 4 meters above sea level, Minicoy represents an ecologically fragile island system highly susceptible to sea-level rise and coastal erosion. The island experiences a tropical humid climate similar to Kerala, receiving an average annual

rainfall of about 1600 mm. The warmest period occurs from March to May, followed by the southwest monsoon that extends from mid-May to September, influencing the seasonal livelihood patterns of the inhabitants. According to the 2011 Census, Minicoy has a population of 10,447 people and a high literacy rate of 92.85%. Fishing and coconut farming form the primary sources of income, complemented by traditional crafts and coir-based activities. The community speaks Mahal, a dialect closely related to Dhivehi, alongside Malayalam, Hindi, and English, reflecting both regional and transnational cultural ties. The island is divided into ten traditional villages known as *Avah*, each governed by its own community council. Coconut trees, fishing boats, and coral ecosystems form the foundation of Minicoy's livelihood and identity.

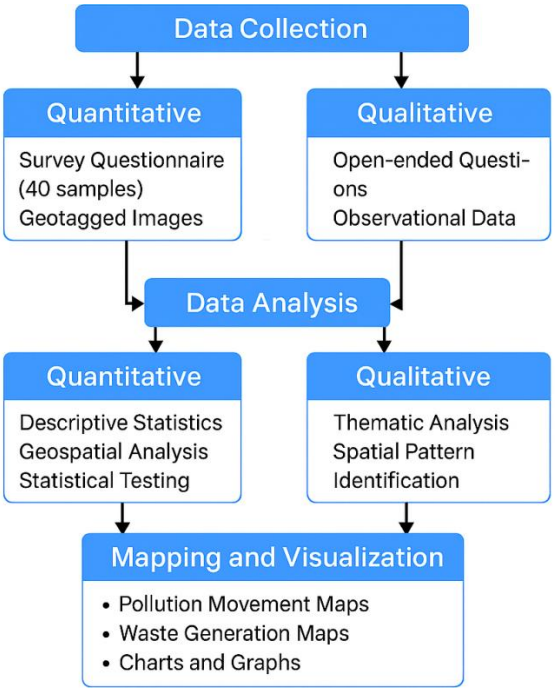


Figure 2. Mythological flowchart

2.2 Methods

A mixed-methods approach was adopted to analyse waste management practices on Minicoy Island. Field surveys collected demographic-linked household waste data and geo-tagged photographs and videos, while landfill sites were identified through Google Earth. A total of 40 household samples were systematically selected across the inhabited stretch, and each location was recorded using GPS. Structured questionnaires captured quantitative information on waste generation and disposal, while open-ended interviews and field observations provided qualitative insights into community awareness and behaviour. Quantitative data were processed

through descriptive statistics and geospatial analysis, including hotspot mapping and spatial pattern detection to identify accumulation zones and pollution pathways. Qualitative data were analysed thematically to interpret community perceptions and adoption barriers. The results were integrated through a mapping and visualisation stage, producing waste generation maps, pollution movement maps, and statistical charts to illustrate how socio-demographic characteristics and spatial patterns interact in shaping waste dynamics on the island. All methods were performed in accordance with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. However, the ethical approval was not required for this study as per the institutional guidelines of the Institute of Social Science, Delhi, because the research involved anonymous questionnaire-based data collection with voluntary participation and no sensitive personal information. The study was approved by the Ethics Committee of the Institute of Social Science (ISS), Vasant Kunj, New Delhi, India.

3. Result

3.1 Socio-demographic profile

The socio-demographic profile of the 40 surveyed households on Minicoy Island reflects a compact island community with moderate literacy and mixed livelihood characteristics. The age structure (Figure 3a) is dominated by middle-aged respondents, with 50% belonging to the 31–45 age groups and 30% to the 46–60 range. Younger adults aged 18–30 constitute 16.7%, while only 3.3% are above 60 years, indicating that the sample largely represents the economically active population. The gender distribution (Figure 3b) shows a strong female predominance, with 86.7% women and 13.3% men, emphasising the central role of women in household and community-level waste management. Educational attainment (Figure 3c) indicates that 33.3% of respondents completed secondary education, 26.7% primary, and 23.3% higher secondary, while 13.3% possessed graduate or higher qualifications, and only 3.3% had no formal education. Occupationally (Figure 3d), homemakers represent the largest group (53.3%), followed by government employees (20%), private-sector workers (16.7%), students (6.7%), and fisherfolk (3.3%). Household size distribution (Figure 3e) shows that two-thirds of families (66.7%) have 4–6 members, while 16.7% have 1–3, and 13.3% exceed six members.

3.2 Household Waste Generation and Management Practices

The household survey on Minicoy Island presents detailed insights into daily waste generation and management behaviour (Figure 4a–d). As shown in Figure 4a, most households (61.3%) generate less than 500 g of solid waste per day, while 29% produce between 500 g and 1 kg, and 9.7% are uncertain about their daily output, reflecting modest household waste quantities typical of small island settings. Figure 4b shows that household waste is largely composed of non-biodegradable materials, with plastics and packaging forming the majority (96.8%), followed by paper and cardboard (83.9%), kitchen or food waste (54.8%), glass and metal (41.9%), and electronic waste (35.5%).Figure 4c indicates limited segregation at the source: only 22.6% of respondents always separate waste, 35.5% do so occasionally, 38.7% do not segregate, and 3.2% are unaware of segregation practices. According to Figure 4d, waste disposal methods are dominated by local authority collection services (81.3%), while 9.4% of households dispose of food waste directly into the sea or shore, 6.2% dump in open community areas known locally as kodi, and 3.1% reported having no defined disposal method. Together, these results depict the composition, quantity and handling behaviour of household waste across Minicoy Island.

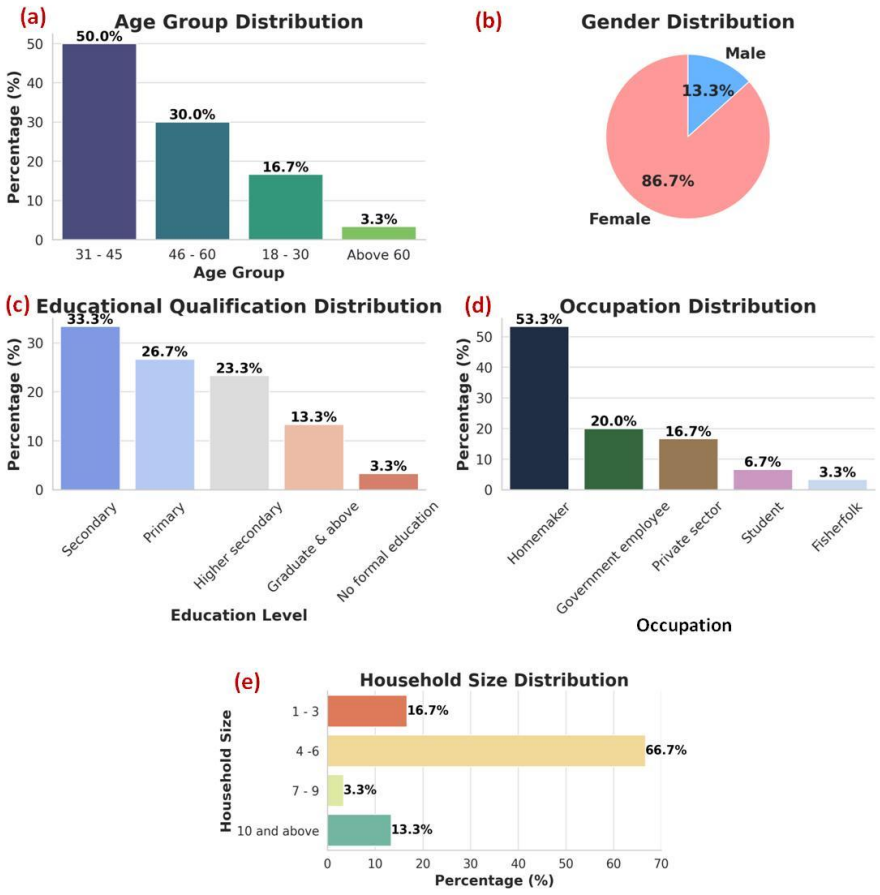


Figure3. Socio-demographic characteristics of surveyed households on Minicoy Island: (a) age distribution, (b) gender composition, (c) education level, (d) occupation, and (e) household size.

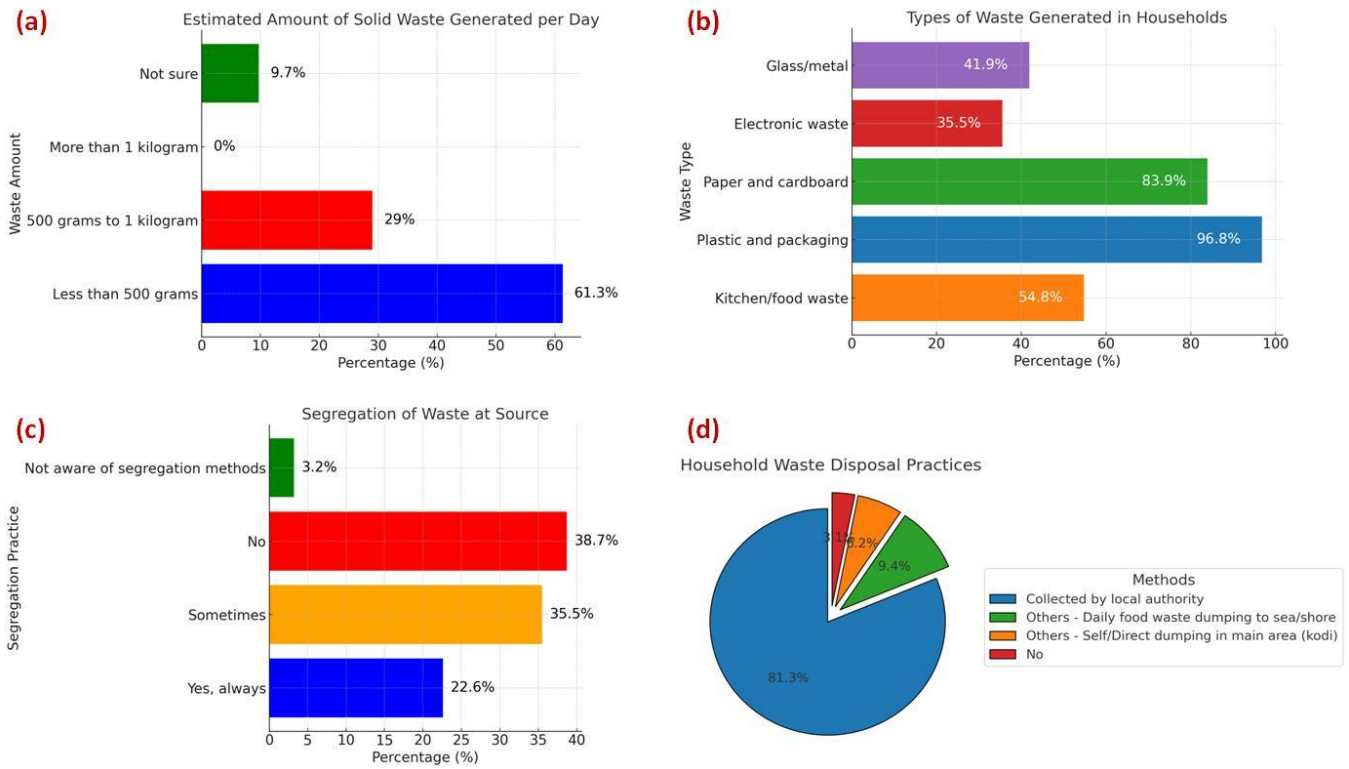


Figure 4. Household waste generation and management practices on Minicoy Island: (a) daily waste generation quantity, (b) waste composition, (c) waste segregation practices, and (d) disposal methods.

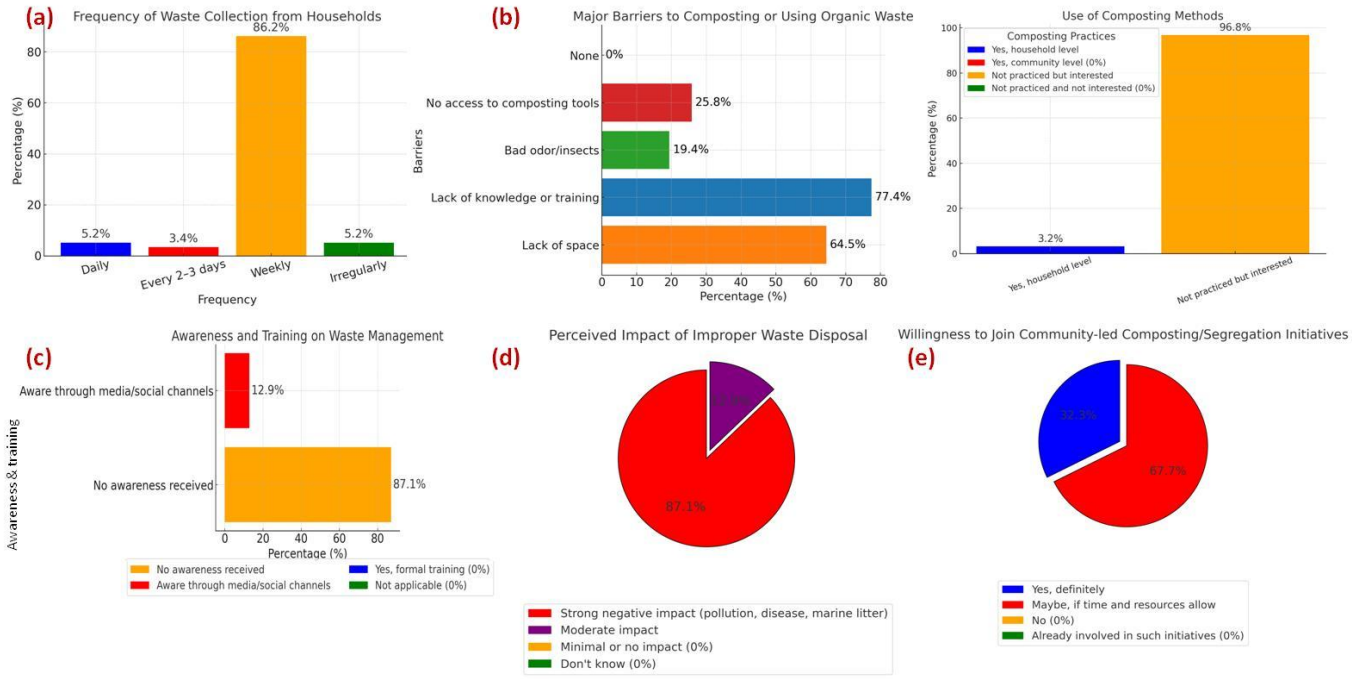


Figure 5. Household waste collection and participation patterns: (a) waste collection frequency, (b) composting practices, (c) access to waste management awareness or training, (d) perception of environmental impacts, and (e) willingness to participate in community-based initiatives.

The household waste management survey on Minicoy Island provides detailed insights into collection frequency, composting practices, awareness, and participation levels (Figure 5a–e).

Waste collection from households occurs predominantly on a weekly basis, reported by 86.2% of respondents, while 5.2% receive daily collection, 3.4% every 2–3 days, and 5.2% irregularly (Figure 5a). Composting practices are minimal, with only 3.2% of households practising composting at the domestic level and 96.8% not composting but showing interest (Figure 5b). The main barriers include lack of knowledge or training (77.4%), limited space (64.5%), inadequate access to composting tools (25.8%), and odor or insect issues (19.4%). Awareness and training on waste management are limited (Figure 5c), as 87.1% of respondents reported no exposure to programmes, while 12.9% learned informally through social or media channels. Perceptions of environmental impact are strong (Figure 5d): 87.1% believe improper waste disposal causes severe negative effects such as pollution, disease, and marine litter, while 12.9% view it as moderately impactful. Figure 5e shows that 67.7% of respondents expressed definite willingness to join community-led composting or segregation initiatives, and 32.3% would consider participation if time and resources allowed.

3.3 Variation of awareness and willingness indices across demographic and socioeconomic groups

The variation in awareness and willingness indices across demographic and socio-economic groups on Minicoy Island (Figure 6a–d) highlights distinct behavioural patterns shaping household participation in sustainable waste practices. As shown in Figure 6a, younger respondents (18–30 years) recorded the highest willingness index (0.85) but a relatively lower awareness index (0.477). The 31–45 age group maintained comparable willingness (0.812) with slightly higher awareness (0.517), whereas respondents aged 46–60 years displayed moderate values (willingness = 0.75; awareness = 0.6). Individuals above 60 years showed consistent willingness (0.75) but improved awareness (0.666), indicating that while readiness to act remains strong across all age categories, awareness improves slightly among older participants. Education-wise variation (Figure 6b) revealed that individuals with higher secondary education exhibited the greatest willingness (0.843), followed by those with secondary education (0.825), while awareness peaked among graduates and above (0.687). Participants with no formal education displayed moderate awareness (0.666) but maintained notable willingness (0.75), suggesting that formal education supports understanding but not necessarily motivation. As presented in Figure 6c, household size also influenced outcomes: families with 7–9 members achieved the highest willingness (1.0) with moderate awareness (0.666), whereas smaller households (1–3 members) had lower values (willingness = 0.75;

awareness = 0.49). Those with 4–6 members demonstrated intermediate indices (willingness = 0.812; awareness = 0.515), indicating that larger households may possess greater collective motivation toward waste practices. Occupational variation (Figure 6d) further underscored the socio-economic dimension. Private sector employees recorded the highest willingness (0.892) and awareness (0.636), followed by homemakers (willingness = 0.787; awareness = 0.59). Fisherfolk and students reported lower but comparable values (willingness = 0.75; awareness = 0.547 and 0.551, respectively), while government employees reflected balanced but moderate engagement (willingness = 0.75; awareness = 0.643).

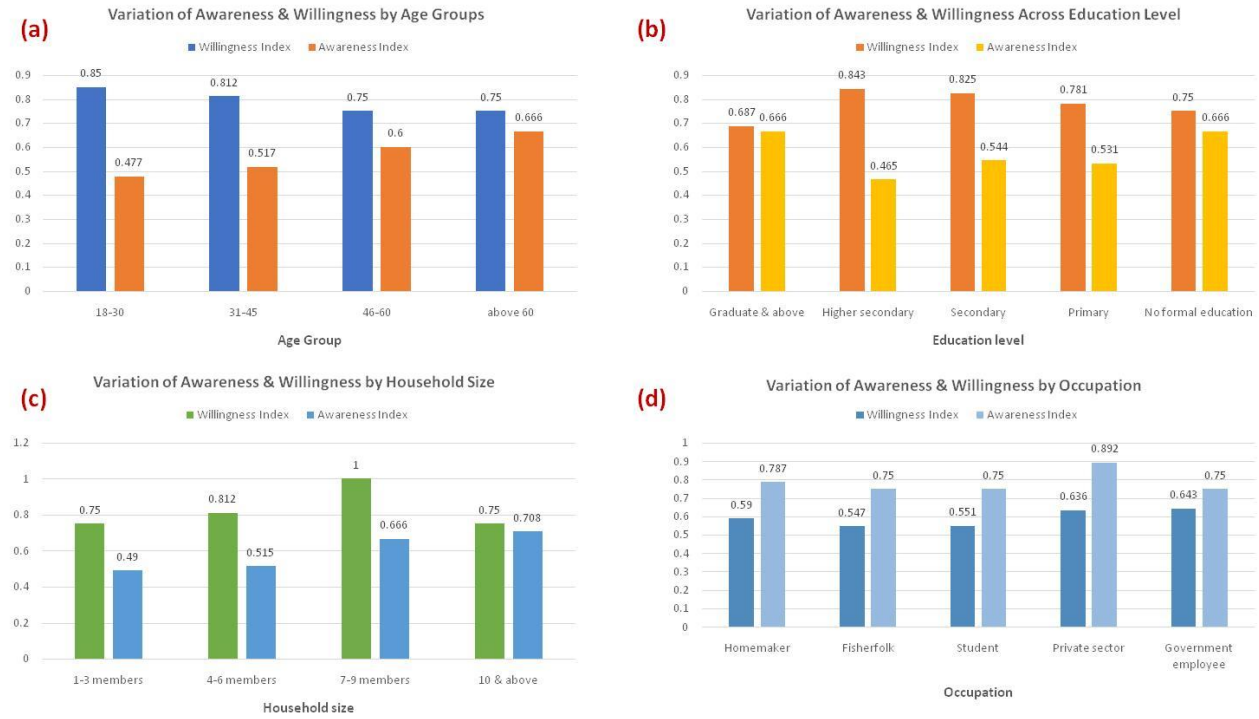


Figure 6. Variation in awareness and willingness indices across (a) age groups, (b) education levels, (c) household size, and (d) occupational categories.



Figure7.Geo-tagged field photographs showing spatial distribution of waste dumping and accumulation sites across residential, roadside, and coastal areas of Minicoy Island.

The geotagged photographs (Figure 7a–f) illustrate the spatial distribution of waste collection and dumping sites across Minicoy Island. The images show un-segregated household waste accumulated near residential zones and public areas, with open dumping occurring along roadsides and coastal fringes. Large mounds of mixed waste are visible near the shoreline, indicating the close proximity of disposal sites to the island's fragile coastal environment. The comparative analysis of satellite imagery (Figure 8a–b) shows a significant transformation of the Minicoy landfill site between 2014 and the present. The landfill, occupying about 0.31 hectares between the lagoon and the sea, expanded from a sparsely filled and partially vegetated area in 2014 to a completely saturated dumping ground in the current image, indicating continuous waste accumulation. The site's proximity to the lagoon and shoreline makes it highly susceptible to leachate seepage and tidal dispersion. Field observations (Figure 8a–c) reveal open burning of mixed waste that produces dense smoke containing dioxins and furans, leaving behind ash and partially burnt residues.



Figure 8. Changes in landfill conditions and waste disposal practices on Minicoy Island: (a–b) satellite imagery comparison showing landfill expansion over time

Discussion

The socio-demographic and household waste management characteristics of Minicoy Island align closely with those observed in other small island communities across the Indo-Pacific region. The predominance of middle-aged respondents and the strong female participation in household waste management activities highlight the gendered nature of environmental responsibilities within small island societies. In Minicoy, women constituted 86.7% of the surveyed population, indicating their central role in waste handling and community-level environmental care. Similar gendered participation patterns have been reported in the Kapoposang Islands of Indonesia, where 72.2% of women were responsible for managing domestic waste but often lacked adequate institutional and infrastructural support to ensure sustainable practices (Etnayanti et al., 2020). In comparison, Gili Trawangan in Indonesia demonstrates a more structured model of engagement, where community partnerships involving women and youth have strengthened collective accountability and improved waste management outcomes (Willmott & Graci, 2016). Thus, while Minicoy exhibits stronger gender inclusion than many comparable islands, it lacks organised institutional frameworks that translate participation into long-term sustainability.Minicoy's household waste generation remains relatively low, with 61.3% of households producing less than 500 grams per day. This volume corresponds to findings from other small islands, such as Pasaran Island, Indonesia, where waste generation averages 0.13 kg per person per day (Mawaddah et al., 2024). In contrast, Reunion Island, a more urbanised island setting, records between 0.6 and 0.8 kg per

person per day, illustrating the influence of higher economic activity and consumer imports on waste generation (Fontaine et al., 2022). Despite its low overall waste volume, Minicoy's waste composition is dominated by non-biodegradable materials, particularly plastics and packaging, which constitute 96.8% of household waste. This is substantially higher than the proportions recorded in Pasaran Island, where organic waste accounts for 44% and plastic waste for 26%. These figures suggest that Minicoy's consumption and disposal patterns have shifted toward greater dependence on packaged goods, likely due to increasing market integration and import reliance. A similar pattern was reported in Fiji's Koroipita community, where household surveys identified plastics and recyclable packaging as the predominant waste types, prompting the establishment of a community-driven segregation and recycling system (Azam et al., 2025). The comparison indicates that while Minicoy's total waste generation is within expected limits for small islands, the composition of its waste presents a significant environmental concern that warrants targeted plastic reduction strategies.

Waste segregation and disposal practices on Minicoy reveal modest community engagement but limited infrastructural support. Only 22.6% of households consistently segregate waste at the source, while 81.3% depend on local authority collection services, with most collections occurring weekly. In contrast, waste segregation initiatives in the Maldives achieved an 84% success rate during pilot trials despite similar spatial and logistical challenges, mainly due to coordinated community participation and island-level waste management centres (Mohamed et al., 2023). Similarly, in Gili Trawangan, a multi-tier waste system combining community volunteers and NGO support ensures frequent waste collection and partial material recovery for recycling (Willmott & Graci, 2016). These examples demonstrate that community-based systems supported by institutional coordination can overcome spatial limitations typical of island settings. Compared to these cases, Minicoy's waste system remains underdeveloped in segregation and collection efficiency, though the consistent presence of a local collection mechanism provides a valuable starting point for scaling up sustainable practices.In terms of awareness and willingness, Minicoy exhibits a distinct behavioural pattern characterised by high willingness but moderate awareness. The awareness index ranges from 0.477 to 0.666, while willingness remains between 0.75 and 1.0 across demographic groups. This mirrors findings from TelukRenjuna, Malaysia, where awareness showed a strong positive correlation with willingness to participate in waste-to-wealth initiatives (Yusoh et al., 2024). Similar research in Indonesia demonstrated that community-based training interventions significantly enhanced both waste management knowledge and behavioural practice, highlighting the

importance of educational engagement as a catalyst for behavioural change (Widiyanto et al., 2019). These findings suggest that Minicoy's population possesses the motivational foundation necessary for behavioural transformation but lacks structured educational and training programmes to reinforce practical knowledge. Consequently, interventions that focus on community learning and capacity-building could bridge this awareness-willingness gap and transform latent motivation into consistent sustainable practice.

The environmental observations on Minicoy further illustrate systemic weaknesses in waste governance. The island's landfill, occupying approximately 0.31 hectares, has expanded over time into a saturated dumping ground, accompanied by open burning of mixed waste. This pattern closely parallels the situation in the small islands of Pulo Aceh and Wakatobi, Indonesia, where open dumping and burning near coastal zones resulted in leachate seepage, marine pollution, and degradation of sensitive ecosystems (Rahmania et al., 2021). In contrast, islands such as Curacao have adopted participatory waste management frameworks that integrate community involvement, waste prevention, and resource recovery to align with the United Nations Sustainable Development Goals (Fuldauer et al., 2019). These approaches emphasise that effective waste management in island settings depends on inclusive governance, local engagement, and adaptive infrastructure that accounts for spatial and ecological constraints. For Minicoy, the lack of a controlled landfill, combined with waste seepage into the lagoon and open burning practices, underscores an urgent need for integrated waste management planning that prioritises ecological sensitivity.

Conclusion

Minicoy Island exhibits strong community willingness and female-led participation in household waste management but faces critical gaps in awareness, segregation practices, and infrastructure. Waste generation remains low, yet the dominance of non-biodegradable materials and reliance on open dumping and burning pose environmental risks to the island's coastal ecosystem. Comparative analyses with other small islands indicate that participatory approaches, training, and decentralised systems can significantly improve waste outcomes. Strengthening institutional support, awareness programmes, and community-driven composting or recycling initiatives is essential for transitioning Minicoy toward a sustainable, circular waste management framework and zero plastic Island.

Declarations

Ethics Approval and Consent to Participate

The study involved human participants through voluntary household surveys. Ethical approval was not required for this study as per the institutional guidelines of the Institute of Social Science, Delhi, because the research involved anonymous questionnaire-based data collection with voluntary participation and no sensitive personal information. All methods were performed in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

The study was approved by the Ethics Committee of the Institute of Social Science (ISS), Vasant Kunj, New Delhi, India.

Consent for Publication

Not applicable.

Data Availability

The datasets generated during and or analysed during the current study are available from the corresponding author on reasonable request.

Competing Interests

The authors declare that they have no competing interests.

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