

# Smart and Circular Lakshadweep: Innovating Solid Waste Management for Sustainable Tourism Development

Sayan Munshi<sup>1,\*</sup>, Devesh Mani Tripathi<sup>2</sup>

## Abstract

*Urban growth necessitates effective resource management, especially for resource-constrained island communities. This study focuses on the Lakshadweep Islands, examining the shift towards a circular economy through the perspective of solid waste management, with an emphasis on enhancing tourism and circular economy principles. The circular economy aims to eliminate waste and continually use resources by creating closed-loop systems where products, materials, and resources are reused, repaired, refurbished, and recycled. This study evaluates current municipal solid waste management practices in Lakshadweep, highlighting their role in achieving net-zero upgrades. The goal is to identify innovative approaches that support resilient, circular, and sustainable island destinations. Data analysis reveals a significant increase in waste generated by tourists, underscoring the need for efficient waste management strategies. The study covers waste generation, collection, transportation, and treatment, highlighting challenges such as the absence of sanitary landfills. It proposes a waste management strategy centered on the circular economy, focusing on reduce, reuse, recycle, and recover. Inspired by the Capraia Smart Island initiative, the study suggests biodiesel production as a renewable fuel solution for the growing number of tourists, advocating decentralized production on populated islands. This approach aligns with the Smart Islands Declaration, marking a shift towards circular practices. The study concludes by stressing the importance of responsible consumption and reducing single-use products for resilient and sustainable waste management on islands.*

**Keywords:** Urban metabolism, solid waste management, tourism upgradation, circular economy, sustainable development

## INTRODUCTION

Tourism is a significant contributor to global waste generation, encompassing various forms such as plastic waste from packaging and single-use items, food waste from hotels and restaurants, paper and cardboard from promotional materials, and electronic waste from tourist electronics. The scale of waste produced by tourism varies widely depending on destination popularity, infrastructure capabilities, and

waste management practices in place. Coastal and island destinations, in particular, face challenges with marine litter due to the prevalent use of plastics. Efforts to quantify tourism-related waste emphasize the need for sustainable waste management strategies that promote reduction, recycling, and proper disposal to mitigate environmental impacts and enhance the sustainability of tourist destinations worldwide [1–4].

In the context of Lakshadweep, tourism-driven islands face unique challenges in balancing economic growth with environmental

### \*Author for Correspondence

Sayan Munshi  
E-mail: sayanmunshi.m@gmail.com

<sup>1</sup>B. Arch, M. Plan, Assistant Professor, Amity University, Kolkata, West Bengal, India

<sup>2</sup>B. Arch, M.Arch, M. Plan, Principal Architect, ICON Architects, Lucknow, Uttar Pradesh, India

Received Date: July 03, 2024

Accepted Date: July 15, 2024

Published Date: July 16, 2024

**Citation:** Sayan Munshi, Devesh Mani Tripathi. Smart and Circular Lakshadweep: Innovating Solid Waste Management for Sustainable Tourism Development. Journal of Geotechnical Engineering. 2024; 11(2): 32–37p.

---

sustainability. This study focuses on solid waste management as a pivotal component of the islands' transformation towards sustainability. As these islands aim to enhance their tourism appeal while embracing circular economy principles, effective waste management practices assume critical importance. Given that tourism activities often lead to increased waste production, there is a pressing need for robust strategies to ensure sustainable development. By examining current solid waste management practices in the Lakshadweep archipelago, this research seeks to uncover innovative methodologies that contribute to the islands' resilience and sustainability. This shift not only addresses environmental concerns but also recognizes waste as a valuable resource in the pursuit of sustainable models for island communities.

### **AIM**

The aim of this study is to identify innovative approaches and tactics that support the island's transition into a resilient, sustainable, and circular getaway.

### **OBJECTIVES**

- To analyze the present condition of municipal solid waste management in the island of Kavaratti.
- To interpret the statistical relationship between tourism and solid waste management

### **SCOPES AND LIMITATION OF THE STUDY**

This study's scope includes an analysis of Lakshadweep Islands' solid waste management procedures, with a particular emphasis on the manner in which tourism affects the island's inorganic waste output. The goal of the study is to comprehend how efficient waste management helps the island move from a conventional "Smart Island" model to a more sustainable and circular. However, there are inherent limitations to take into account, such as the findings' specificity to Lakshadweep's distinct features, potential temporal constraints resulting from the study's timeline, resource limitations affecting the availability of data, and the subjective nature of evaluating the impacts of tourism. In this study, only municipal waste is taken into account.

### **LITERATURE REVIEW**

Wastes collected in industrial and residential areas are considered urban wastes. If not collected or managed scientifically, they may pose serious threats to health. When it comes to waste management, the islands face specific challenges that frequently lead to more complicated and significant issues than in mainland areas. Additionally, there is not much land available for disposing of waste on many islands. Lack of space can result in overflowing landfills, endangering public health and the environment. Due to their popularity as tourist destinations, islands frequently see an increase in waste generation during the peak season of the year. The influx of tourists might prove excessive for the infrastructure and waste management systems designed for the local population, which could result in more litter and stress on disposal facilities. This at times led to waste being dumped illegally—that is, individuals or businesses discarding waste in places not approved. Concerns about the environment and public health are made worse by this practice [5–8].

The Smart Islands Declaration, which was adopted in June 2020, is now the fundamental document of the Smart Islands Initiative and provides essential direction for tackling the issues that islands confront. In addition to outlining the challenges faced by islands, this extensive proclamation highlights how enormously capable they are of taking the lead in implementing a low-carbon, intelligent, sustainable, and inclusive development paradigm. The Declaration was originally drafted by representatives of European islands and stemmed from discussions at the 1st Smart Islands Forum in June 2016 in Athens, Greece. Islands make a bold call to action in its sections, committing to 10 tactical measures that will help them become successful, inclusive, and smart societies. As a result, the Smart Islands Declaration serves as a guide for equipping islands to successfully negotiate the challenging landscape of sustainable development, promote resilience, and set out on a path towards a more prosperous and connected future. The major points concerned in the declaration directs towards climate

change, smart technologies, renewable energy, e-mobility, zero waste, environmental conservation, sustainable tourism, and citizen empowerment, which redirect towards the concept of circular economy [8–12].

### **CASE STUDY**

Nestled in the heart of the Cetacean Sanctuary and within the Tuscan Archipelago National Park in Italy, Capraia is an exemplary instance of environmentally conscious innovation. For many years, the biodiesel-fueled Enel facility there has effectively supplied energy to both locals and summer visitors. This success gave rise to the Capraia Smart Island project, which involves locals in a collaborative strategy for gradual de-carbonization. Locals actively participate in sustainable practices in construction, agriculture, fishing, tourism, and internal mobility, in addition to energy-related issues. Notably, locals are now farming on the over 100 hectares of former colony terraces, revitalizing agriculture with an emphasis on organic products and environmentally friendly practices. A specialized Working Group comprising the Kyoto Club, ITABIA, Green Chemistry Bionet, and the Institute for Atmospheric Pollution of the CNR (Consiglio Nazionale delle Ricerche) works with professionals from a range of fields, including the DG Energy of the European Commission, to advance this initiative. By offering solutions that have the potential to completely transform services, resource management, and lifestyles, the unified vision aims to link resources to the Smart Island's changing needs. It is evident from the case that biodiesel, which is produced domestically from vegetable oils, animal fats, or recycled restaurant grease, is a renewable and biodegradable fuel. The Renewable Fuel Standard's biomass-based diesel and total advanced biofuel requirements are both satisfied by biodiesel [13–15].

### **DATA ANALYSIS AND FINDINGS**

Lakshadweep is composed of 35 islands with a combined land area of 32 km<sup>2</sup>, an extended sea zone of 7,00,000 km<sup>2</sup>, and an area of approximately 700 km<sup>2</sup> devoted to lagoons surrounded by coral reefs. Based on Census data from India, the population of Lakshadweep was 64,473 in 2011. By 2023, that number is expected to rise to 68,500. Due to its appeal, Lakshadweep observes a large influx of foreign and domestic visitors [16]. The impact of waste generation and tourism is demonstrated by the statistics on tourism.

Inbound tourism to Lakshadweep is seen to have multiplied over the base year and is trending in the direction of a notable increase. This expansion is likely to put a heavy burden on the current service system and infrastructure. According to standard calculations, the amount of waste generated by tourism has nearly tripled in the past 10 years. (as shown in Figure 1).

#### **Present Status of Solid Waste Management (SWM): Generation**

According to the 2021 National Mission of Clean Ganga report, the amount of waste generated for the archipelago of Lakshadweep is 35 tonnes per day (TPD), of which 21 MT is coconut residue and 11.5 MT is household waste and leaf litter. The highest concentration of plastic waste is included in the 2.5MT quantum of non-biodegradable waste.

#### **Solid Waste Management: Collection**

Using twin bins (green and blue), the UT (Union Territory) Administration manages the waste collection process on the island. The green bins, which have a 200-L capacity, are designated to collect biodegradable waste at significant nodes, while the blue bins are designated for non-biodegradable waste. In the Kalpeni area, a total of 29 biogas plant units are operational.

#### **Solid Waste Management: Transportation**

For the management of dry waste, there is a central garbage depository on each of the 10 inhabited islands. The central garbage depository yard, where waste from public spaces is collected for forward linkages, is overseen by the Village Dweep Panchayat (VDP). To move the plastic materials throughout the islands, employees are armed with 12 e-carts, 4 four-wheelers, and 3 three-wheelers in addition to community trash cans for the collection of plastic waste. For the purpose of collecting, sorting, and

transporting waste, casual laborers have been hired in proportion to the population and amount of waste produced in each location.

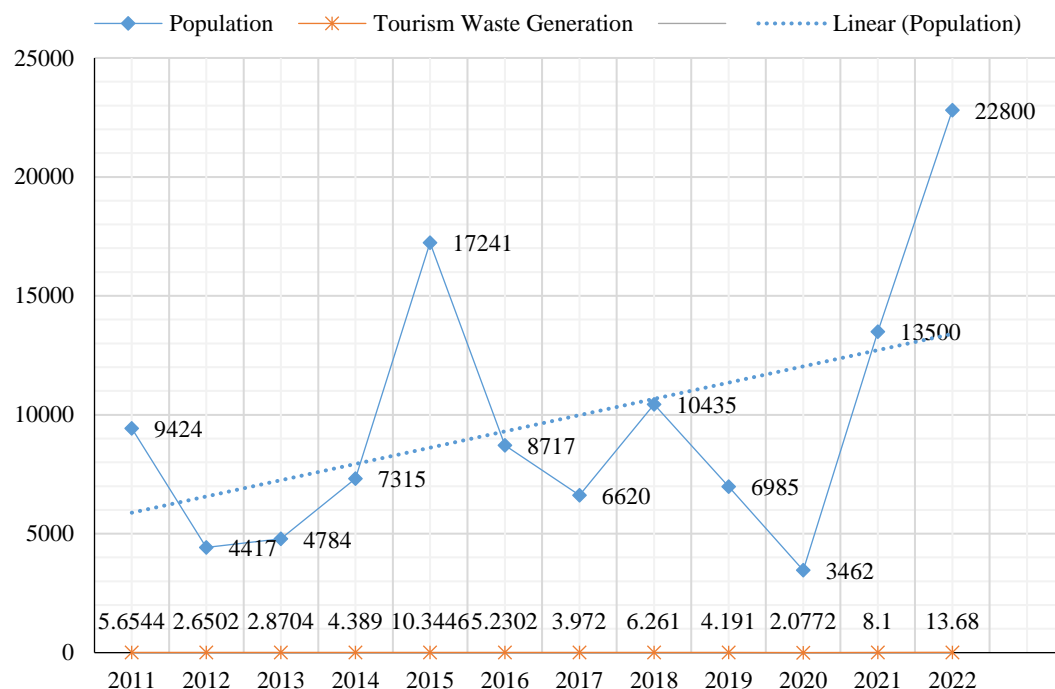


Figure 1. Trends of tourism and waste.

### Solid Waste Management: Treatment

The Thumboor Model compost pits, compound walls, material recovery facilities (MRFs), and incinerators capable of processing 100 kg of municipal solid waste per hour are among the waste processing facilities currently in use. The Kavaratti treatment facility shreds the majority of its produced waste, which is coconut residue, at a rate of 15 kg per hour, 50 kg per hour for plastic bottles, and 250 kg per hour for bio composting machines. Other suggestions for managing municipal solid waste (MSW) include putting incinerators weighing 50 kg and 20 kg on the islands of Kalpeni, Kiltan, Chetlat, Kadmath, Birta, and Bangram. There are no sanitary landfills on the Lakshadweep archipelago. According to the tourism data structure for the study years 2015 and 2022, it is evident that there has been a significant increase in tourism, which indicates that waste generation will rise significantly. The tourism sector is the largest producer of inorganic waste, which includes plastics, cells, packed water bottles, and other materials. A key strategy to manage solid waste in a more orderly and beneficial way is through the circular economy. The study suggests the essential elements for creating a solid waste management system that is circular economy-driven. Reduce, reuse, recycle, and recover are the four ‘R’s that are highlighted by the circular economy framework.

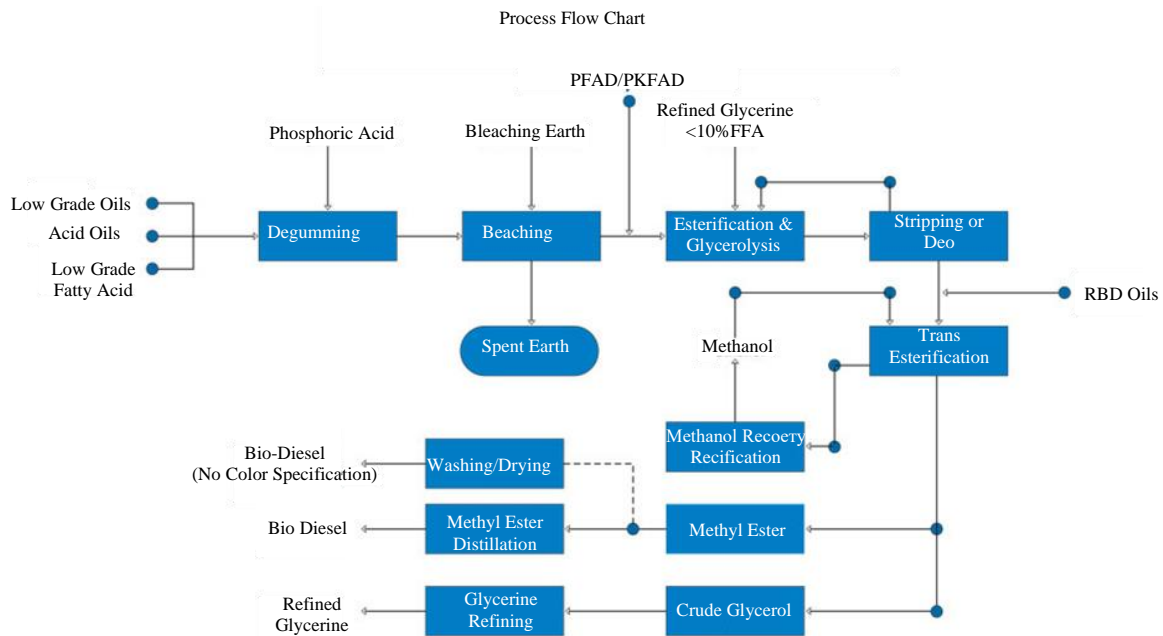
### ROLE OF BIODIESEL AS A RENEWABLE STANDARD FUEL

According to Capraia case, biodiesel can be used interchangeably with petroleum-based diesel in a number of different applications. It is mostly used in diesel engine cars for mixing with petro-diesel for combustion. In the past 10 years, conventional diesel and biodiesel that complies with aviation fuel regulations have been used to power airplanes and oceangoing ships and liners. Moreover, biodiesel is used in power generators. A variety of backup power generation systems are built to accept biodiesel as a dependable and environmentally friendly fuel source.

### Production of Biodiesel

The biodiesel sector strives to operate with zero discharge. In a biodiesel manufacturing or processing plant, methyl or ethyl groups are added to the aliphatic chains of vegetable or animal fats to give them

diesel-like qualities. This process is known as biodiesel processing. In order to do this, lipids (such as vegetable oil, fatty acids, animal fat, and leftover cooking oil) and alcohol (methyl/ethyl) are chemically reacted to produce fatty acid esters. This process can be carried out in a *jatropha*, *karanja*, *mahua*, enzymatic, continuous stirred tank reactor, or Multifeedstock B100 Biofuel Plant (Figure 2).



**Figure 2.** Biodiesel production flowchart. *Source:* Mectech India.

## CONCLUSION

Addressing the high waste production on islands like Lakshadweep requires comprehensive and sustainable strategies. This study demonstrates the significance of transitioning from "smart islands" to "circular islands" by leveraging solid waste management to enhance tourism and adhere to circular economy principles. By redefining waste as a valuable resource, the proposed waste management strategy focuses on the principles of reduce, reuse, recycle, and recover. The current MSW management practices in Lakshadweep face challenges such as the absence of sanitary landfills and increased waste generation from tourism. Drawing inspiration from the Capraia Smart Island initiative, the study suggests incorporating biodiesel production from waste as a renewable fuel solution. This approach not only supports the circular economy but also aligns with the Smart Islands Declaration's objectives, addressing climate change, smart technologies, renewable energy, zero waste, and sustainable tourism. Implementing decentralized biodiesel production on the 10 inhabited islands of Lakshadweep can significantly reduce the need for waste transport over vessels, mitigate the risk of waste spillage into the sea, and minimize open incineration. This strategy contributes to waste-to-energy conversion, promoting environmental conservation, and citizen empowerment. Fostering responsible consumption and reducing single-use products are vital steps toward resilient and sustainable waste management on islands. By adopting these innovative approaches, Lakshadweep can successfully transition from "smart islands" to "circular islands," ensuring a sustainable and prosperous future for its communities and ecosystems.

## Recommendation

Addressing the issue of high waste production in islands requires comprehensive strategies that consider the unique challenges posed by their geographical, environmental, and economic contexts. Implementing sustainable waste management practices, promoting recycling initiatives, and raising awareness among residents and visitors are crucial steps toward mitigating the impact of excessive waste on islands. Production of biodiesel will not only contribute towards the concept of circular

economy but will provide a clean alternative to address the rising tourism load. This, brings the study to a conclusion that the present mechanism of waste management could be augmented and the central garbage depository for biodiesel production in 10 inhabited islands, which will act as a decentralized node for waste collection and treatment and this will result in less or now raw waste transport over vessel which may lead to spillage of waste into water and also address the issue of open incineration and this can be tapped down to produce waste to energy which will address the points of climate change, smart technologies, renewable energy, e-mobility, zero waste, environmental conservation, sustainable tourism, and citizen empowerment as mentioned in the Smart Islands Declaration and help Lakshadweep to achieve "smart islands" to "circular islands" status. Additionally, fostering a culture of responsible consumption and reducing reliance on single-use items can contribute to a more sustainable and resilient waste management system on islands.

## REFERENCES

1. Grameen. Towards a Swachh and Swasth Bharat by 2025. [Online]. February 6, 2023. Available at <https://sbmgramin.wordpress.com/2023/02/06/all-lakshadweep-villages-have-achieved-model-odf-plus-status/>
2. Amasuomo E, Baird J. The concept of waste and waste management. *J Manage Sustain*. 2016; 6 (4): 88–96. doi: 10.5539/jms.v6n4p88.
3. Monni M. Capraia Smart Island, a circular economy model. *Mondo Machina / Machinery World*. July–September 2017. Available at <https://www.mondomacchina.it/en/capraia-smart-island-circular-economy-model-c1796>
4. Lakshadweep Pollution Control Committee. National Mission for Clean Ganga. Monthly progress report in the NGT matter OA. March 2, 2022. Available at <https://sbmgramin.wordpress.com/2023/02/06/all-lakshadweep-villages-have-achieved-model-odf-plus-status/>
5. Smart Island Declaration. 10 action points towards becoming smart, inclusive and thriving societies. [Online.]. n.d. Available at <https://www.smartislandsinitiative.eu/en/declaration.php>
6. Duval M. Switching from "smart islands" to "circular islands"...and how it could inspire major corporations and cities. Greater Paris Metropolitan Region. August 20, 2023. Available at <https://www.linkedin.com/pulse/switching-from-smart-islands-circular-islandsand-how-could-duval>
7. Kumar Metal Industries. Biodiesel: applications. [Online]. 2023. Available at <https://www.kumarmetal.com/biodiesel-applications>
8. India Environment Portal. Report filed by the Union Territory of Lakshadweep regarding compliance of Municipal Solid Waste Management Rules, 2016. [Online]. November 15, 2022. Available at <http://www.indiaenvironmentportal.org.in/content/473979/report-filed-by-the-union-territory-of-lakshadweep-regarding-compliance-of-municipal-solid-waste-management-rules-2016-15112022/>
9. UN Environment Programme. Island Nations Get New Lifeline to Beat Pollution. Geneva, Switzerland: UN Environment Programme; 2022. Available at <https://www.unep.org/news-and-stories/press-release/island-nations-get-new-lifeline-beat-pollution>
10. Romano SD, Sorichetti PA. . Introduction to biodiesel production. In: *Dielectric Spectroscopy in Biodiesel Production and Characterization*. Green Energy and Technology. London, UK: Springer; 2010. pp. 7–27.
11. UT Administration of Lakshadweep. [Online]. Available at <https://lakshadweep.gov.in/tourism/>
12. Capraia Smart Island Project [Online]. Available at <https://www.capraiasmartisland.it/>
13. International Air Transport Association (IATA). Environmental initiatives [Online]. Available at <https://www.iata.org/en/programs/environment/>
14. National Mission for Clean Ganga. Annual report on waste generation in Lakshadweep. Ministry of Environment, Forest and Climate Change, Government of India; 2021.
15. Smart Islands Declaration. [Online]. 2020. Available at <https://www.smartislands.eu/>
16. United Nations World Tourism Organization (UNWTO). Sustainable Tourism. [Online]. n.d. Available at <https://www.unwto.org/sustainable-development>