# METHODOLOGY FOR ASSESSING THE TOURISM CARRYING CAPACITY OF ESTUARINE ECOSYSTEMS: A CASE OF KOCHI

Submitted to the Indian Institute of Technology Kharagpur
for the partial fulfilment of the degree

*of*

**MASTER OF CITY PLANNING**

*by*


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April, 2025

# CERTIFICATE

This is to certify that the thesis entitled **Methodology for assessing the Tourism Carrying Capacity of Estuarine Ecosystems : A Case of Kochi**, submitted by Tushita Basak to the Indian Institute of Technology Kharagpur, is a bona fide research work to the best of our knowledge. The thesis has been accepted by the external examiners and we consider it worthy of consideration for the award of the degree of Master of City Planning of the Institute.

| | |
|---|---|
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# DECLARATION

I certify that the work contained in this report titled '**Methodology for assessing the Tourism Carrying Capacity of Estuarine Ecosystems : A Case of Kochi**' is done by me under the guidance of my supervisor Prof. (Dr.) Subrata Chattopadhyay. The work has not been submitted by me or any other student in any other institute for any degree or diploma. I have confirmed to the norms and guidelines given in the ethical code of conduct of the institute.

All the material (data, theoretical analysis, figures, tables, and texts) that have been used from other sources are given due credit by citing them in the text of the report and giving their details in the references to the best of my knowledge.

_____

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# ACKNOWLEDGEMENT

The work presented in this thesis would not have been possible without the support of many on the way and I take this opportunity to thank all the people who made it possible for me to pursue this body of work.

First and foremost, I would like to thank my guide Professor (Dr.) Subrata Chattopadhyay for the time that he put in this project. I never could have managed to bring together my vision and efforts if it wasn't for him. His suggestions have contributed in shaping this project immensely. I would further like to thank professors at ARP department for their time and valuable inputs throughout the year and the staff of ARP department for their assistance at every stage.

I would like to extend my deepest gratitude to the staff of the District Tourism Promotion Council (DTPC), Ernakumlam, and the officers of the Statistics Wing of Kerala Tourism for generously sharing crucial data and patiently assisting me throughout the research process. I am also thankful to the Information Officers of Kerala Tourism, whose inputs greatly enriched the context of this study.

My heartfelt thanks go to Mr. Jojo T.D from ATREE for his guidance and thoughtful engagement at every step. I am also grateful to the Kottayam Nature Society for their support and encouragement.

A special note of appreciation is due to the many local tour operators and residents who took the time to share their experiences and perspectives. Their willingness to engage in meaningful conversations has added depth and authenticity to this research.

This work is a reflection of the collective effort, wisdom, and kindness extended to me, and I remain sincerely thankful to all who contributed to it.

# ABSTRACT

The Vembanad estuary, one of the largest and most ecologically significant wetland systems in India, supports a diverse range of livelihoods and is a key attraction within Kerala's tourism landscape. This thesis explores the multifaceted dynamics of tourism in the Vembanad region, aiming to situate its tourism activity within the broader ecological, socio-cultural, and economic context. By examining existing tourism patterns, stakeholder perspectives, and regional planning frameworks, the study identifies both the opportunities and constraints that influence sustainable tourism development in the wetland region.

Central to this research is the development of a methodology to assess tourism carrying capacity—an essential tool for balancing ecological integrity with tourism growth. The proposed framework integrates environmental sensitivity, infrastructure capacity, visitor experience, and community well-being, offering a nuanced approach tailored to the specific conditions of the Vembanad ecosystem. Through a combination of spatial analysis, field surveys, and stakeholder engagement, the study provides insights that can inform responsible tourism planning and policy-making in estuarine contexts.

**Keywords:** Vembanad estuary, tourism carrying capacity, sustainable tourism, estuarine ecosystems, Kerala, spatial analysis, stakeholder engagement, environmental planning, regional tourism, wetland tourism

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# 1 INTRODUCTION

Tourism is a billion-dollar industry today, contributing to nearly 9.1% of the global GDP in the year 2023 as per the Economic Impact Report (WTTC, 2019). This thesis intends to explore the impact of tourism on the Vembanad Wetland region and its people, identify key challenges and propose planning interventions that can foster sustainable tourism development in the region without compromising its ecological integrity.

## 1.1 BACKGROUND

### 1.1.1 TOURISM IN INDIA

The tourism industry in India has experienced remarkable growth over the last couple of decades. This expansion can be attributed to several factors, including government initiatives like *Dekho Apna Desh* and the *Swadesh Darshan* schemes alongside the growing demand for authentic and culturally immersive travel experiences. This has shifted the tourism epicentres from iconic destinations and urban centres to lesser-known destinations, smaller cities and even rural areas. The objective is to provide tourists with niche tourism experiences often linked to heritage, wellness, ecotourism and adventure. Click or tap here to enter text. The changing dynamics in Indian tourism has largely integrated isolated destinations into themed regional tourism circuits.

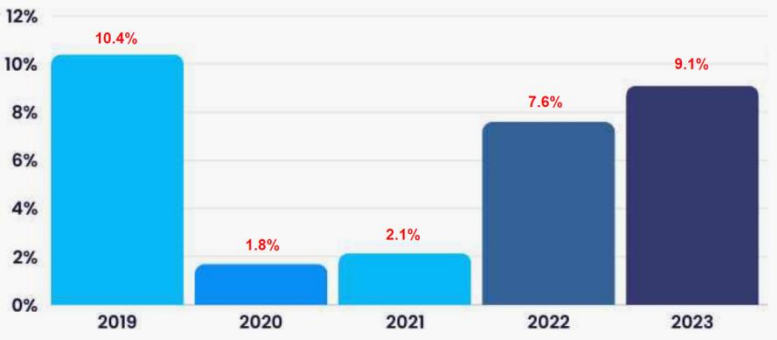



**FIGURE 1: GLOBAL TOURISM CONTRIBUTION TO GDP**

*Source: WTTC*

### 1.1.2 TOURISM IN THE VEMBANAD

The Vembanad-Kol wetland system forms a considerable portion of the floodplains of Kerala. Designated as a Wetland of International Importance (Ramsar Site) under the Ramsar Convention in 2002, it is undoubtedly one of the largest wetland systems on the southwestern coast on India. The ecotourism circuit along the backwaters of the wetland

is one of the most sought-after experiences in India, attracting tourists to its serene waterways, lush landscapes and cultural richness. The three significant stops along this circuit are Kochi, Alappuzha and Kumarakom, each with its own unique selling points.

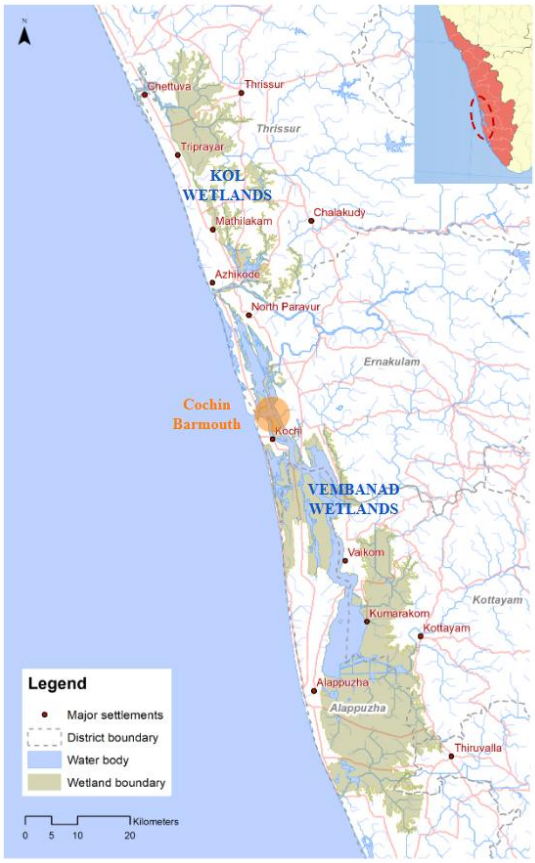



**FIGURE 2: THE VEMBANAD WETLANDS**

*Source: Author*

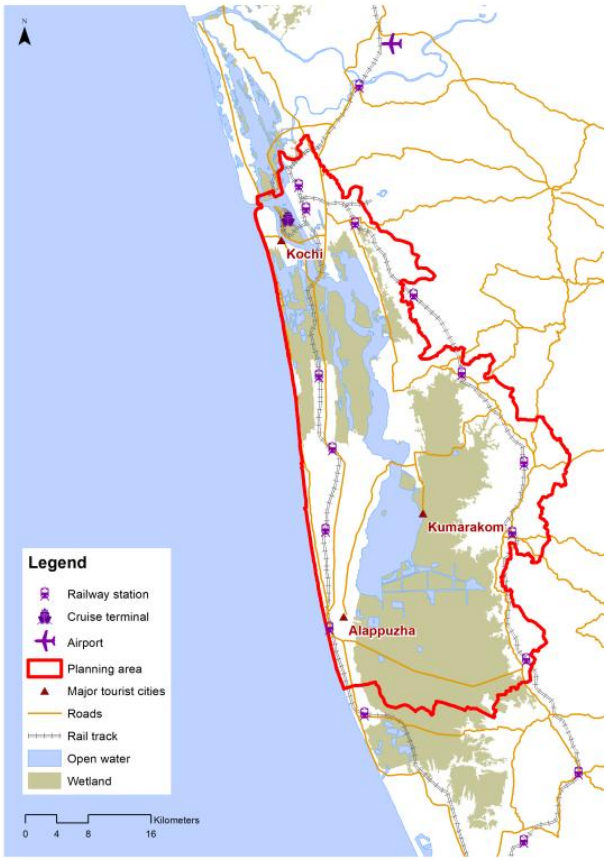



**FIGURE 3: THE DELINEATED STUDY AREA**

*Source: Author*

## 1.2 ISSUES

The rising pressures of tourism activities in the Vembanad has put immense pressure on the fragile environment of the estuarine ecosystem. Enumerated below are some of the pressing issues arising due to unplanned expansion of tourism:

1) Water pollution
2) Habitat destruction
3) Solid waste and plastic pollution
4) Disturbance to marine life
5) Limited carrying capacity

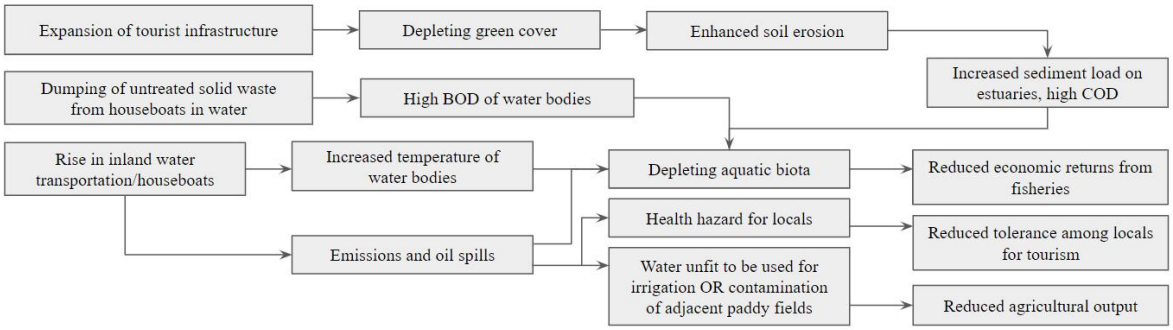



**FIGURE 4: IMPACT OF TOURISM ON WETLANDS**

*Source: Author*

## 1.3 AIM AND OBJECTIVES

This thesis aims to formulate the best-fit policy and planning interventions for the long-term sustainable growth of tourism in the Vembanad Wetlands by resolving the conflict between tourism development and its ecological limitations.

The objectives of thesis are as follows:

1) To identify the nature, extent and indicators of tourism development in the ecological context of estuarine ecosystems.
2) To analyze the tourism carrying capacity of the region and establish the strained and underdeveloped pockets.
3) To propose corrective measures that relieve strained systems and promote development of underdeveloped aspects of tourism.

## 1.4 SCOPE

The study will broadly explore the following aspects:

1) Present an overview of the Vembanad region and its current tourism scenario.
2) Establish a framework to assess the region's tourism carrying capacity.
3) Propose interventions for sustainable tourism development in the wetlands.

## 1.5 LIMITATIONS

While this thesis aims to provide a comprehensive analysis of the impact of tourism on the wetlands, there are several limitations that may affect the scope and depth of the findings:

1) Longitudinal surveys which could provide a deeper understanding of seasonal and long-term variations could not be conducted due to time and resource constraints.
1) Non-availability of current and localized data points of certain parameters.

## 1.6 METHODOLOGY

A five-step methodology has been followed in the study to reach the desired aim. The figure below shows the basic workflow followed during the study and the different tasks involved at each stage.


**FIGURE 5: RESEARCH METHODOLOGY**

*Source: Author*

# 2 LITERATURE REVIEW

This chapter includes both literature reviews and case studies. Various research papers and case studies have been reviewed to understand the different tools and techniques required for achieving the outlined objectives of this study.

## 2.1 TOURISM CARRYING CAPACITY

United Nations World Tourism Organization (UNWTO, 2018) defined tourism carrying capacity as the maximum number of people that may visit a tourist destination at the same time, without causing destruction of the physical, economic and sociocultural environment and an unacceptable decrease in the quality of visitors' satisfaction.

### 2.1.1 EVALUATION APPROACHES

The are multiples approaches by which Tourism Carrying Capacity (TCC) of a destination can be calculated. The following table list the different evaluation approaches of TCC, their objectives and limitations (Pásková et al., 2021):

**TABLE 1: EVALUATION APPROACHES OF TCC**

| Static TCC Concept | Limits of Acceptable Change (LAC) | Visitor Optimisation | System Dynamic |
|---|---|---|---|
| **Establish maximum limits on the basis of the regenerative capacity of the destination's social and ecological systems** | Establish limits considering the needs of stakeholders and their perceived acceptable level of adverse changes | Determine optimal use of destination resources as a compromise between sub-optimal visitation and maximizing benefits | A complex and adaptive system of the destination that captures the key processes including links between tourism, nature and stakeholders |

*Source: Author*

### 2.1.2 ASSESSMENT DIMENSIONS

The impact factors of tourism can be broadly categorized into five dimensions as follows:

**TABLE 2: INDICATOR DIMENSIONS**

| Perspective | Name of Methodology | Analysis frameworks |
|---|---|---|
| ***Resources*** **Limits of space and infrastructure** | Physical/facility carrying capacity | PCC (Physical Carrying Capacity) RCC (Real Carrying Capacity) |

| Perspective | Name of Methodology | Analysis frameworks |
|---|---|---|
| ***Experience*** **Dissatisfaction to tourists and stakeholders** | Psycho-social carrying capacity | Informal Interviews (Likert Scale)<br>Social Cost-Benefit Analysis<br>LAC framework |
| ***Finance*** **Overall economic benefits/ losses** | Economic carrying capacity | Visitor spending surveys<br>Economic base models<br>Cost- Benefit analysis |
| ***Ecology*** **Negative impact on environment** | Environmental carrying capacity | Driver-Pressure-State-Impact-Response (DPSIR) Model |
| ***Management*** **Disruption of regulations, law and order** | Administrative/political carrying capacity | ECC (Effective Carrying Capacity) |

*Source: Author*

### 2.1.3 CARRYING CAPACITY ASSESSMENT VARIABLES

The carrying capacity in a destination is captured through predominantly two types of variables (ESPON, 2020):

1) Pressure factors (Pi) – Quantifies the stress on the region due to limited resources and growing footprint
2) Support factors (Si) – Quantifies the resilience of the region to absorb the mounting demand for resources

$$P_i = \sum_{j=1}^{n} P'_{ij}\, w_j^p \quad \text{.....(1)}$$

$$S_i = \sum_{j=1}^{n} S'_{ij}\, w_j^s \quad \text{.....(2)}$$

where, $S'_{ij}$ and $P'_{ij}$ are the normalized values of the jth support and pressure indicator for ith city in the region, respectively. Also, $w_j^p$ and $w_j^s$ are the weights of the support and pressure indicators.

## 2.2 CASE STUDIES

The case studies area selected with the purpose of understanding the predominant challenges to tourism development in estuarine areas and identify best practices in planning and management of tourism. The theoretical concepts derived from the literature study form the backdrop of the analysis of the individual cases to some extent.

## 2.2.1 SELECTION CRITERIA

The selection process ensured that, as far as possible, the cases exhibited surface similarities with area under study. The case studies have been thus selected with emphasis on the following criteria:

1) Similar ecological context
2) Varying stages of tourism development
3) Different cultural and socio-economic backgrounds
4) Reflect diverse approaches to tourism planning

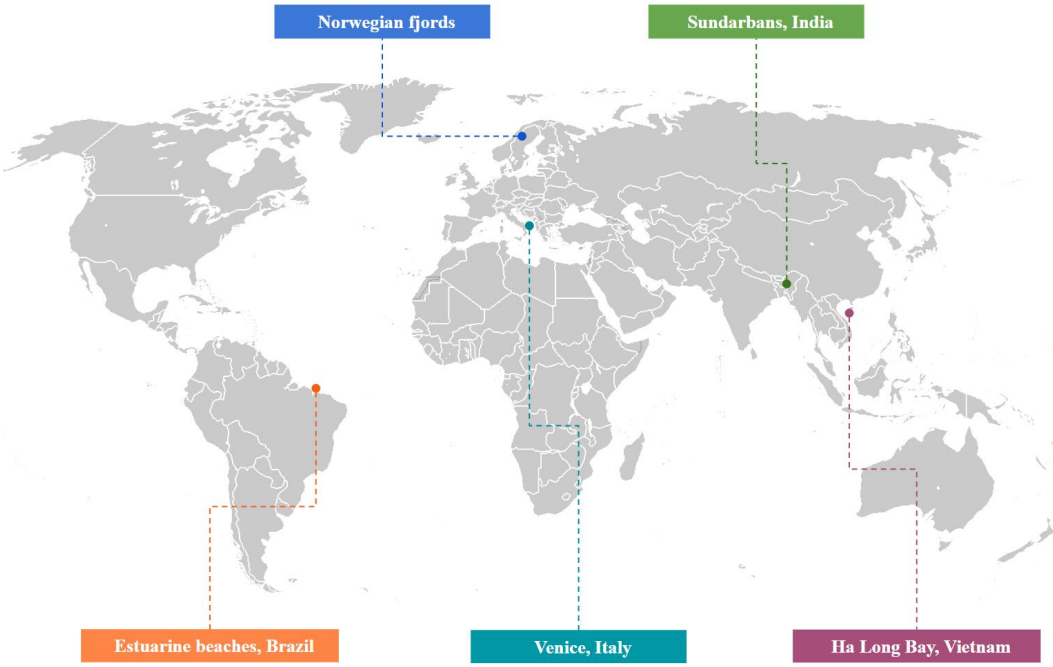



**FIGURE 6: SELECTED CASE STUDIES**

*Source: Author*

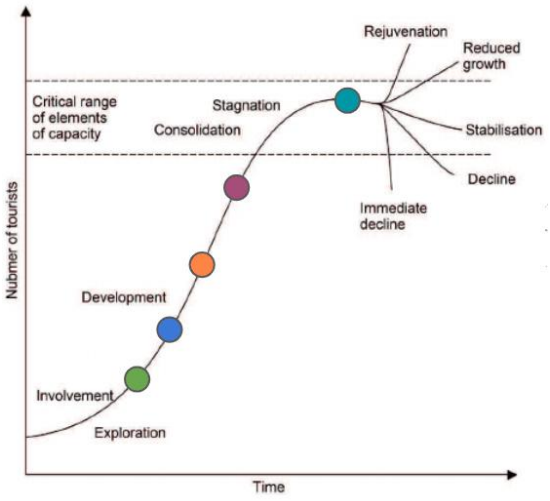



**FIGURE 7: TALC STAGE OF CASE STUDY AREAS**

*Source: Author*

## 2.2.2 COMPARATIVE ANALYSIS

**TABLE 3: COMPARATIVE ANALYSIS OF CASE STUDIES**

| Parameter | Venice, Italy | Ha Long Bay, Vietnam | Estuarine Beaches, Brazil | Norwegian Fjords | Sundarbans, India |
|---|---|---|---|---|---|
| ***Tourists*** | ~ 8 million (annual) | ~6 million (annual) | ~5 million (annual) | ~2 million (annual) | ~1 million (annual) |
| ***Type of Estuary*** | Lagoonal estuary (Venetian estuary) | Karst estuary (formed by limestone formations) | Estuarine beaches (formed where river meets ocean) | Glacial fjords (formed by submerged valleys) | Tidal estuary (confluence of Ganges and Brahmaputra) |
| ***Tourist Infrastructure*** | Highly developed: diverse accommodation facilities | Well-developed: boat cruises, hotels, eco-lodges | Moderately developed: beach resorts, basic amenities | Well-developed: cruises, hotels, ports, scenic tours | Underdeveloped : eco-lodges, boat tours, basic facilities |
| ***Stage of Tourism*** | Stagnation: post-maturity | Consolidation : nearing maturity | Development: expanding | Development: steady growth | Involvement: potential underdeveloped |
| ***Limiting Dimension*** | Social carrying capacity | Ecological carrying capacity | Physical carrying capacity | Economic carrying capacity | Administrative carrying capacity |
| ***Challenges*** | Overtourism, gentrification | Pollution, coral destruction | Lack of accessibility | High-cost market | Human-wildlife conflict |
| ***Intervention to boost tourism*** | - Diversification of accommodation facilities<br>- Affordable mode of arrival New tourism products | - Opening up new islands to reduce pressure on hotspots<br>- Developing new tourist urban centres | - Improving accessibility to underdeveloped beaches to reduce pressure on hotspots | - Government subsidies to promote development of tourist enterprises | - Voluntourism<br>- Development of community-based tourism projects |
| ***Intervention to manage tourism*** | - Limiting the size of tourist groups<br>- Tourism fee, lower in off-seasons to distribute tourism throughout the year<br>- Cruise liners exceeding 25,000 tons have been prohibited from entry | - Restrictions on building in environmentally sensitive areas.<br>- Limiting visitor numbers during peak seasons to reduce overcrowding. | - Tourists and private companies have to pay an<br>- Environmental Preservation Fee (TPA) for maintenance of the ecosystem | - Imposition of stricter regulations on the number of boats allowed<br>- Limitation of tourist activity in protected marine zones<br>- Visitor caps during peak periods | - Incentives for entrepreneurship<br>- Increase access/entry routes to the region<br>- Livelihood clusters for skill development |

*Source: Author*

# 3 BASELINE ANALYSIS

This section deals with the analyses of the present situation of the study area pertaining to the current status of the host population and development of tourism in the region. This information was finally utilized to formulate the tourism carrying capacity, which may exist at the horizon year.

## 3.1 STUDY AREA DELINEATION

The delineation of focus area for the study has been done based on a careful understanding of the existing scenario. The spatial layers utilised to arrive at the study area are as follows:

1) Road infrastructure
2) Administrative jurisdiction
3) Wetland based livelihoods
4) Major tourist towns
5) Topography

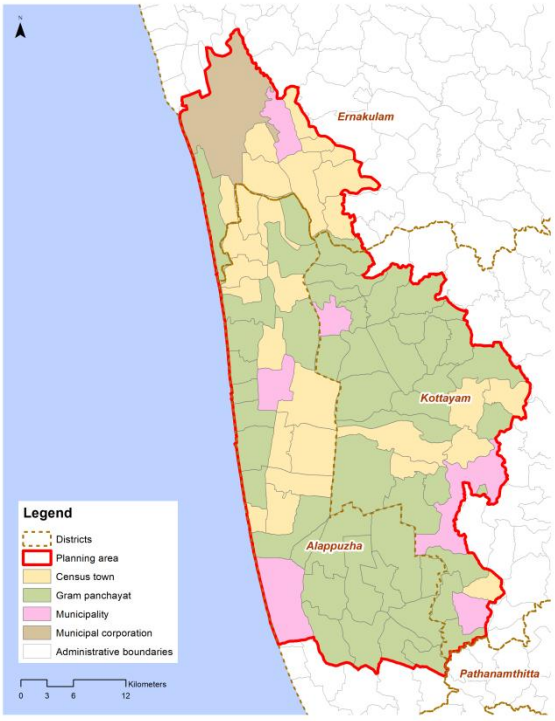



**FIGURE 8: ADMINISTRATIVE JURISDICTION MAP**

*Source: Author*


**FIGURE 9: LAYOUT OF MAJOR ROADS**

*Source: Author*

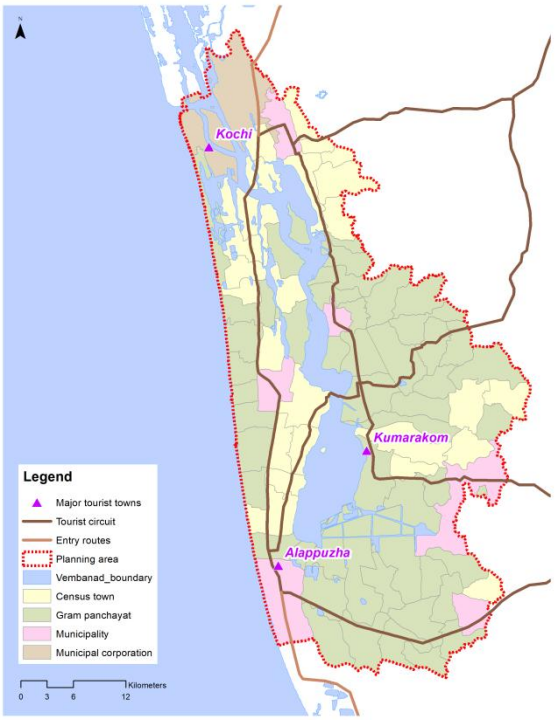



**FIGURE 10: MAJOR TOURIST TOWNS**

*Source: Author*

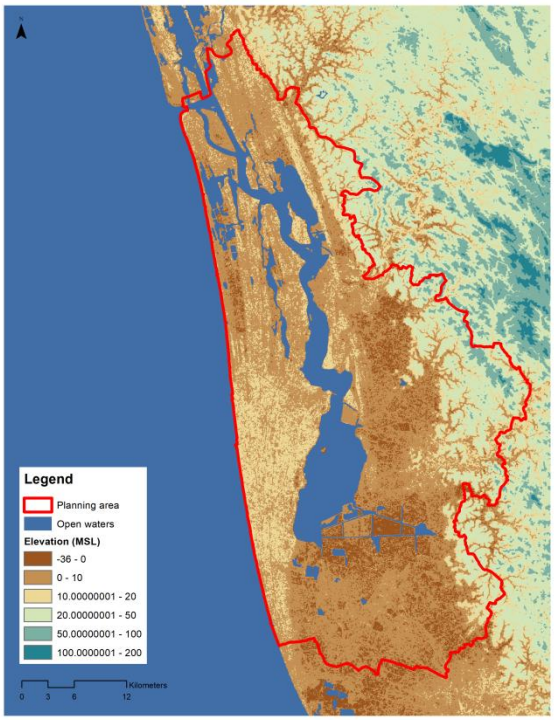



**FIGURE 11: TOPOGRAPHY MAP**

*Source: Author*

## 3.2 REGIONAL CONNECTIVITY

Regional connectivity in the area is facilitated through a combination of air, road and water-based transportation networks. Despite these, there is limited integration between the various transport modes and seasonal disruptions due to flooding continue to affect seamless regional mobility.

***Air connectivity***

The primary entry point is the Cochin International Airport, located approximately 30 km from Kochi. It is a major international and domestic hub, providing connectivity to key cities across India and abroad, especially the Middle East and Southeast Asia.

***Road connectivity***

Road connectivity is supported by major highways NH 66 and NH 183. Public and private bus services ensure frequent and affordable travel.

***Major waterways***

An extensive inland waterway network with National Waterway 3 (NW 3) traverses through the Vembanad lake and its kayals. Public ferries, houseboats, and traditional canoes ply these waters, supporting both daily commutes and tourism activities.

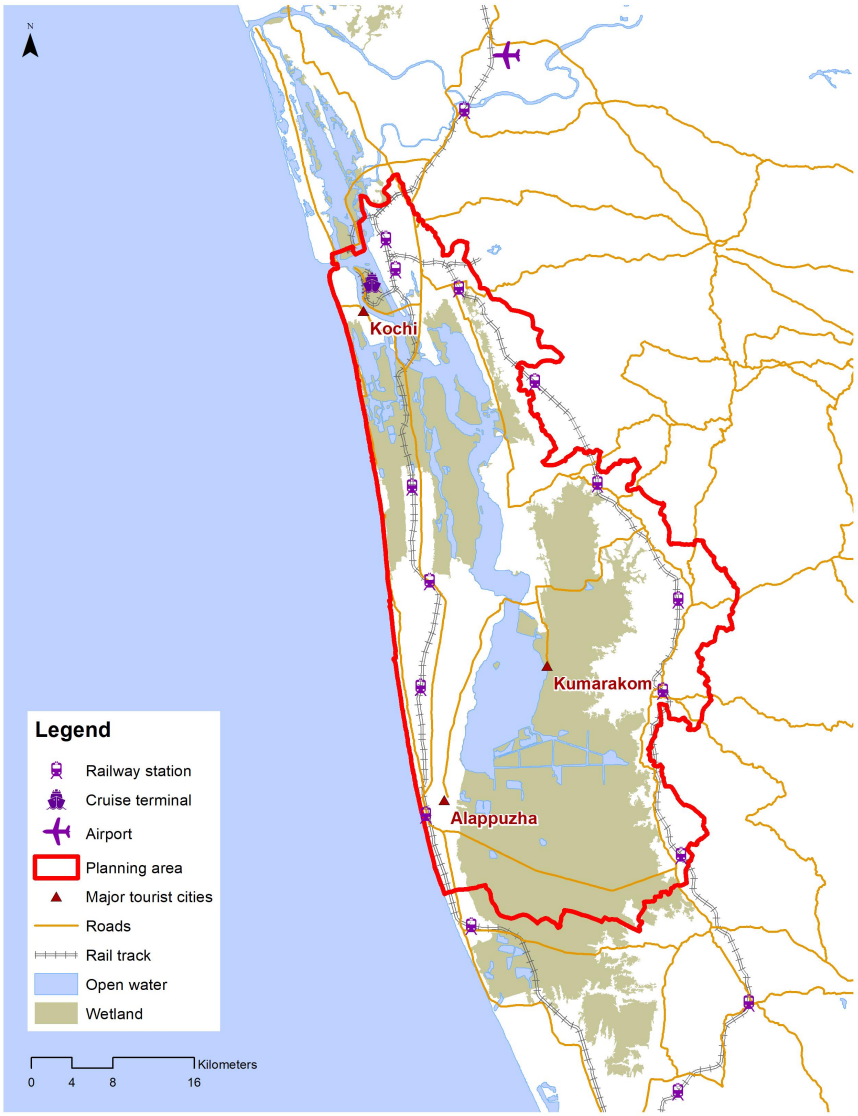



**FIGURE 12: REGIONAL CONNECTIVITY MAP**

*Source: Author*

## 3.3 DEMOGRAPHY

The population comprises a mix of urban and rural communities, with livelihoods primarily rooted in agriculture, fishing, coir processing, and tourism-related services.Literacy rates are high, in line with Kerala's overall human development indicators, and women's participation in community-based tourism and local governance is notable.

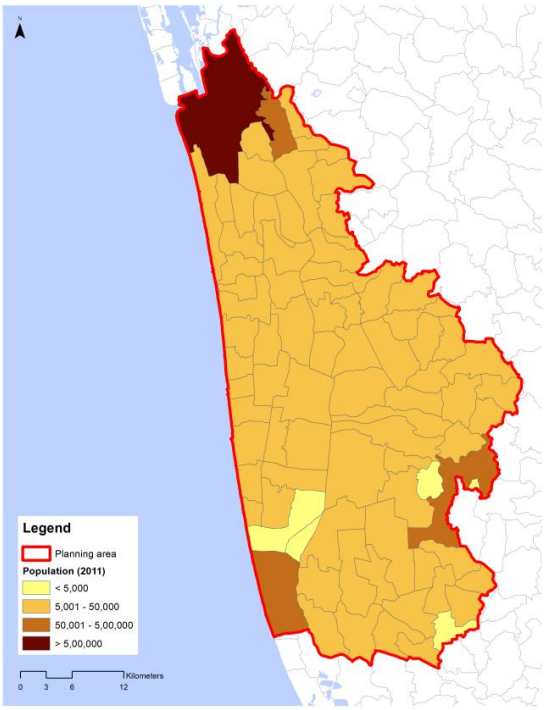



**FIGURE 13: POPULATION DISTRIBUTION (2011)**

*Source: Author*

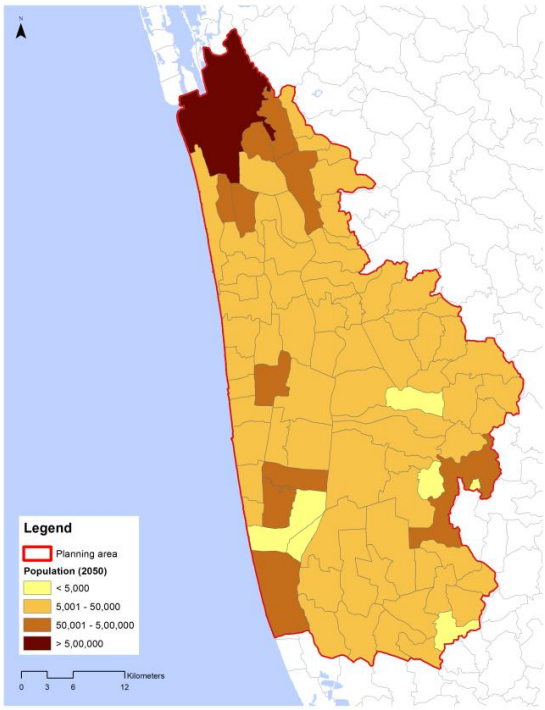



**FIGURE 14: PROJECTED POPULATION (2050)**

*Source: Author*

## 3.4 WETLAND HYDROLOGY

The Vembanad Lake catchment is nourished by a network of major west-flowing rivers that originate from the Western Ghats and drain into the lake, playing a critical role in maintaining its ecological balance and hydrological dynamics. Prominent among these rivers are the Periyar, Meenachil, Pamba, and Muvattupuzha, each contributing significant freshwater inflows that support the lake's estuarine character. These rivers traverse diverse landscapes—from forested highlands to fertile midlands and densely populated lowlands—carrying not just water but also sediments and nutrients essential for the productivity of the Vembanad wetland system. Their seasonal flows influence salinity gradients, fish breeding cycles, and the health of paddy fields, especially in the Kuttanad region. However, increasing upstream interventions such as dams, sand mining, and pollution are altering their natural regimes, posing challenges to the sustainability of the lake and its dependent ecosystems. Together, these rivers form the lifelines of the Vembanad catchment, linking the highlands to the coast in a fragile but vital hydrological continuum.


**FIGURE 15: MAJOR RIVERS AND DRAINAGE BASINS OF THE VEMBANAD CATCHMENT**

*Source : Author*

The monsoon flow dominates in all four rivers, contributing between 84–91% of the annual streamflow, confirming the heavy seasonal dependency. The non-monsoon contribution is relatively higher in Muvattupuzha (over 20%), which suggests this river maintains better year-round flow, potentially due to better base flow or catchment characteristics.

**TABLE 4: DISCHARGE DATA OF RIVER BASINS DRAINING TO VEMBANAD**

| River Basin | Area (km²) | Stream Gauge Station | Stream Flow (Mm³) - Average Annual | Stream Flow (Mm³) - Monsoon | Stream Flow (Mm³) - Non-Monsoon |
|---|---|---|---|---|---|
| **Periyar** | 5411.07 | Neeleswaram | 7266 | 6440 | 526 |
| **Muvattupuzha** | 2011.16 | Ramamangalam | 4791 | 3799 | 992 |
| **Meenachil** | 859.58 | Kidangoor | 1988 | 1668 | 160 |
| **Pamba** | 2180.38 | Malakkara | 4067 | 3592 | 475 |
| **Periyar** | 5411.07 | Neeleswaram | 7266 | 6440 | 526 |
| **Muvattupuzha** | 2011.16 | Ramamangalam | 4791 | 3799 | 992 |
| **Meenachil** | 859.58 | Kidangoor | 1988 | 1668 | 160 |

*Source : Central Water Commission*

Seasonality is evident — all rivers show a sharp increase in discharge from May to June, peaking during July or August, typical of the Southwest Monsoon period. Peak discharge occurs in July, especially for Periyar, which touches nearly 1800 MCM. Other rivers also peak in the same month but with comparatively lower magnitudes. Rapid decline post-monsoon: The streamflows decrease significantly by October, indicating reduced rainfall and runoff. Low flow from January to April, consistent with dry season conditions. Periyar consistently shows the highest discharge across all months, aligning with the large catchment and higher rainfall capture. Meenachil has the flattest curve, denoting a smaller basin with lesser flow variability and overall discharge.

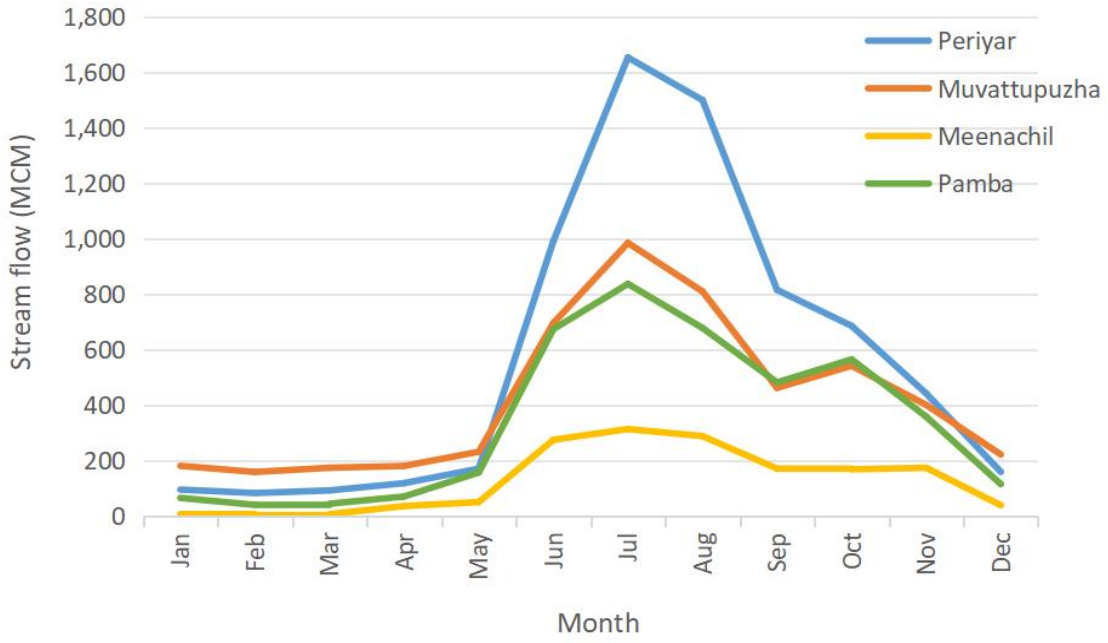



**FIGURE 16: MONTHLY AVERAGE RIVER DISCHARGE**

*Source: Central Water Commission*

## 3.5 LANDUSE

The Vembanad region has witnessed significant Land Use Land Cover (LULC) changes over the past few decades, largely driven by human interventions and environmental pressures. Traditionally dominated by extensive paddy fields and wetland ecosystems, the landscape has gradually shifted toward more fragmented agricultural patterns, expansion of settlement areas, and increased plantation cropping. Urbanization pressures along the coastal belt and the growth of tourism infrastructure have further transformed parts of the wetland margins.

### 3.5.1 LULC CHANGE WITHIN CATCHMENT AREA

Vegetative Cover shows a slight decrease from 65.95% in 2017 to 58.58% in 2023, indicating a trend of gradual degradation or conversion to other land uses. Built-up area shows a consistent increase, rising from 10.78% in 2017 to 25.95% in 2023, reflecting rapid urbanization and infrastructure expansion within the catchment.

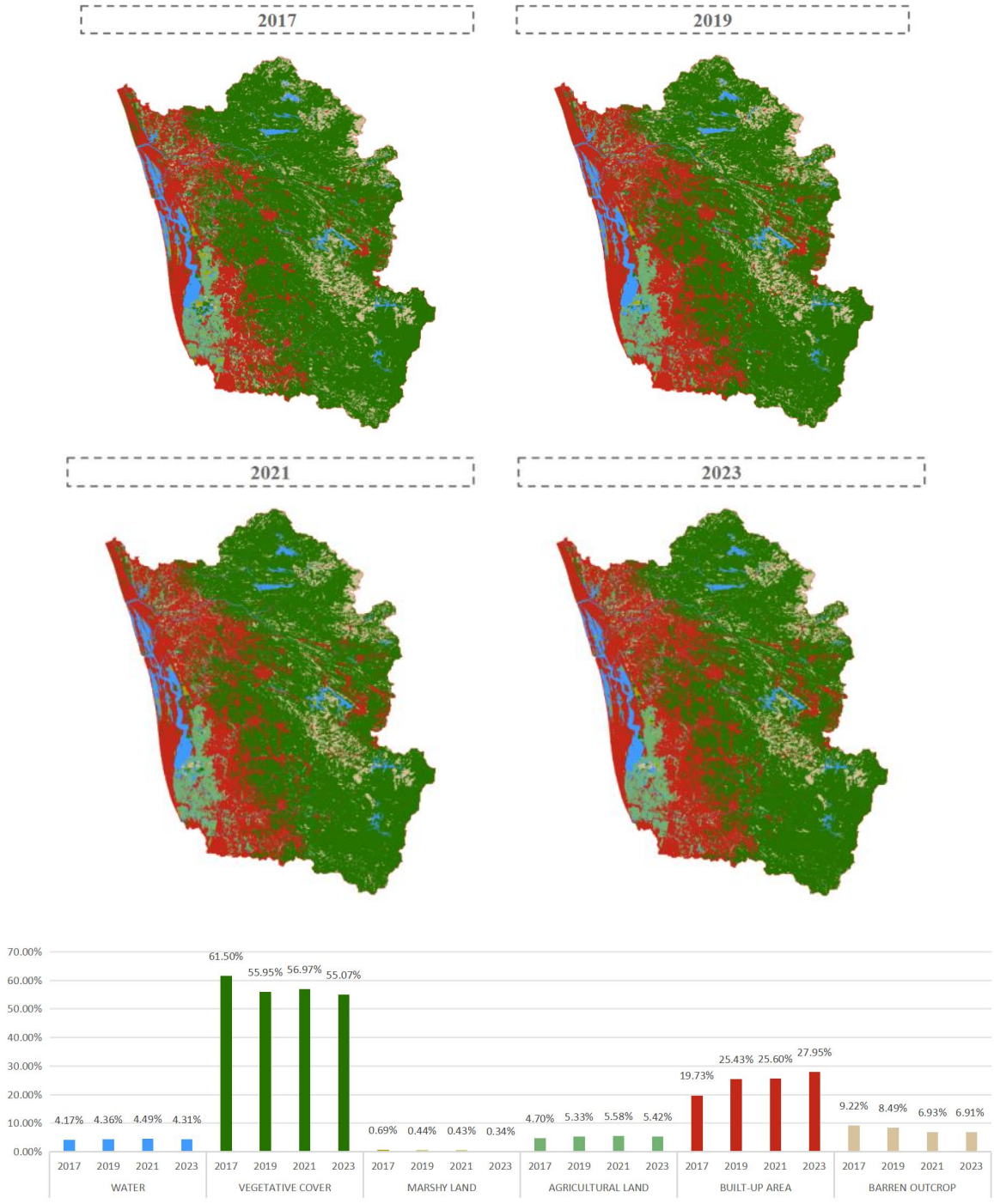



**FIGURE 17: LULC CHANGES IN THE VEMBANAD CATCHMENT**

*Source: Author*

## 3.5.2 LULC CHANGE WITHIN ZONE OF INFLUENCE

The LULC analysis within the Zone of Influence of the wetland reveals a clear trend of rapid urbanization. Built-up area has significantly increased from 48.40% in 2017 to 54.01% in 2023. This expansion has come at the cost of vegetative cover, which declined from 21.89% to 15.79%, reflecting a substantial loss of green spaces.

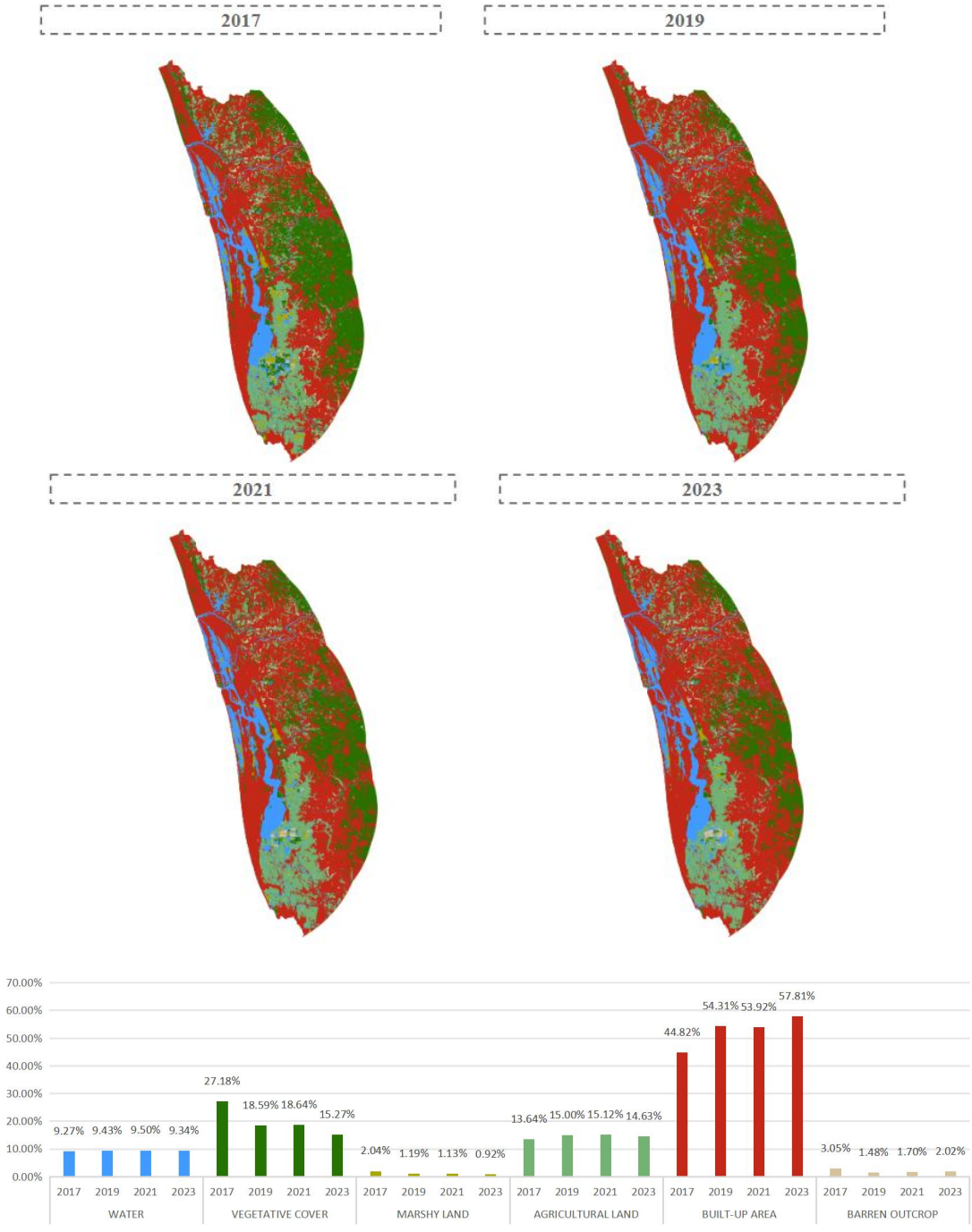



**FIGURE 18: LULC CHANGES IN THE VEMBANAD ZONE OF INFLUENCE**

*Source: Author*

### 3.5.3 LULC CHANGE WITHIN STUDY AREA

The Land Use Land Cover (LULC) analysis within the study area from 2017 to 2023 reveals a clear trend of rapid urbanization. Built-up area has significantly increased from 45.72% in 2017 to 51.62% in 2023, indicating intensified developmental pressure on the region. This expansion has come at the cost of vegetative cover, which declined from 9.22% to 3.39%, reflecting a substantial loss of green spaces. Agricultural land also reduced slightly, suggesting conversion into urban infrastructure. Marshes under the wetlands have decreased from 4.29% to 2.06% indicating a decaying wetland ecosystem.

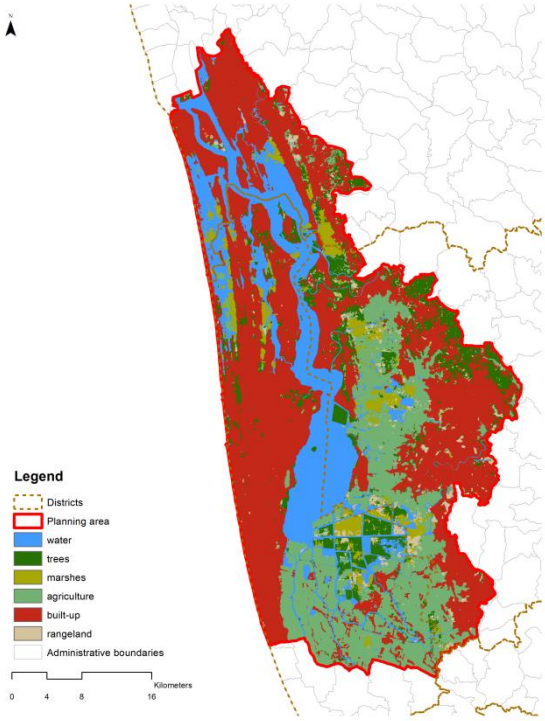



**FIGURE 19: LULC (2017)**

*Source: Author*

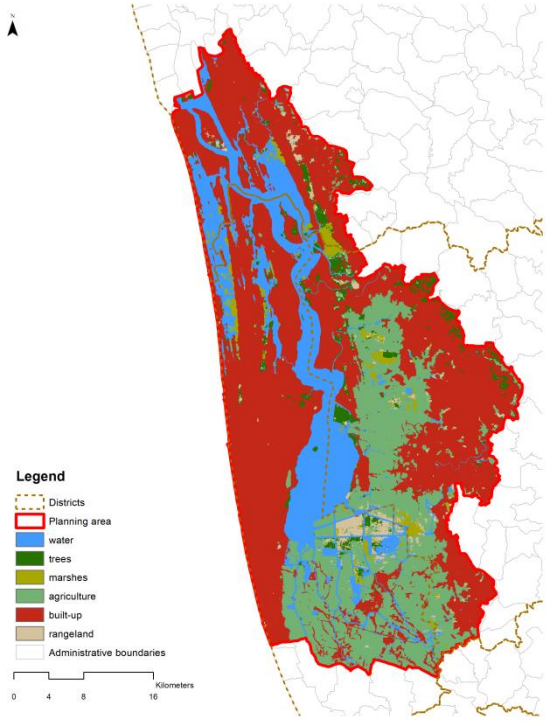



**FIGURE 20: LULC (2023)**

*Source: Author*

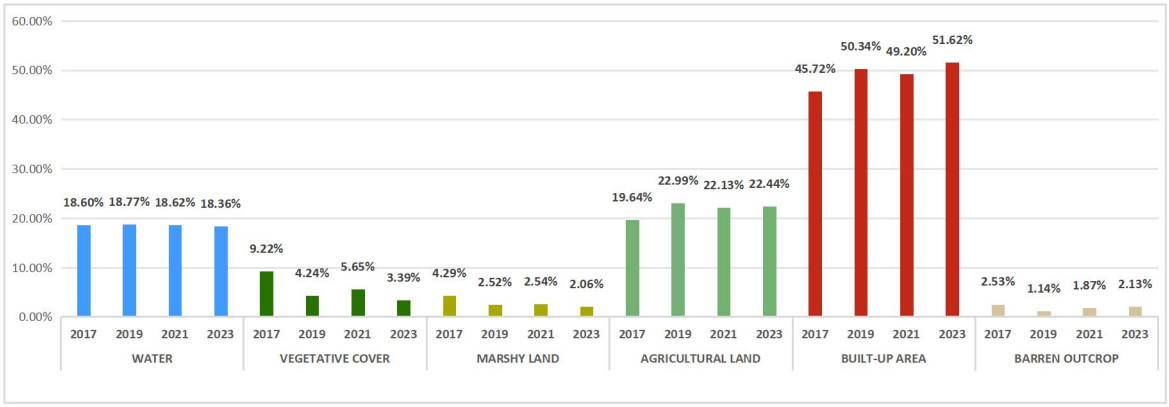



**FIGURE 21: LULC ANALYSIS (2017-2023)**

*Source: Author*

The LULC change detection shows that the most prominent transition is from vegetation to agricultural land, encompassing nearly 7000 hectares, which underscores the substantial conversion of natural vegetation for agricultural purposes. Other notable conversions include marshes to agricultural land and vegetation to built-up areas, reflecting ongoing trends in land development and habitat transformation. These LULC changes are likely to have significant implications for hydrological dynamics and ecosystem sustainability within the river basins studied

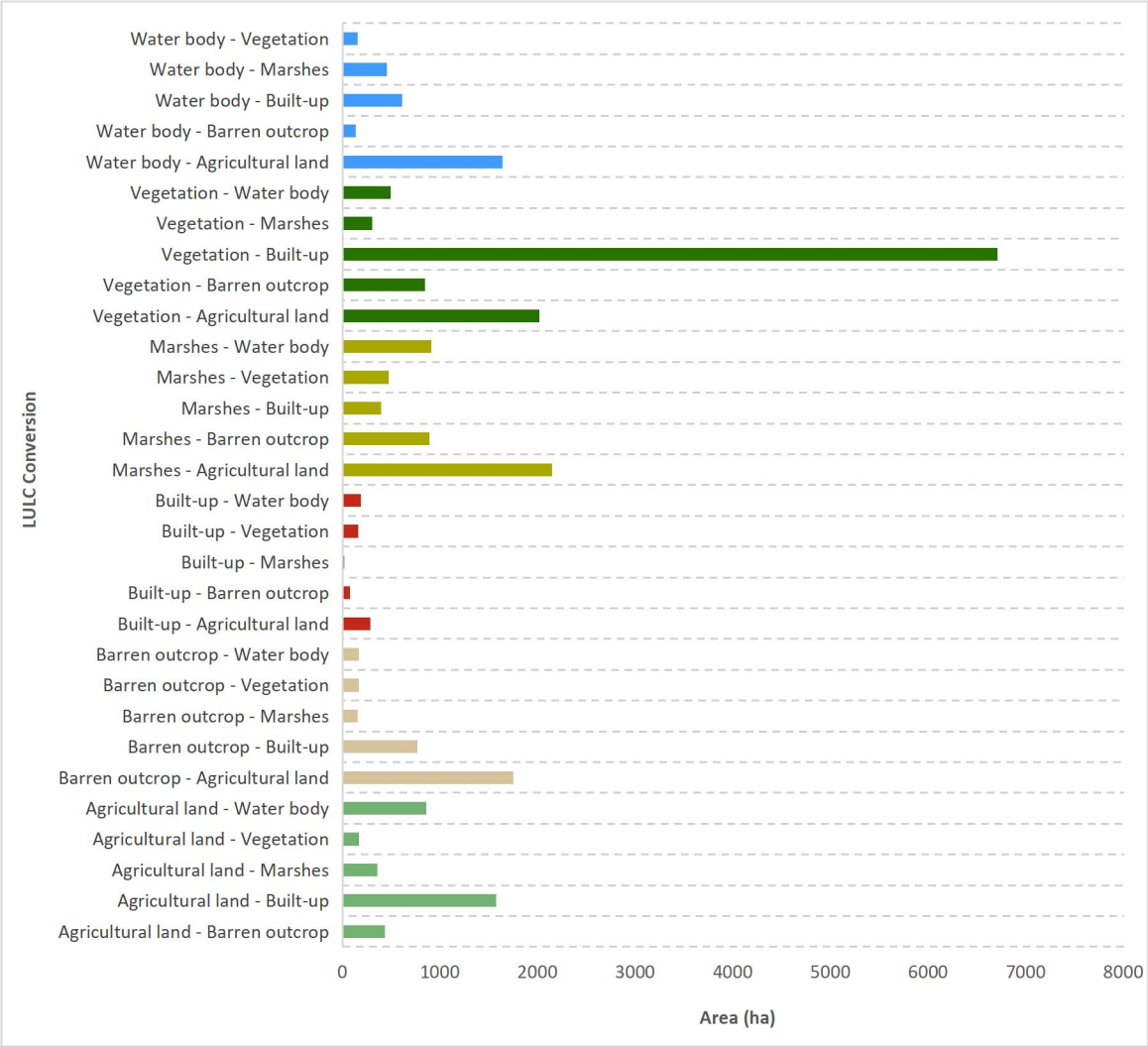



**FIGURE 22: LULC CHANGE DETECTION ANALYSIS (2017-2023)**

*Source: Author*

## 3.6 LOCAL LIVELIHOODS

The Vembanad Wetlands support a diverse range of local livelihoods by virtue of its unique estuarine ecosystem. Key stakeholders include fisheries, clam collectors, and farmers who rely on the lake's natural productivity for their livelihoods. Tourism

operators also play a significant role, with the scenic backwaters attracting visitors year-round. Additionally, coir retting units and industries located near the lake contribute to the local economy, albeit with potential environmental impacts. The spatial map further illustrates how these stakeholder groups are distributed across different zones.

1) Agriculture: Predominantly paddy cultivation in the low-lying Kuttanad region which is known for its below sea-level farming.
2) Fisheries: Both inland and brackish water fisheries are widespread with the region seeing a rise in aqua cultural activities.
3) Clam collection: The lake is one of the largest sources of black clam.
4) Tourism operators: The backwater tourism is a major livelihood with tour operators, tour guides and homestays benefiting from the region's scenic value.
5) Coir makers: The activity supports small-scale cottage industries in the region.
6) Industries: Small and medium scale industries including food processing, chemical and cement manufacturing.


**FIGURE 23: LOCAL LIVELIHOODS IN THE VEMBANAD**

*Source: Author*

### 3.6.1 AGRICULTURE

The Vembanad region exhibits a rich and diverse agricultural landscape, shaped largely by its unique wetland ecosystem. The area is divided into distinct agricultural zones — Upper Kuttanad, Lower Kuttanad, Kayal Lands, and Vaikomom Kari — each reflecting localized variations in land use patterns, water availability, and soil conditions. The Kayal Lands, centrally located, are notable for their extensive below-sea-level paddy cultivation along with other mixed cropping systems, while the Upper Kuttanad areas practice a one-paddy-one-shrimp system of cultivation known as "Pokkali" farming.

**TABLE 5: AGRICULTURAL ZONES AND CROPPING PATTERNS**

| Zone | Primary crops | Cropping seasons | Cropping patterm |
|---|---|---|---|
| **Upper Kuttanad** | Paddy, Coconut, Pokkali | Virippu (May–Sep), Puncha (Nov–Mar) | Double cropping (Paddy-Paddy), some inter-cropping with coconut |
| **Lower Kuttanad** | Paddy, Coconut, Banana | Puncha (Nov–Mar) | Single cropping (Paddy), Coconut on bunds, Banana as intercrop |
| **Kayal Lands (below sea level farming)** | Paddy | Puncha (Nov–Mar) | Single crop paddy (one major season), occasional short-term aquaculture post-harvest |
| **Vaikom Kari** | Coconut, Paddy (limited), Pepper, Vegetables | Virippu (May–Sep), fish farming (Oct–April) | Mixed cropping (Perennial plantations + limited seasonal paddy) |

*Source: Author*

1) Puncha is the dominant season across all low-lying zones (especially Kayal Lands and Lower Kuttanad), relying heavily on controlled water management.
2) Virippu is practiced where slight elevation or better drainage exists (like in Upper Kuttanad).
3) In the Kayal lands, paddy cultivation is a unique phenomenon because the fields are often reclaimed from the lake and protected by bunds.
4) Vaikom Kari areas, being relatively higher and less flood-prone, support perennial crops like coconut and pepper, with some vegetable cultivation.
5) After paddy harvest, short-term aquaculture (mainly shrimp farming) is also common in Upper Kuttanad areas.

The agricultural practices here are deeply intertwined with the seasonal rhythms of the wetland, requiring adaptive strategies like raised bunds, polder systems, and rotational farming to manage water levels and maintain soil fertility.

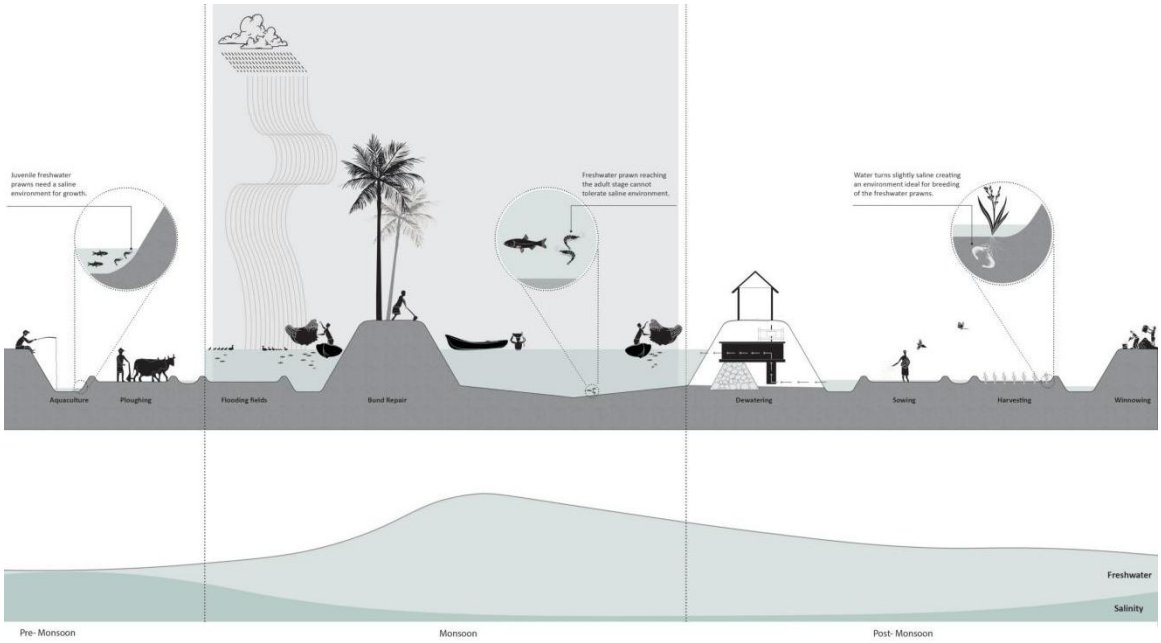



**FIGURE 24: WATER SALINITY AND AGRICULTURAL CYCLES**

*Source: Watson et. al. (2019)*

Crop lands, particularly concentrated in the southern and eastern parts of the region, dominate the agricultural matrix, while pockets of fallow land suggest areas experiencing either seasonal flooding challenges or shifting cultivation patterns.

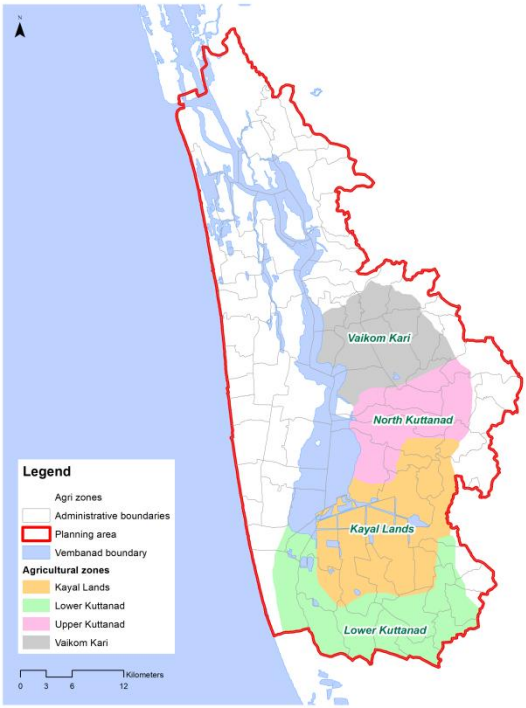



**FIGURE 25: MAJOR AGRICULTURAL ZONES**

*Source: Author*

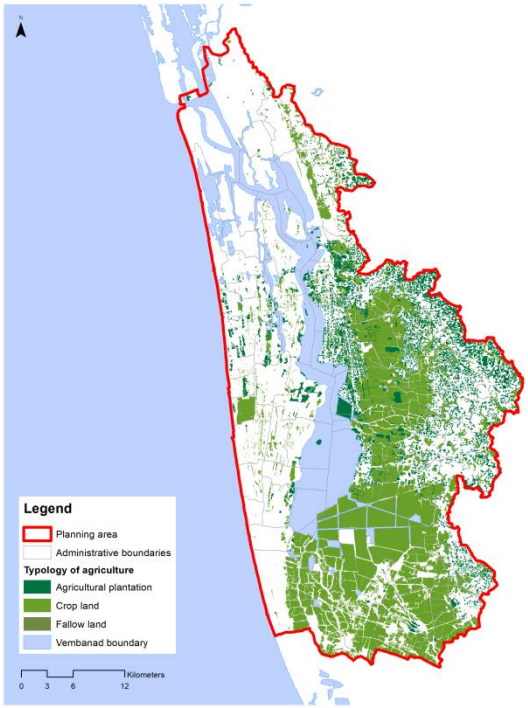



**FIGURE 26: AGRICULTURAL LAND TYPOLOGY**

*Source: Author*

The distribution of primary agricultural products highlights paddy cultivation as dominant in the low-lying areas, particularly in Alappuzha and parts of Kottayam, where the fertile wetland soils and controlled water regimes favor rice farming. Coconut plantations also cover substantial portions, especially in the coastal and slightly elevated regions, supporting traditional livelihoods and agro-ecological stability. The secondary agricultural products area diverse. Rubber plantations emerge prominently in the eastern highland margins, reflecting a shift toward cash crops. Pepper cultivation also appears in patches, signaling an adaptation to smaller land holdings and changing market demands.

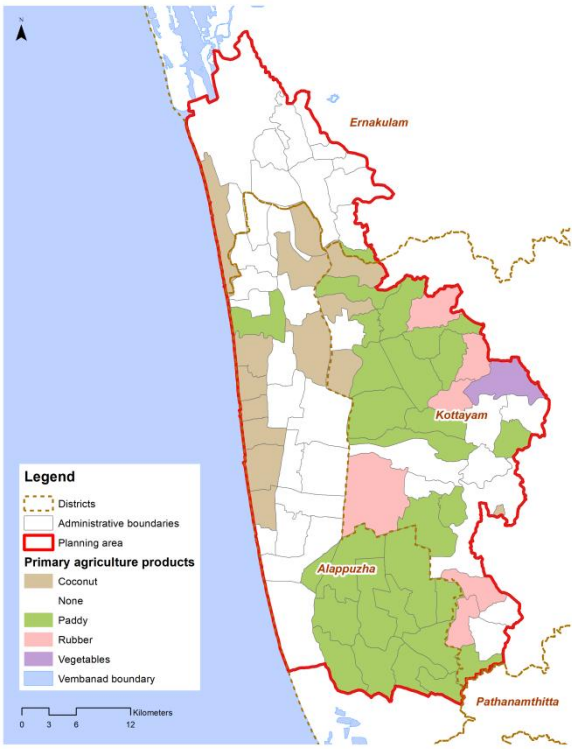



**FIGURE 27: PRIMARY AGRICULTURAL PRODUCE**

*Source: Author*

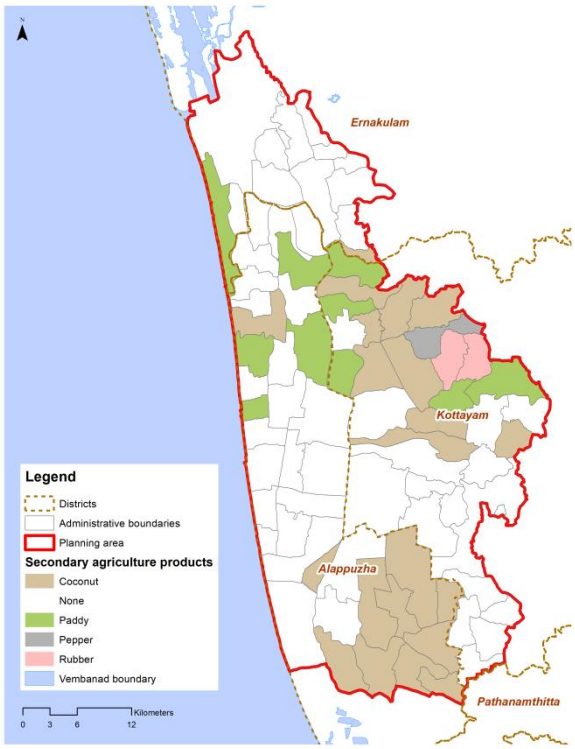



**FIGURE 28: SECONDARY AGRICULTURAL PRODUCE**

*Source: Author*

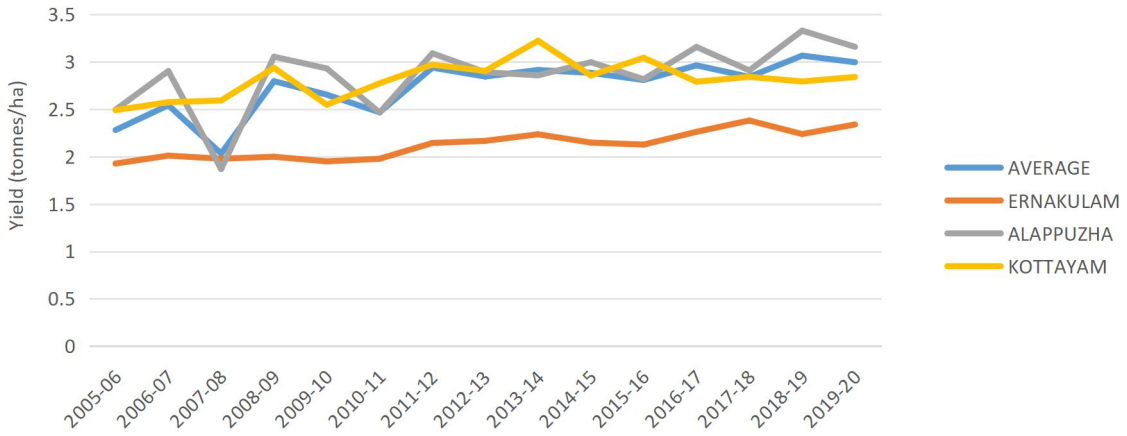



**FIGURE 29: PADDY YIELD IN THE VEMBANAD**

*Source: Author*

Agriculture continues to be a primary livelihood source, especially in Alappuzha and parts of Kottayam. In particular, southern Alappuzha stands out with more than 50% of the working population dependent on agriculture, emphasizing the region's deep-rooted agricultural traditions. Areas with 20%–50% agricultural workforce coverage also dominate much of the wetland hinterlands, reflecting the persistent significance of farming even amidst growing urbanization pressures.

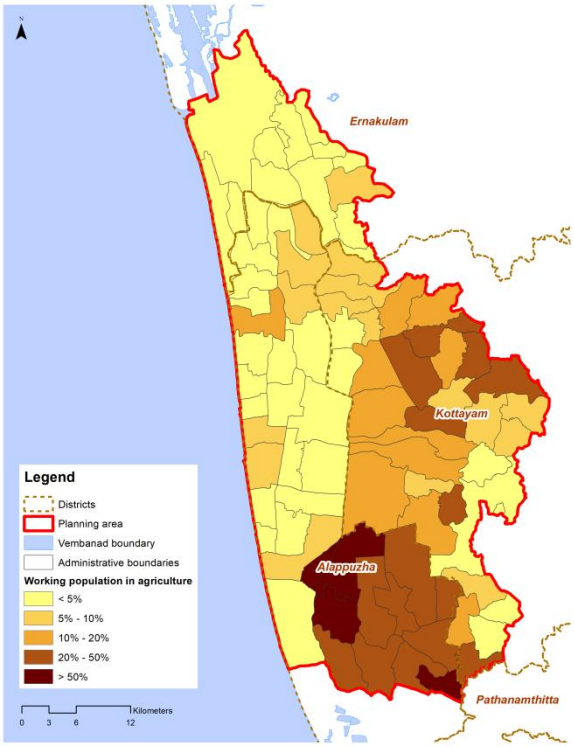



**FIGURE 30: PERCENTAGE OF POPULATION IN AGRICULTURE SECTOR**

*Source: Author*

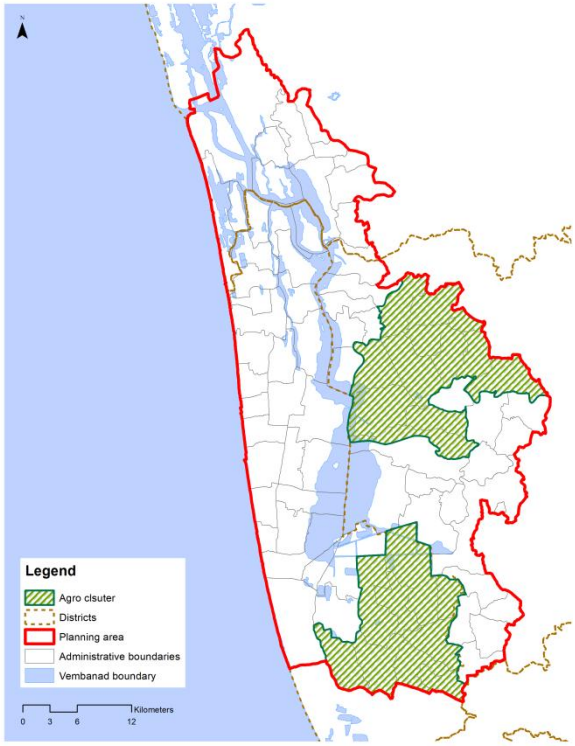



**FIGURE 31: POTENTIAL AGRO CLUSTER FOR TOURISM DEVELOPEMENT**

*Source: Author*

Agriculture has largely regressed to a subsistence level, a shift closely tied to the growing fragmentation of landholdings. Over generations, traditional agricultural lands have been subdivided through inheritance, leading to extremely small and scattered plots that are often insufficient for commercial-scale farming.

**TABLE 6: AVERAGE LAND HOLDING SIZE (HA)**

| Year | Ernaulam | Alappuzha | Kottayam | Average |
|---|---|---|---|---|
| **2000-01** | 0.18 | 0.15 | 0.30 | 0.210 |
| **2005-06** | 0.17 | 0.15 | 0.30 | 0.207 |
| **2010-11** | 0.19 | 0.14 | 0.30 | 0.207 |
| **2015-16** | 0.15 | 0.13 | 0.26 | 0.179 |

*Source: Author*

### 3.6.2 FISHERIES

The fisheries sector in the Vembanad region forms a vital pillar of the local economy, culture, and food security. The Vembanad Lake sustains a rich diversity of aquatic life, supporting both capture fisheries and traditional aquaculture practices. The lake's dynamic ecosystem — characterized by a delicate balance between freshwater inflows and saline intrusion — enables a range of fish, prawn, and clam species to thrive. Over the years, however, the sector has faced mounting challenges due to overfishing, habitat degradation, pollution, changing salinity patterns, and the construction of barriers like the Thanneermukkom Bund.

The absolute area under fisheries highlights significant concentrations in the Alappuzha district, particularly in the Kuttanad region. Certain panchayats in southern Alappuzha show fisheries occupying more than 30% of their total land area, indicating a heavy dependence on aquaculture and capture fisheries for livelihoods. In contrast, in most of Kottayam and parts of northern Ernakulam, fisheries constitute less than 5% of the land use, showing a stronger orientation toward agriculture or other economic activities.

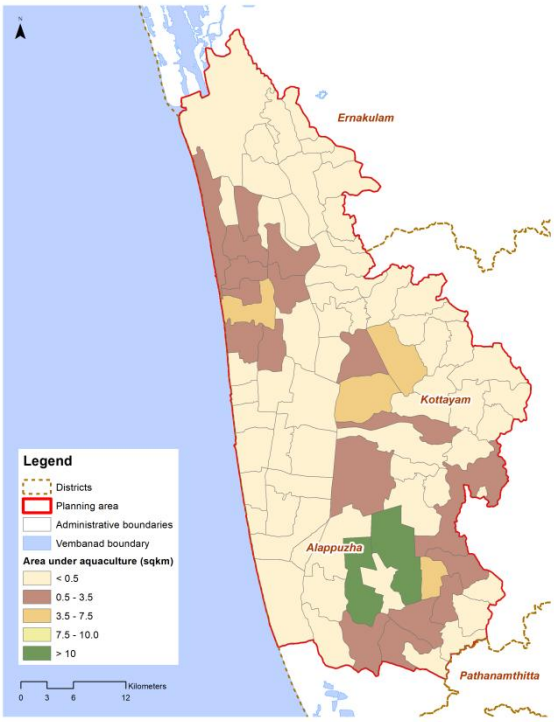



**FIGURE 32: AREA UNDER FISHERIES (SQKM)**

*Source: Author*

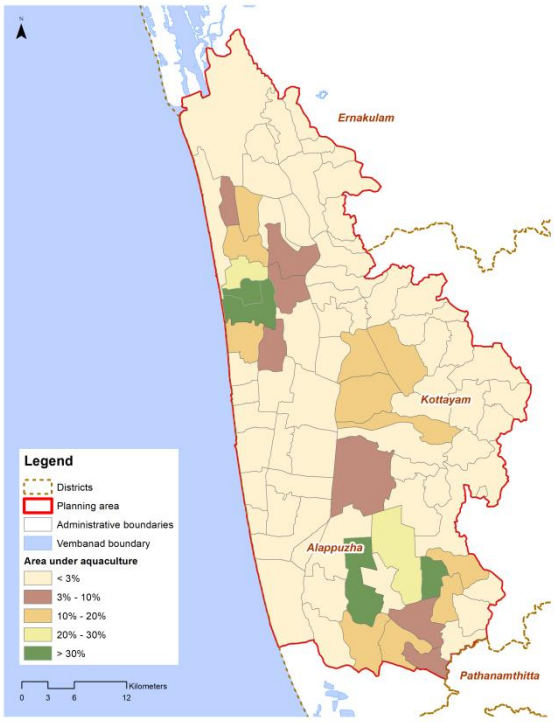



**FIGURE 33: PERCENTAGE AREA UNDER FISHERIES**

*Source: Author*

The region reflects the adaptive and multifaceted nature of aquaculture shaped by the region's salinity gradients, traditional knowledge systems, and ecological contexts. Both freshwater and backwater aqua culture systems are prevalent.

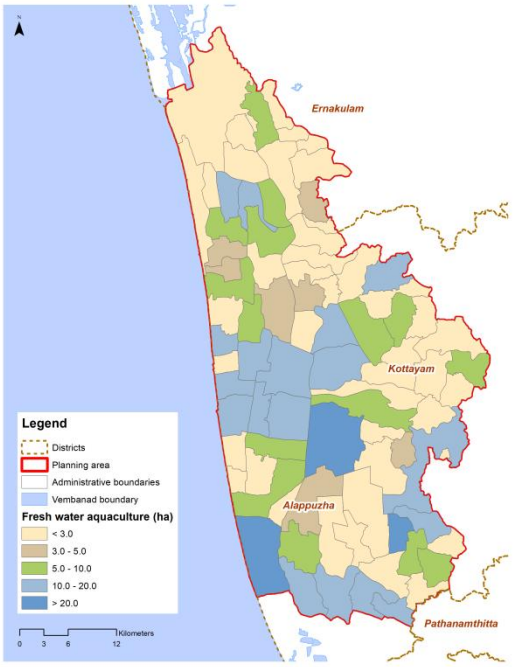



**FIGURE 34: AREA UNDER NATURAL FRESHWATER AQUACULTURE**

*Source: Author*

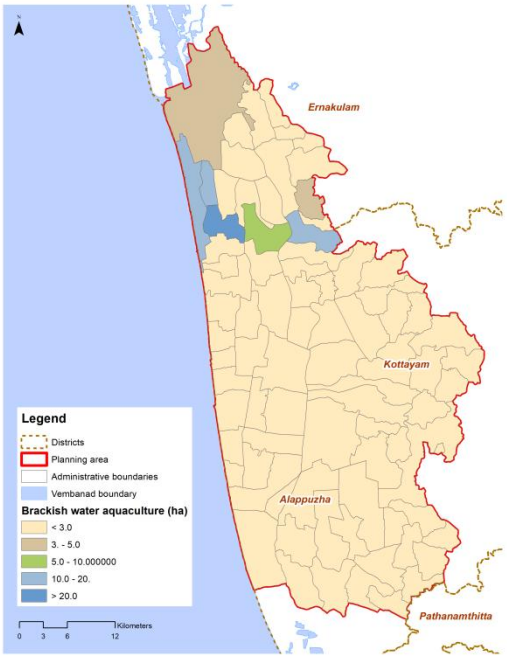



**FIGURE 35: AREA UNDER BRACKISH WATER AQUACULTURE**

*Source: Author*

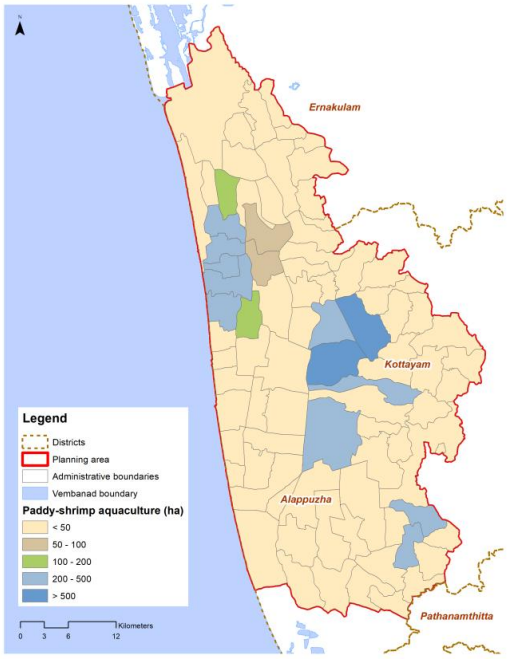



**FIGURE 36: AREA UNDER POKKALI FARMING (ONE PADDY - ONE SHRIMP)**

*Source: Author*

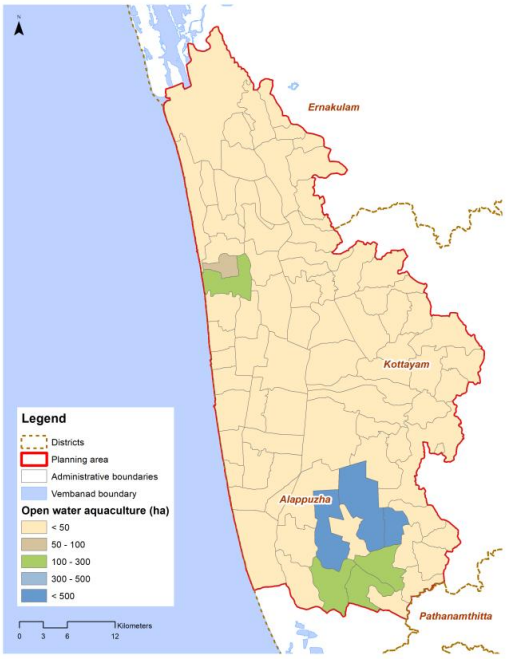



**FIGURE 37: AREA UNDER OPEN WATER AQUACULTURE**

*Source: Author*

The trends in fish catch from reveal a marked shift in the composition of fisheries production. Prawn consistently records the highest catch volumes, displaying noticeable fluctuations but maintaining dominance throughout the decade. Peaks in prawn catch

around 2017-18 and 2020-21 highlight its growing importance, largely driven by its high export demand and profitability in international markets. In contrast, the catch volumes of indigenous species like Etroplus and Tilapia have shown a steady decline, particularly after 2017-18. This trend points towards a larger transformation where aquaculture practices are being reoriented to prioritize species that fetch better commercial returns, often at the cost of biodiversity and traditional livelihoods. The loss in indigenous fish populations also raises concerns about ecosystem health, nutritional security, and the sustainability of aquatic resources in the Vembanad backwaters.

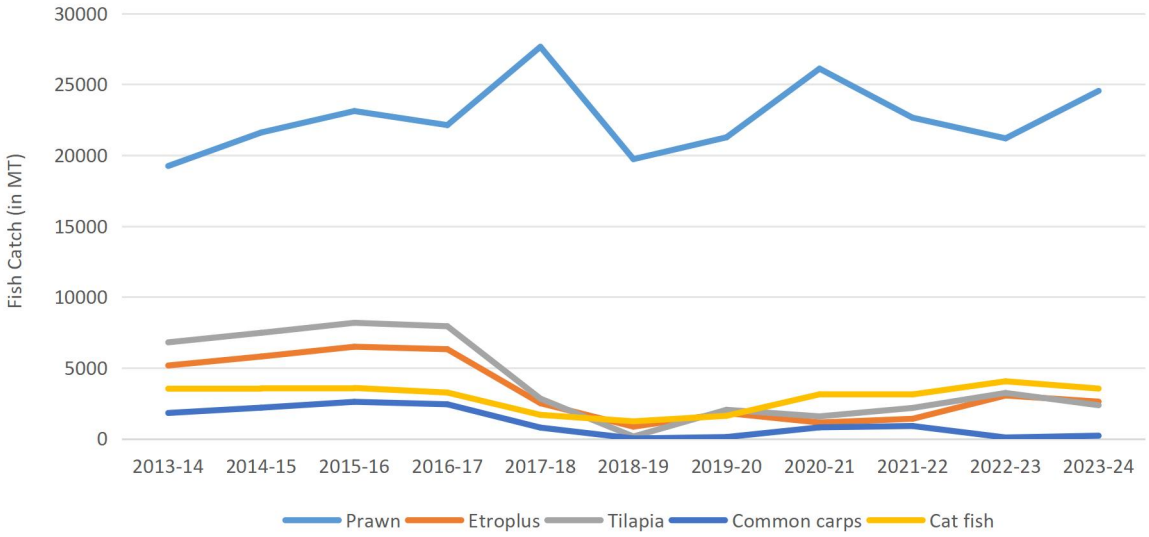



**FIGURE 38: FISH CATCH IN THE VEMBANAD**

*Source: Author*

The western coastal areas, particularly near the Vembanad backwaters and adjoining parts of Alappuzha and Ernakulam districts, have a high concentration of inland fisheries-based livelihoods. Several panchayats record more than 20% of their population working in fisheries, as indicated by the darkest shades. These areas align with the regions where traditional fishing communities have historically resided and where easy access to both marine and inland water bodies supports active fishing and aquaculture activities.

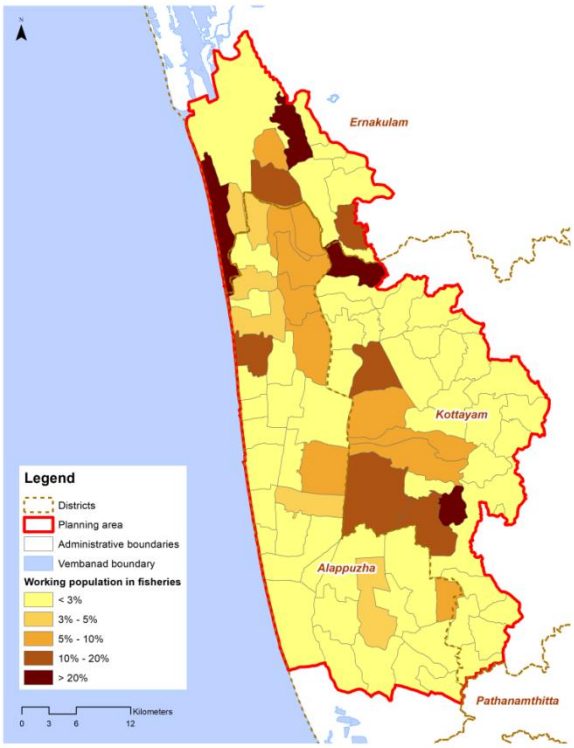



**FIGURE 39: PERCENTAGE OF POPULATION IN FISHERIES SECTOR**

*Source: Author*

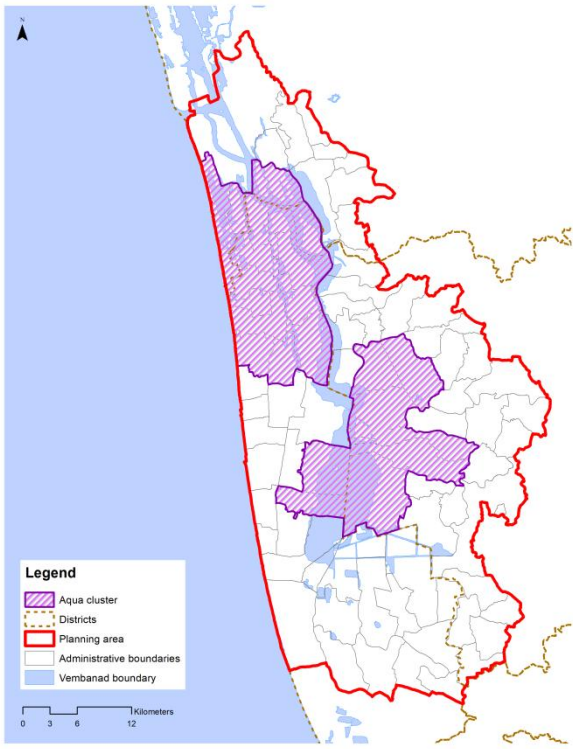



**FIGURE 40: POTENTIAL AQUA CLUSTER FOR TOURISM DEVELOPMENT**

*Source: Author*

## 3.6.3 COIR MAKERS

A notable concentration of coir-producing villages is seen along the coastal belt, especially in the districts of Alappuzha and southern Ernakulam. These regions have traditionally been the heartland of Kerala's coir industry, taking advantage of the abundant availability of coconut palms and the proximity to backwaters, which provide the water needed for retting (the process of soaking coconut husks). The spread of coir-producing villages aligns with the historical significance of the industry as a cottage-based livelihood for many households, particularly among women.

**FIGURE 41: PROCESSING COIR**

*Source: Deccan herald*

**FIGURE 42: COIR HANDICRAFTS**

*Source: Coir Kerala 2014*

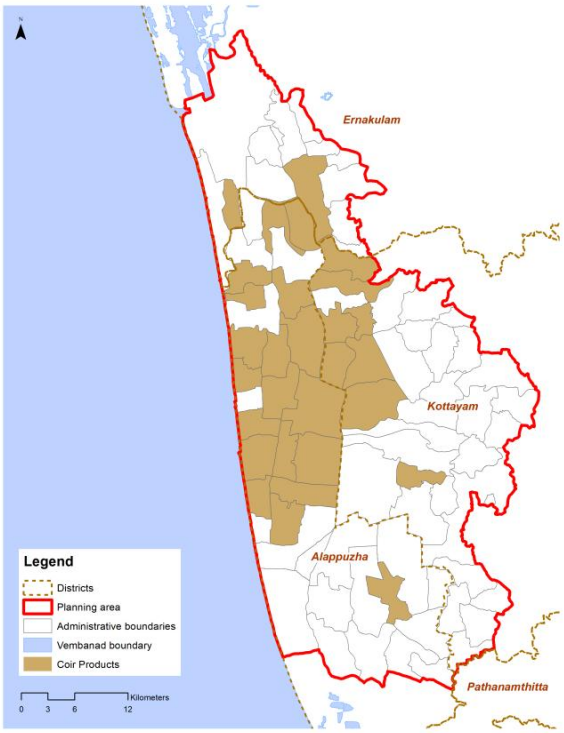



**FIGURE 43: VILLAGES PRODUCING COIR PRODUCTS**

*Source: Author*

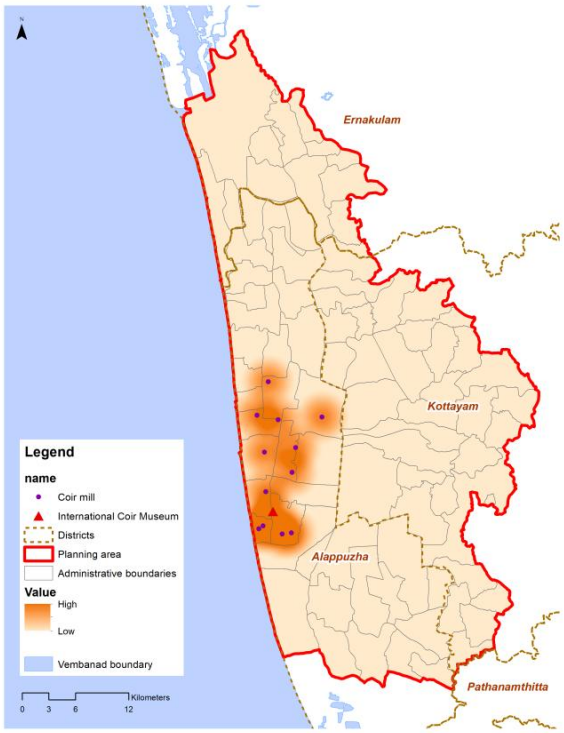



**FIGURE 44: LOCATION OF COIR PROCESSING MILLS**

*Source: Author*

## 3.7 TOURISM

Tourism in the Vembanad region offers a diverse range of experiences. It forms the ecological heart of responsible and eco-tourism efforts in Kerala alongside cultural tourism and houseboat tourism. The three major tourism hotspots in the region are:

1) **Kochi:** It serves as the gateway to the Vembanad and is a major cultural hub, attracting visitors to its rich colonial heritage and vibrant art scene. The Kochi Biennale is a major cultural attraction of the city. Alongside the city registers a high footfall as being a part of the South Asian Cruise circuit. The city, with its enhanced connetivity infrastructure, acts as the gateway to the region.

2) **Alappuzha:** It is famous for its intricate network of canals and backwaters, offering traditional houseboat cruises and budget homestays. It is the epicentre of houseboat tourism in the region.

3) **Kumarakom:** It presents a more upscale tourist experience with luxury resorts, ayurvedic spas and bird-watching sanctuaries.

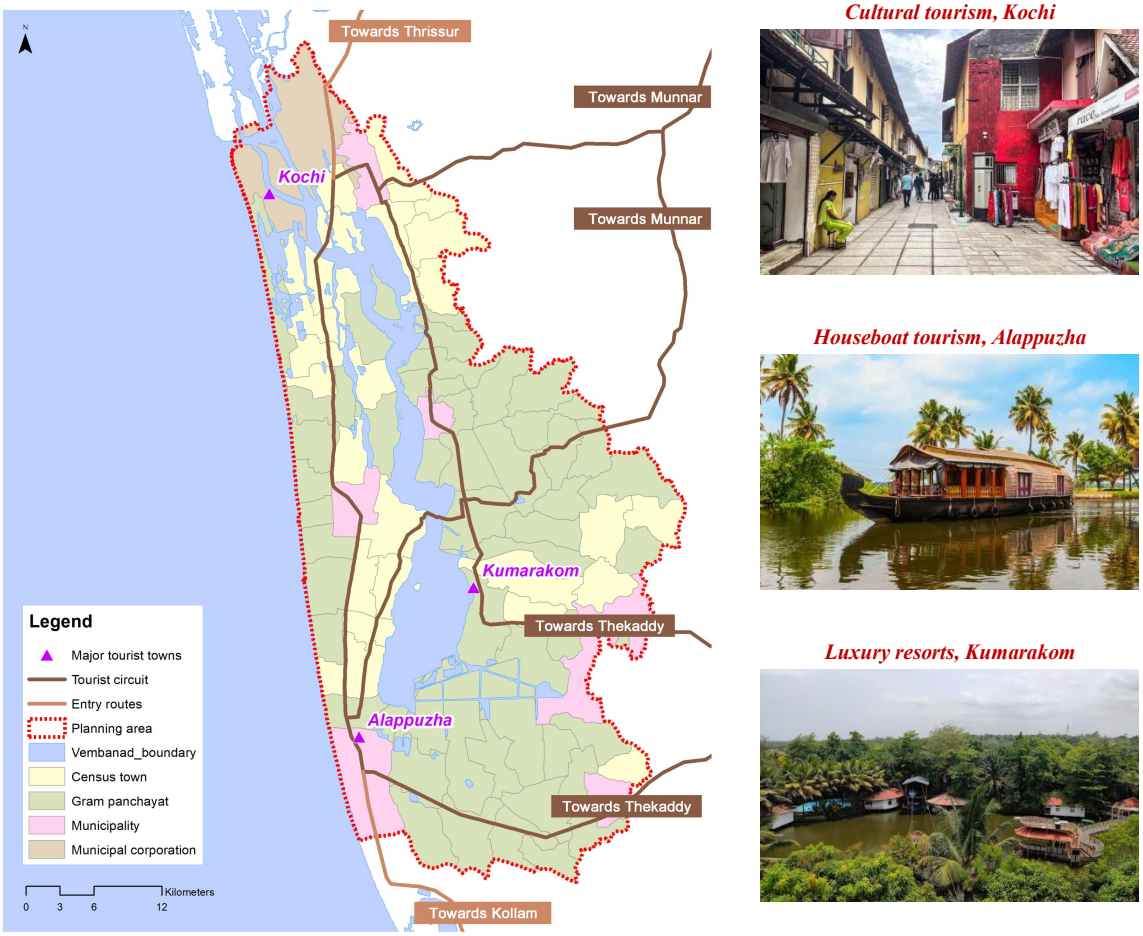



**FIGURE 45: TOURISM IN THE VEMBANAD**

*Source: Author*

## 3.7.1 REGIONAL CIRCUITS

There area primarily three local thematic circuits are in the region, each covering an average of 180 km distance taking 3-4 days of journeying via various modes. For all these circuits, Kochi is the starting and ending point.

**TABLE 7: THEME CIRCUITS OF THE REGION**

| Theme | Destination | Attractions |
|---|---|---|
| **Cultural circuit** | Kochi | Journey by road starts via NH 66 |
| | Kalady | Hindu temples and religious sites |
| | Athirapaally | Waterfalls and dams |
| | Mala | Jewish religious sites and churches |
| | Azhikode | Beaches, forts, religious sites |

| Theme | Destination | Attractions |
|---|---|---|
| **Backwater circuit** | Kochi | Journey starts from Cochin port |
| | Kumarakom | Eco-tourist village |
| | Mannar | Portuguese architectural remnants |
| | Alappuzha | Beach and waterways |
| **Nature circuit** | Kochi | Journey by road starts via SH 16 |
| | Thattekad | Bird sanctuary |
| | Valara | Waterfalls |
| | Munnar | Hill station with tea gardens |
| | Vagamon | Waterfalls and adventure sports |

*Source: Author*

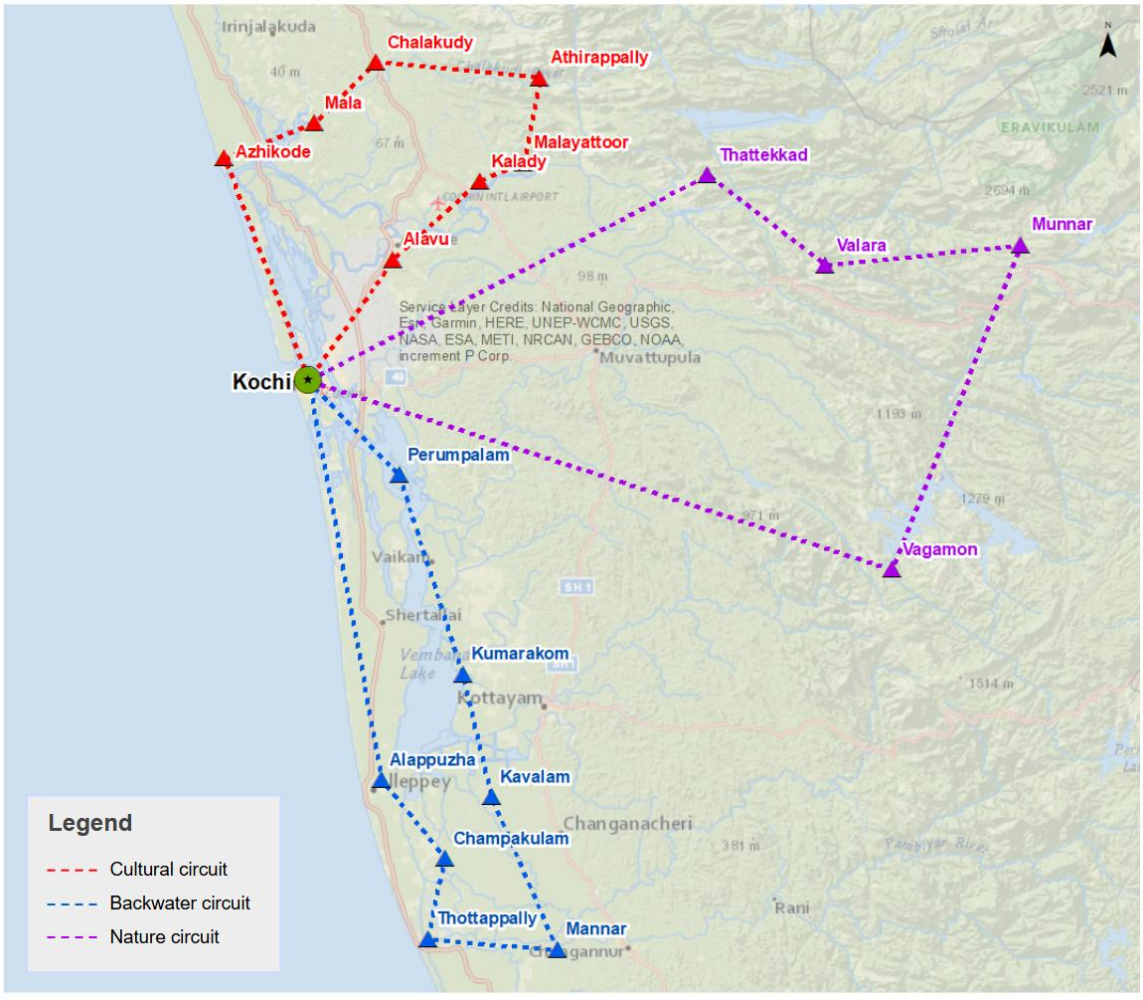



**FIGURE 46: REGIONAL TOURIST CIRCUITS**

*Source: Author*

### 3.7.2 TOURIST FOOTFALL

The tourist population in the region had shown a steady increase in the past concidincing with the promotion of Kerala as 'God's own country', with the tourist footfall multiplying nearly fourfold over the 16-year period, reflecting growing popularity possibly due to improved infrastructure, effective tourism promotion, and increased interest in eco-tourism. However, the growth rate has started to stabilize, with minor fluctuations and a general downward trend indicated. By 2012, the growth rate briefly dipped into the negative before recovering modestly in the following years, remaining relatively steady but much lower compared to the earlier years. This suggests that while the total tourist numbers continued to rise, the pace of growth became more controlled and predictable after an initial period of high volatility.

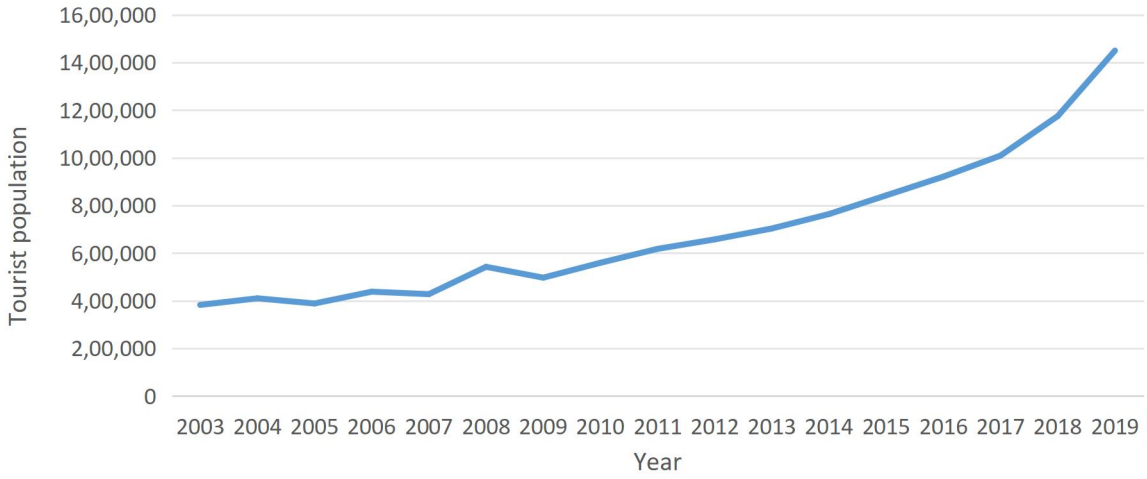



**FIGURE 47: TOURIST FOOTFALL IN THE VEMBANAD**

*Source: Kerala Tourism*

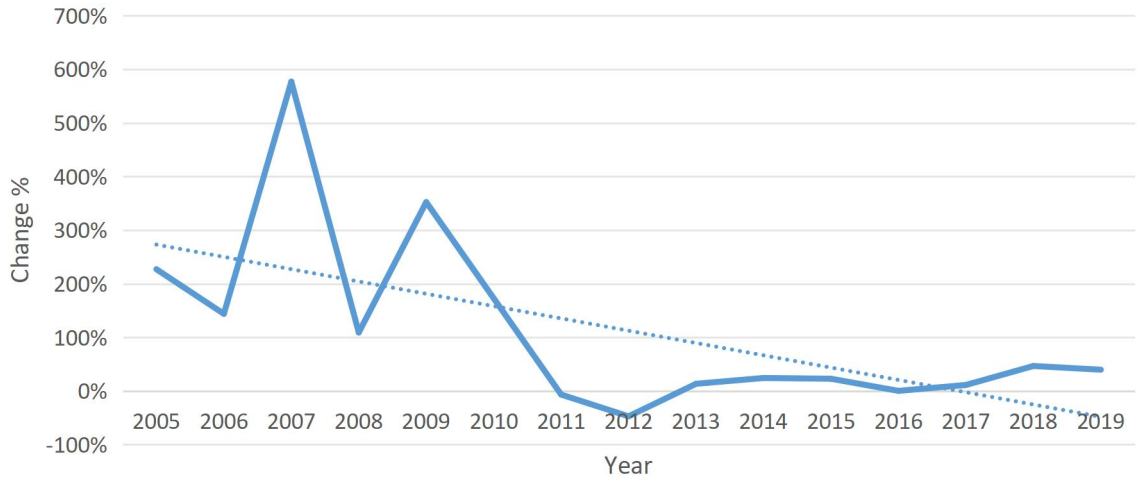



**FIGURE 48: RATE OF CHANGE OF ANNUAL TOURIST GROWTH RATE**

*Source: Kerala Tourism*

## 3.7.3 BACKWATER CIRCUIT

The tourism scenario surrounding the Vembanad wetlands is heavily influenced by the unique ecological and cultural assets of the region. The destinations of Kochi, Alappuzha, and Kumarakom form the core of the backwater circuit, each offering distinct experiences—Kochi with its cultural and historical sites, Alappuzha with its famed houseboat cruises, and Kumarakom with luxury resorts and tranquil wetland vistas. As reflected in Figure 15, Alappuzha has consistently drawn the highest tourist population from 2016 to 2023, accounting for up to 39% in recent years, highlighting its dominance in the wetland tourism economy. Kochi's share has remained steady around 11–12%, likely due to its urban orientation and cultural tourism niche. Meanwhile, Kumarakom's contribution, around 17–19%, reflects its upscale and ecotourism appeal.

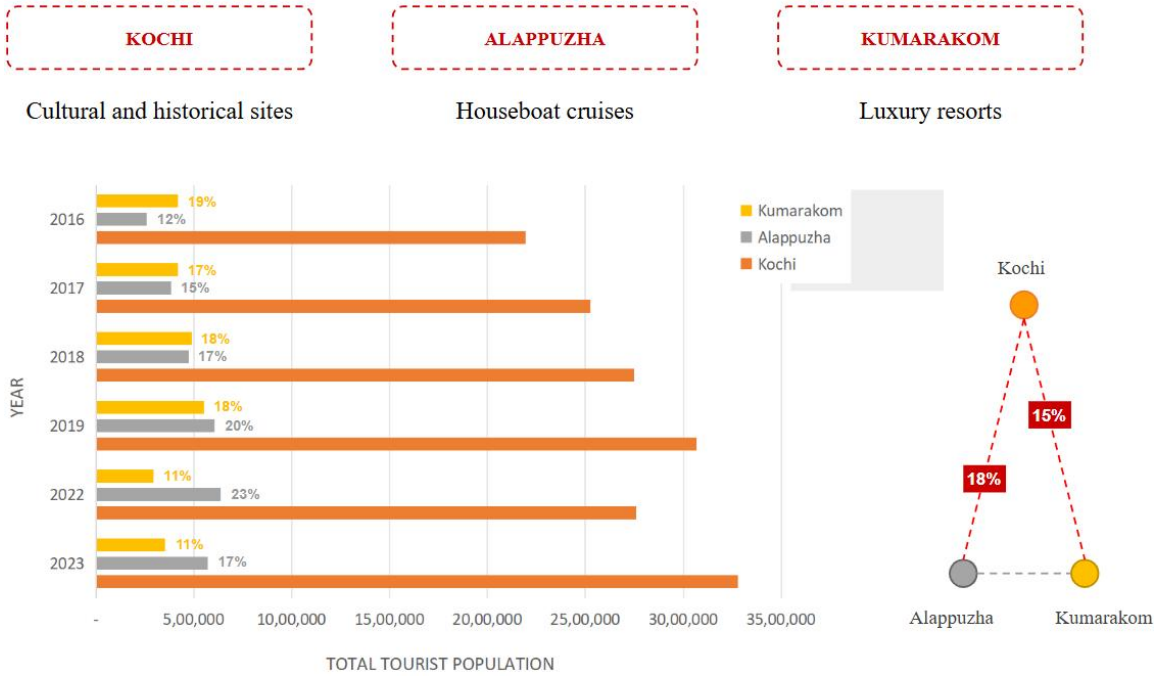



**FIGURE 49: DESTINATION-WISE TOTAL TOURIST POPULATION**

*Source: Kerala Tourism*

### 3.7.3.1 NATURE OF TOURISM AND TOURIST PROFILE

#### 3.7.3.1.1 KOCHI

Kochi holds a pivotal position in Kerala's tourism network, acting as the gateway to multiple tourist circuits across the region. Strategically located along the southwest coast of India, Kochi seamlessly connects a variety of landscapes, from serene backwaters and vibrant beaches to historic colonial towns and lush hill stations. Its rich cultural heritage, shaped by centuries of global trade and colonial influence, makes it a natural starting

point for heritage and cultural circuits, particularly through Fort Kochi and Mattancherry. Simultaneously, its proximity to the Vembanad backwaters and destinations like Kumarakom enables tourists to easily transition into eco-tourism and backwater circuits.

**FIGURE 50: CULTURAL TOURISM IN KOCHI**

*Source: Kerala Tourism*

### *Length of stay*

The pie charts in Figure 18 provide deeper insight into visitor behavior. Among foreign tourists, a large portion (over 50%) stays for 1–2 days, and about 36% are repeat travelers, indicating Kochi's role as a short-stay but attractive destination for returning visitors. In contrast, domestic tourists show a similar short-stay pattern, with the majority spending 1–2 days, but a lower repeat visit percentage (around 16%).

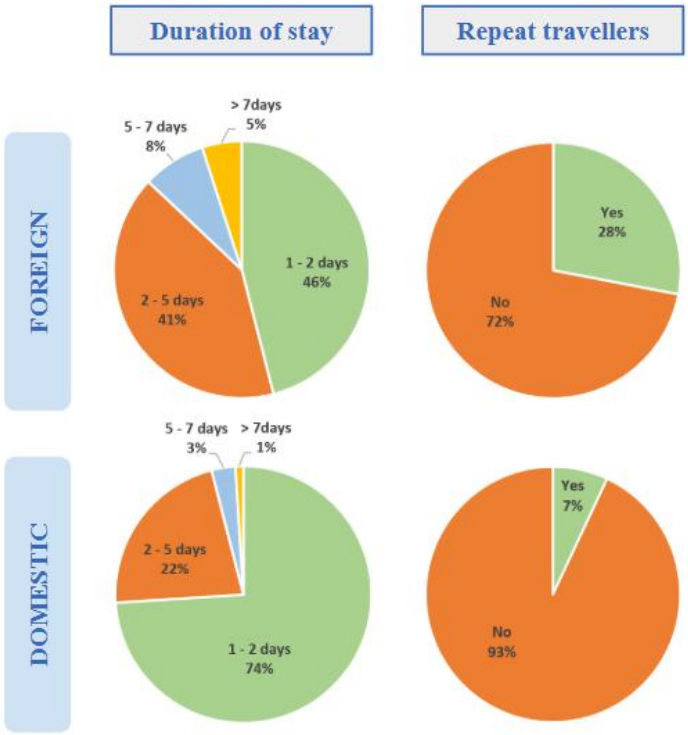



**FIGURE 51: TOURIST TRAVEL AND STAY PATTERNS, KOCHI**

*Source : Author, primary survey*

### *Mode of arrival*

Between 2013-14 and 2019-20, Kochi experienced a consistent upward trend in passenger traffic through cruise vessels. Foreign tourists predominantly arrive by air (67%), with a small but notable segment using cruise vessels (11%), while domestic tourists mainly use rail and road transport. A significant majority of both foreign (79%) and domestic (68%) tourists visit the backwaters, underscoring their central role in regional tourism appeal.

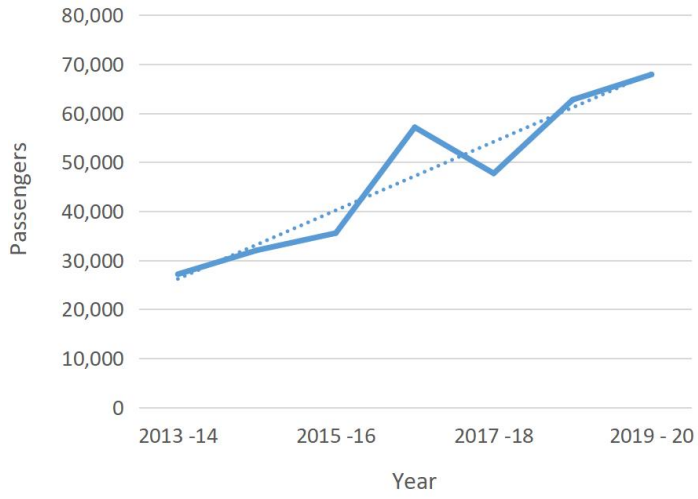



**FIGURE 52: PASSENGERS ARRIVING ON CRUISE VESSELS (2013 - 2020)**

*Source: Cochin Port Authority*

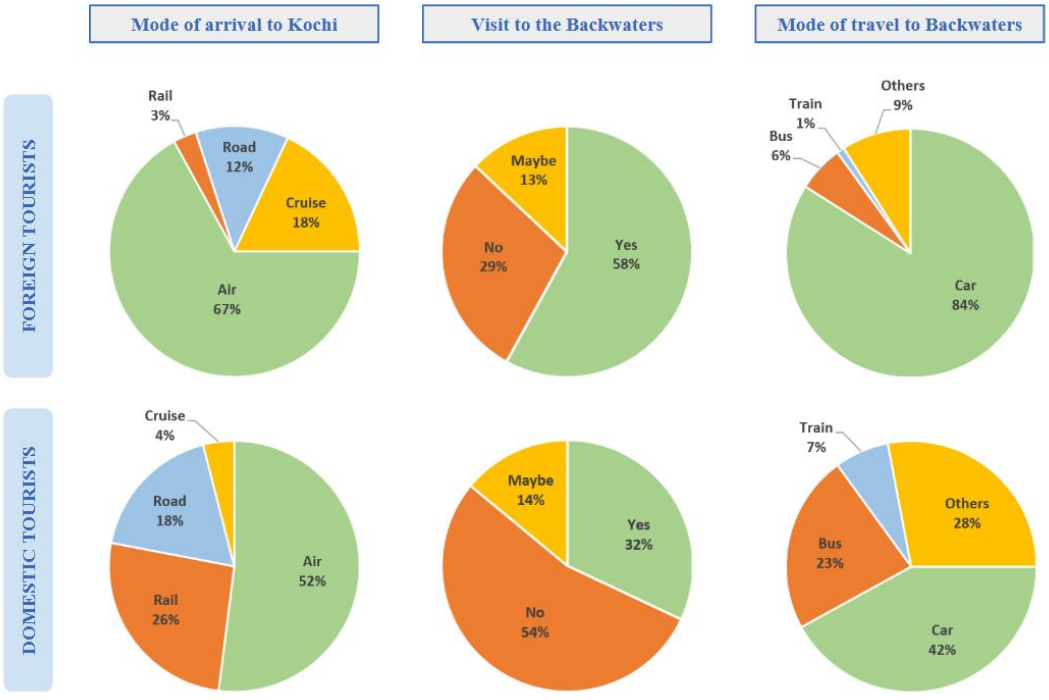



**FIGURE 53: MODE OF ARRIVAL TO THE VEMBANAD**

*Source: Author, primary survey*

***Accomodation***

The density map (Figure 19) shows that hotels and accommodation facilities are heavily concentrated in central Kochi, particularly around Fort Kochi and the main city area, with lower densities as one moves towards the outer zones. This spatial distribution aligns with the tourist flow pattern and heritage attractions in the region.

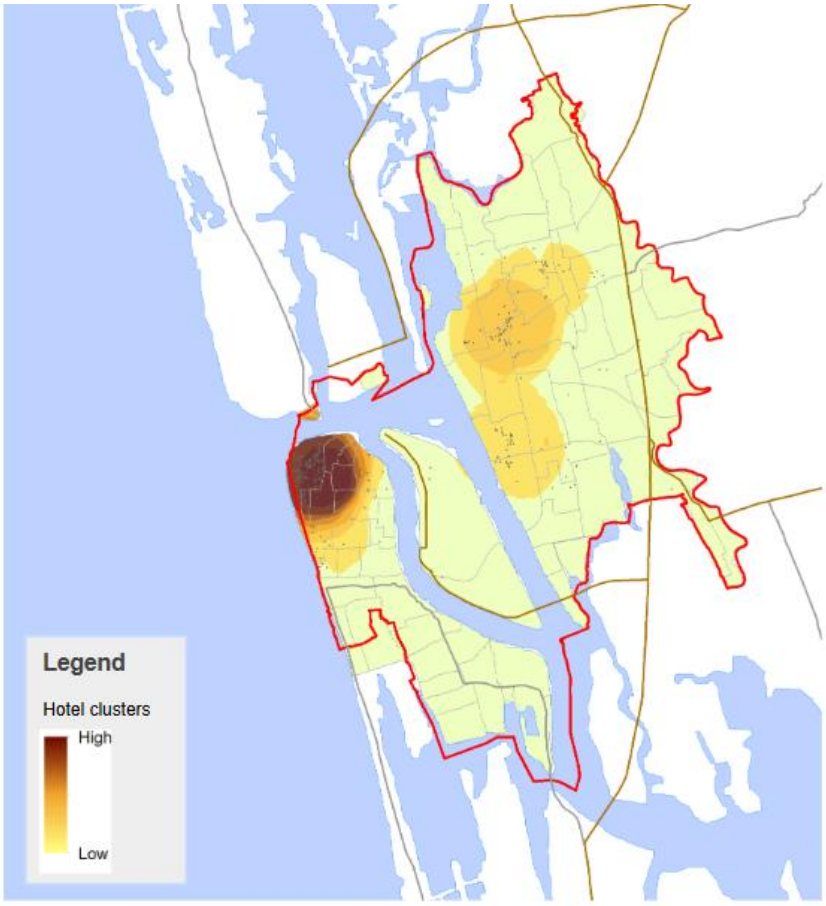



**FIGURE 54: DENSITY MAP OF HOTELS AND ACCOMMODATION FACILITIES**

*Source: Author*

### 3.7.3.1.2 ALAPPUZHA AND KUMARAKOM

Alappuzha and Kumarakom are two iconic destinations that occupy a central position in Kerala's backwater tourism circuit. Often called the "Venice of the East," Alappuzha is renowned for its intricate network of canals, lagoons, and paddy fields, offering visitors the quintessential Kerala houseboat experience. It serves as a major hub for backwater cruises, snake boat races, and coastal tourism. Located just across the Vembanad Lake, Kumarakom complements Alappuzha with its tranquil setting, luxury resorts, and the famous Kumarakom Bird Sanctuary, making it a favorite for eco-tourism and birdwatching enthusiasts. Both destinations are seamlessly connected through the

expansive Vembanad wetlands and form a critical part of the backwater circuit that often starts from Kochi. Their close proximity to each other allows tourists to experience the vibrancy of Alappuzha's waterways alongside the serene, nature-rich landscapes of Kumarakom, making them indispensable stops for anyone exploring Kerala's unique aquatic ecosystems and traditional rural life.

**FIGURE 55: BACKWATER TOURISM IN ALAPPUZHA AND KUMARAKOM**

*Source: Kerala Tourism*

### *Accommodation types and facilities*

Alappuzha dominates in terms of houseboat tourism, with over 700 houseboats compared to less than 150 in Kottayam. On the other hand, Kottayam leads in accommodation infrastructure, offering nearly 3,000 rooms, more than Alappuzha's. This suggests that while Alappuzha attracts more backwater tourism, Kumarakom caters to luxury resort tourism.

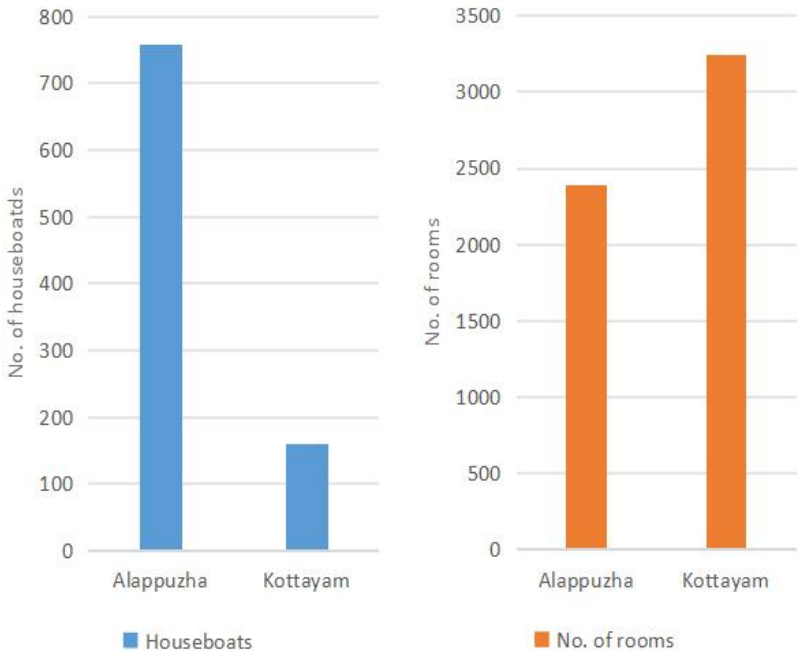



**FIGURE 56: HOUSEBOAT AND ROOM NUMBER OF THE DISTRICTS (2019)**

*Source: Kerala Tourism*

Alappuzha shows the highest concentration of hotels while Kumarakom has the highest availability of rooms, but a moderate concentration of hotels.

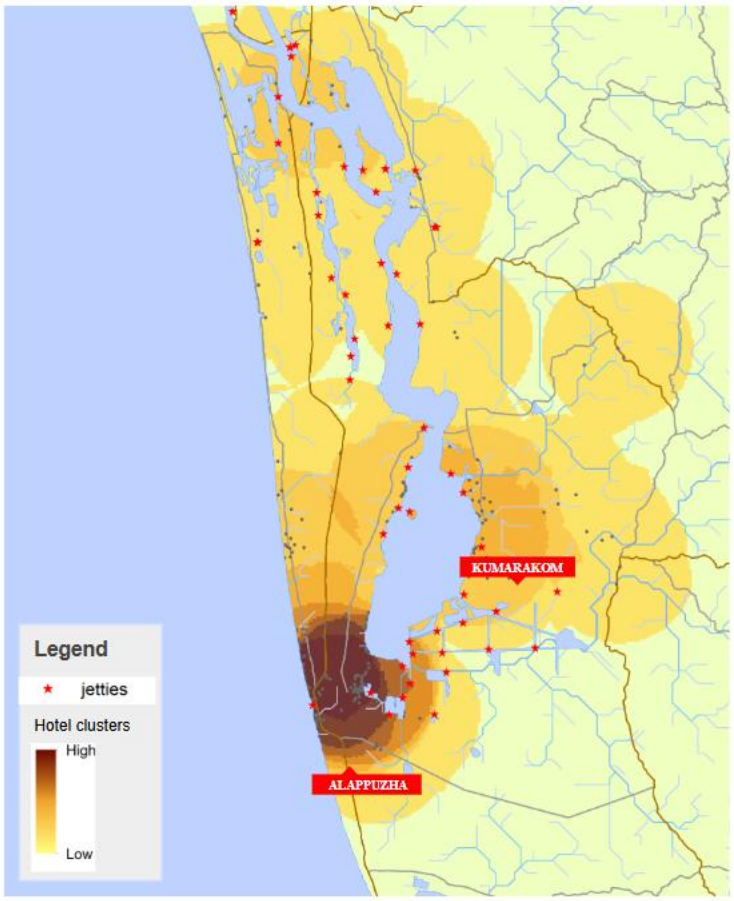



**FIGURE 57: DENSITY MAP OF HOTELS AND ACCOMMODATION FACILITIES**

*Source: Author*

### *Length of stay*

Among foreign tourists, 57% stay for 3 to 5 days, 31% stay for 1 to 2 days, and only 12% stay for more than 6 days, indicating that foreign visitors generally prefer longer stays. In contrast, domestic tourists tend to stay for shorter periods, with 63% staying for just 1 to 2 days, 29% staying for 3 to 5 days, and only 8% extending their visit beyond 6 days. Regarding repeat travel behavior, only 18% of foreign tourists are repeat visitors, while a larger 82% are first-time visitors. Domestic tourists show a higher rate of repeat visits, with 27% returning and 73% visiting for the first time. Overall, foreign tourists tend to stay longer but are less likely to revisit, whereas domestic tourists favor shorter stays but have a greater tendency to return.

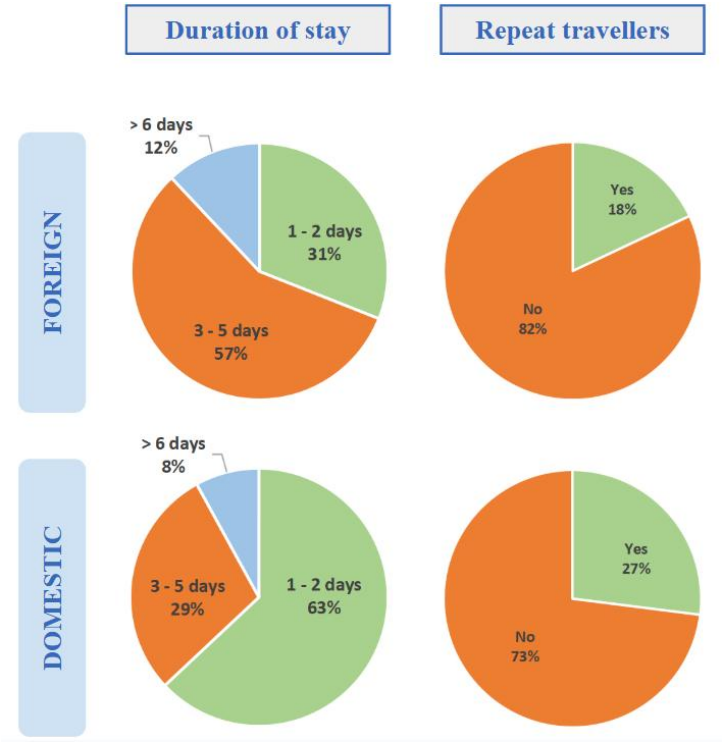



**FIGURE 58: TOURIST TRAVEL AND STAY PATTERNS, ALAPPUZHA AND KUMARAKOM**

*Source : Author, primary survey*

### 3.7.3.2 TOURIST INFLOW PATTERN

Ernakulam consistently attracted the highest number of tourists, both foreign and domestic, with clear seasonal peaks during the months of November to March and noticeable declines during the monsoon season from June to August. Among foreign tourists, Ernakulam showed strong, regular fluctuations, while Alappuzha experienced noticeable seasonal spikes, particularly around December and January, likely due to its popularity for backwater tourism. Kottayam maintained a lower but steady inflow of foreign tourists without significant peaks. In terms of domestic tourists, Ernakulam again dominated, with tourist numbers reaching over 4.5 million, and similar seasonal patterns of peaks during winter and summer holidays. Alappuzha and Kottayam recorded much smaller but consistent domestic tourist numbers, following similar seasonal variations. A significant dip in tourist numbers is seen in mid-2018, likely due to the Kerala floods, but tourism quickly rebounded by the end of 2019. Overall, the data highlights Ernakulam as the major tourist hub, with strong seasonal trends influencing travel patterns and a resilient recovery following natural disruptions.

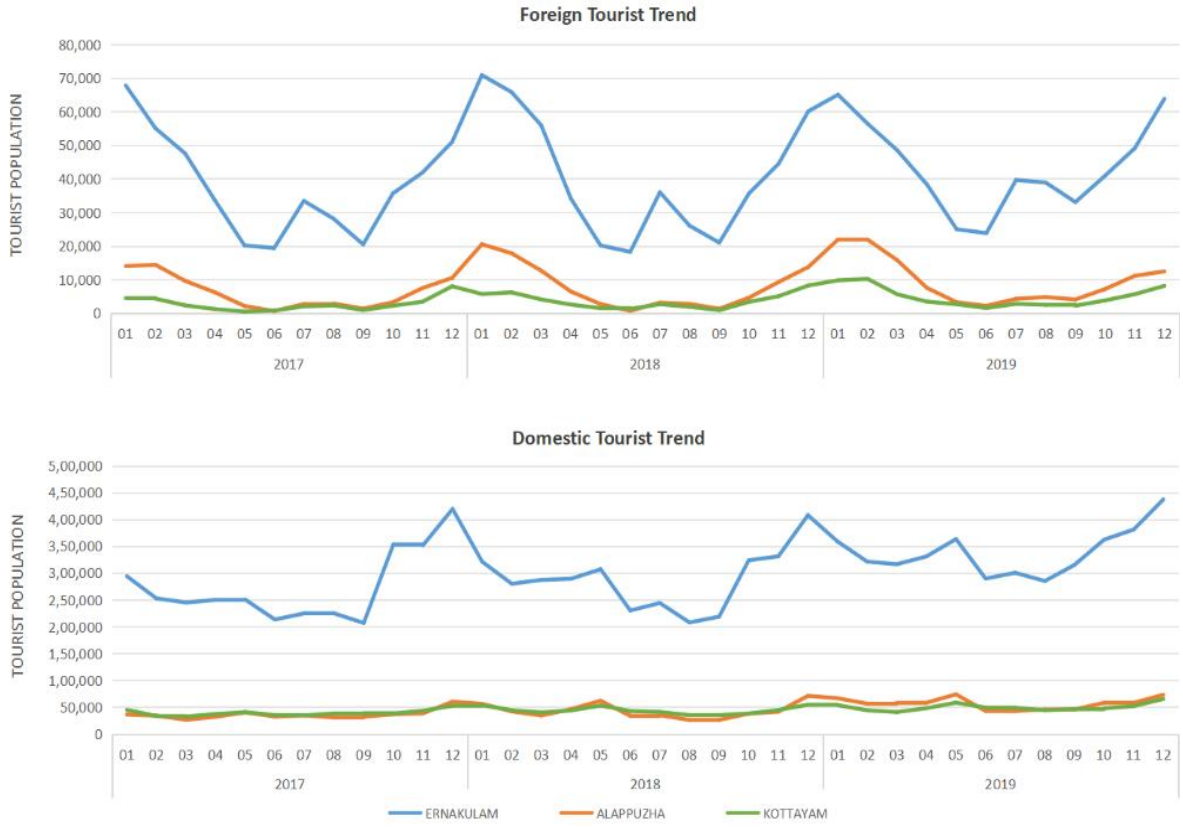



**FIGURE 59: MONTHLY TOURIST INFLOW PATTERN**

*Source : Kerala Tourism*

Seasonality in tourist inflow is depicted by higher Gini coefficient, which indicates greater inequality in the distribution of tourist arrivals. Among foreign tourists, Alappuzha shows the highest inequality (0.42704), followed by Kottayam (0.37232) and Ernakulam (0.21631), with an overall average of 0.25453. This suggests that foreign tourist arrivals are unevenly distributed, especially in Alappuzha and Kottayam. In contrast, domestic tourism shows much lower Gini coefficients across all three districts. This indicates that domestic tourist arrivals are more evenly distributed.

**TABLE 8: SEASONALITY OF TOURIST INFLOW**

| Gini coefficient | Ernakulam | Alappuzha | Kottayam | Average |
|---|---|---|---|---|
| **Foreign** | 0.21631 | 0.42704 | 0.37232 | 0.25453 |
| **Domestic** | 0.11557 | 0.17057 | 0.09565 | 0.11528 |
| **Total** | 0.11736 | 0.18519 | 0.10726 | 0.12049 |

*Source : Author*

The correlation table shows the relationship between total tourist arrivals in Ernakulam, Alappuzha, and Kottayam. A correlation value closer to 1 indicates a strong positive relationship. The correlation between Ernakulam and Alappuzha is 0.8449, and between Ernakulam and Kottayam is 0.8494, suggesting a strong positive relationship in tourist trends between these districts. The highest correlation is observed between Alappuzha and Kottayam at 0.9007, indicating that tourist flows between these two locations are highly synchronized. Overall, the strong correlations imply that tourism patterns across these districts move similarly, likely due to their geographical proximity, shared tourist circuits, or similar seasonal influences.

**TABLE 9: CORRELATION MATRIX OF TOTAL TOURIST ARRIVALS**

| Correlation | Total tourists | | |
|---|---|---|---|
| | **Ernakulam_T** | **Alappuzha_T** | **Kottayam_T** |
| **Ernakulam_T** | 1 | 0.844951218 | 0.849369424 |
| **Alappuzha_T** | 0.844951218 | 1 | 0.900710266 |
| **Kottayam_T** | 0.849369424 | 0.900710266 | 1 |

*Source : Author*

### 3.7.3.3 TOURIST POPULATION FORECAST

Holt-Winters triple exponential smoothing method is a forecasting technique ideal for data with both trend and seasonality components. It uses three smoothing equations: one for the level, one for the trend, and one for the seasonal component, allowing the model to predict future values more accurately by capturing periodic fluctuations and overall growth trends.

In the graph, the solid blue line represents historical tourist arrival data from 2017 to 2019, while the dashed red line shows the 5-year forecast from 2020 to 2025. The forecast indicates a steady and significant growth in tourist numbers over the years, with strong seasonality observed in each year, peaking towards the end of each cycle. The tourist population is projected to rise from about 598,584 in 2020 to nearly 1 million by 2025. The trend continues beyond 2025, as shown in the forecast table, predicting over 1.65 million tourists by 2030. This suggests a positive outlook for tourism, with robust growth expected, driven by both seasonal peaks and an upward trend in overall tourist interest.

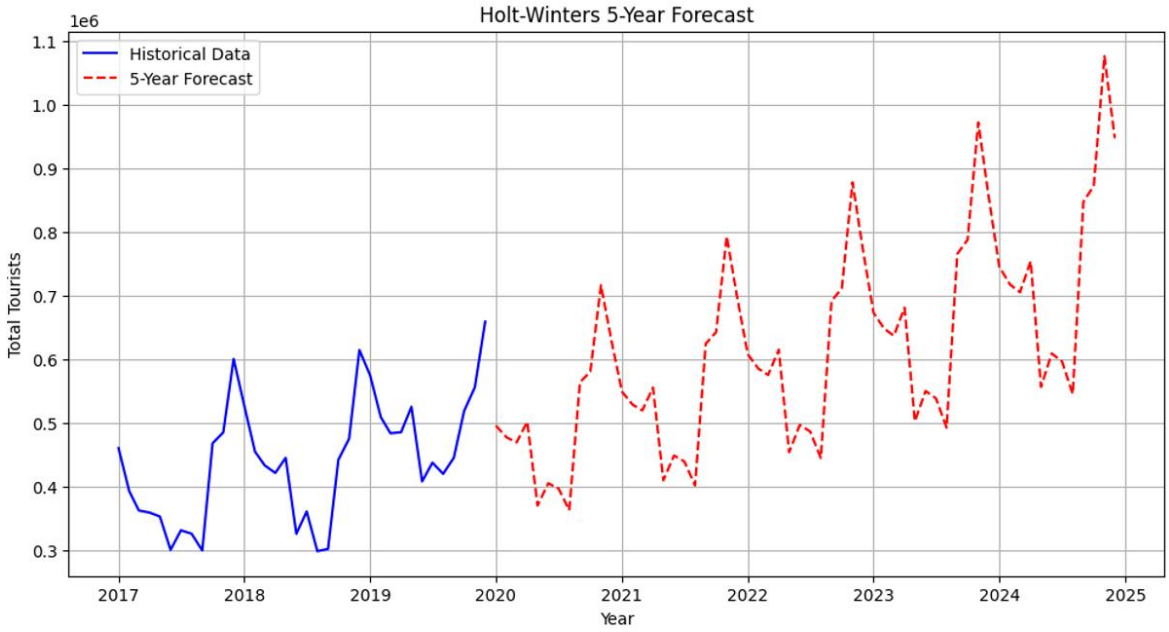



**FIGURE 60: MONTHLY TOURIST POPULATION FORECAST**

*Source : Author*

### 3.7.3.4 EARNINGS FROM TOURISM

Earnings for tourism are measured across two categories: Foreign Exchange Earnings and Total Revenue (Direct and Indirect). Ernakulam consistently dominates both categories, generating significantly higher earnings compared to Alappuzha and Kottayam. This trend suggests that while tourism is growing across all three districts, Ernakulam is driving the bulk of the economic benefits, likely due to better infrastructure, connectivity, and a broader tourist offering.

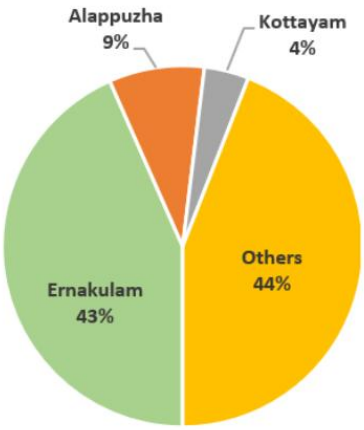



**FIGURE 61: FOREIGN EXCHANGE EARNINGS**

*Source : Kerala Tourism*

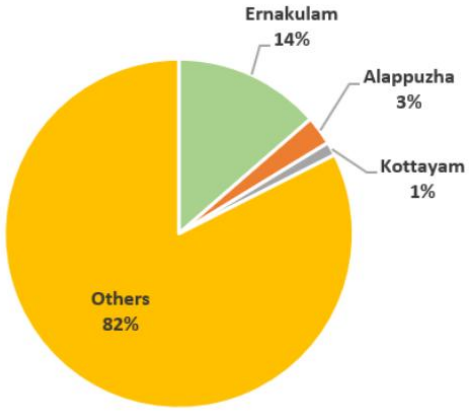



**FIGURE 62: TOTAL REVENUE EARNING**

*Source : Kerala Tourism*

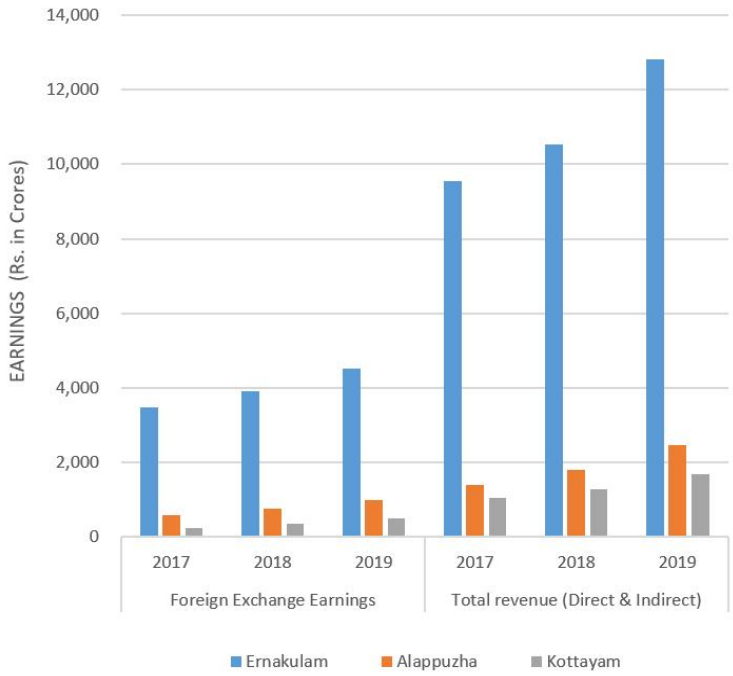


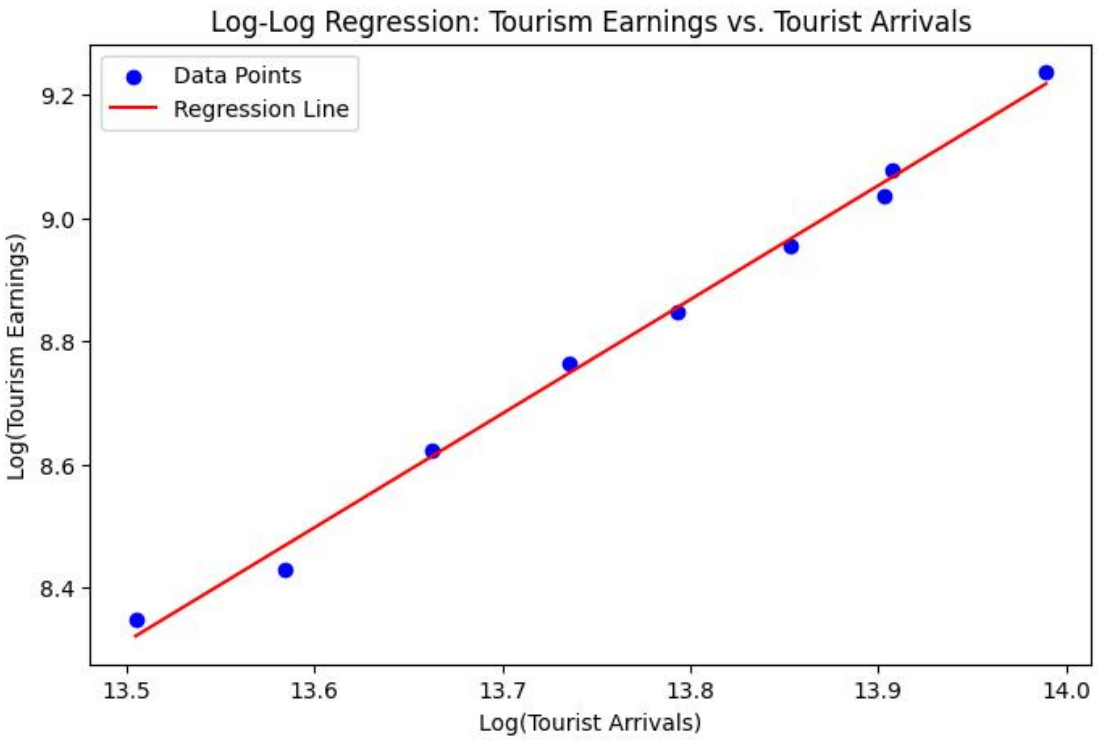

**FIGURE 63: EARNINGS FROM TOURISM OVER**

*Source : Kerala Tourism*

### 3.7.3.5 TOURISM EARNINGS FORECAST

The log-log regression model is a widely used econometric technique where both the dependent and independent variables are transformed using natural logarithms. This method is particularly effective when modeling relationships that are multiplicative in nature and when estimating elasticity — the percentage change in one variable resulting from a percentage change in another. In the context of forecasting tourism earnings, the log of earnings is regressed against the log of tourist numbers, allowing for a direct estimation of elasticity.

Such a regression model was worked out for the Vembanad region, where the coefficient for log_Tourists is 1.8530. This value indicates the estimated elasticity, meaning that a 1% increase in tourist arrivals is associated with approximately a 1.85% increase in tourism earnings. The negative constant term (-16.7040) is typical in log-log models and adjusts the baseline level of earnings when tourist numbers are low. The very high t-statistics and extremely low p-values (0.000) for both coefficients confirm that the model is statistically significant. Overall, the model suggests a strong and highly elastic relationship between tourist volume and tourism earnings, emphasizing the critical economic impact of even small increases in tourist numbers.




| | coef | std err | t | P>\|t\| |
|---|---|---|---|---|
| const | -16.7040 | 0.717 | -23.303 | 0.000 |
| log_Tourists | 1.8530 | 0.052 | 35.600 | 0.000 |

Estimated Elasticity: 1.8530

**FIGURE 64: LOG-LOG RELATIONSHIP PLOT OF TOURIST EARNINGS VS TOURIST ARRIVALS**

*Source : Author*

### 3.7.3.6 BOATS IN THE BACKWATERS

#### 3.7.3.6.1 TYPES AND STATISTICS

The Vembanad waters are home to a vibrant variety of boats that cater to different facets of tourism, offering visitors unique experiences. Houseboats are a major attraction, providing comfortable overnight accommodations that allow tourists to immerse themselves in the serene beauty of the backwaters. Shikaras, traditional open boats with canopies, are popular for daytime sightseeing tours through the picturesque canals, offering a closer look at village life and lush landscapes. Motor boats primarily serve as a means of transportation during the off-season, ensuring connectivity for both locals and tourists across various parts of the region. Speed boats add an element of adventure to the backwaters, offering thrilling water sport activities for those seeking a burst of excitement. Together, these diverse types of boats

enrich the tourism offerings in Vembanad, catering to a wide range of preferences from relaxed stays to adrenaline-pumping rides.


**FIGURE 65: TYPES OF TOURIST BOATS IN THE VEMBANAD**

*Source : Author*

| Type | Number (approx) |
|---|---|
| Registered houseboats | 917 |
| Unregistered houseboats | 800 |
| Shikhara | 236 |
| Motor boats | 136 |
| Speed boats | 66 |
| **TOTAL** | 2155 |

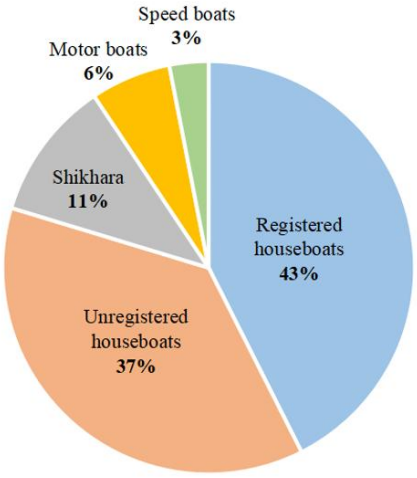



**FIGURE 66: PERCENTAGE SHARE OF BOAT TYPES**

*Source : Author*

Alappuzha consistently holds a much larger share of houseboats compared to Kottayam. Despite the growing number of houseboats, the average tourist population per day has fluctuated, peaking in 2018 and then declining by 2023. Consequently, the boat-to-tourist ratio improved to 1:3 in 2023, indicating that there are now relatively more boats available per tourist. This could suggest either a drop in tourist demand post-2018 or an oversupply of houseboats relative to the tourist inflow, potentially hinting at underutilization of capacity in recent years.

**TABLE 10: BOAT TO TOURIST RATIO IN THE VEMBANAD**

| Year | Alappuzha (registered houseboats) | Kottayam (registered houseboats) | Total (registered houseboats) | Average tourist population per day in peak month | Boat to tourist ratio |
|---|---|---|---|---|---|
| **2015** | 634 | 81 | 715 | 3115 | 1:4 |
| **2018** | 758 | 159 | 917 | 4750 | 1:7 |
| **2023** | 821 | 162 | 983 | 3050 | 1:3 |
| **2015** | 634 | 81 | 715 | 3115 | 1:4 |
| **2018** | 758 | 159 | 917 | 4750 | 1:7 |
| **2023** | 821 | 162 | 983 | 3050 | 1:3 |
| **2015** | 634 | 81 | 715 | 3115 | 1:4 |

*Source : Author*

### 3.7.3.6.2 TRIP CHARACTERISTICS AND EARNINGS

The economic dynamics of different boat types operating in the Vembanad waters is different. Houseboats generate the highest average daily earnings, especially in peak season, owing to their overnight accommodation and higher rates, followed by speed boats, shikharas, and motor boats. Despite having shorter trips and fewer passengers, speed boats achieve significant earnings due to higher hourly rates and multiple trips. shikharas and motor boats, offering budget-friendly options, earn comparatively less but cater to larger or family groups. Additionally, a marked drop in earnings during the lean season across all boat types indicates strong seasonality in the tourism business. Overall, houseboats dominate the tourism revenue landscape, while speed boats offer lucrative returns through volume and premium pricing.

**TABLE 11: AVERAGE EARNINGS FROM BOAT TRIPS**

| Parameter | Houseboat | Shikhara | Motor boat | Speed boat |
|---|---|---|---|---|
| **Operational timings** | 12pm - 9am | 8am - 6pm | 10am - 4pm | 8am - 6pm |

| Parameter | Houseboat | Shikhara | Motor boat | Speed boat |
|---|---|---|---|---|
| **Trips/day** | 1 | 8 | 1 | 6 |
| **Trip duration** | 8 hours | 1 hour | 6 hours | 1 hour |
| **Avg. passengers** | 10 (5 rooms) | 5 (1 family) | 30 (heads) | 3 (heads) |
| **Avg. rate in peak season** | Rs. 15,000/day | Rs. 2,000/hr | Rs. 500/head | Rs. 4000/hr |
| **Avg. rate in lean season** | Rs. 8,000/day | Rs. 1,500/hr | Rs. 300/head | Rs. 2,500/hr |
| **Avg. earnings/day in peak season** | Rs. 75,000 | Rs. 16,000 | Rs. 15,000 | Rs. 24,000 |
| **Avg. earnings/day in lean season** | Rs. 40,000 | Rs. 12,000 | Rs. 9,000 | Rs. 15,000 |

*Source : Author*

The cost analysis reveals that houseboats incur the highest operational expenses, driven by extensive fuel consumption (due to twin engines and additional DG set usage) and high fixed costs for labor and maintenance. Despite slower cruising speeds, houseboats cover significant distances, resulting in substantial fuel needs. In contrast, shikharas and motor boats demonstrate much lower daily costs, attributed to better mileage and simpler operational setups. Speed boats, while having high cruising speeds and longer distances traveled, have moderate operational costs, making them cost-effective relative to their earning potential. Overall, houseboats require heavy daily investments, while shikharas and motor boats offer more economical operation, and speed boats strike a balance between cost and performance.

**TABLE 12: AVERAGE COST INCURRED FOR BOAT OPERATIONS**

| Parameter | Houseboat | Shikhara | Motor boat | Speed boat |
|---|---|---|---|---|
| **Operating hours/day** | 10 hours | 8 hours | 6 hours | 6 hours |
| **Cruising speed** | 10 km/hr | 10 km/hr | 15 km/hr | 30 km/hr |
| **Distance travelled** | 100 km | 80 km | 90 km | 180 km |
| **Mileage** | 0.85 km/l | 1 km/l | 2 km/l | 1.5 km/l |
| **Fuel consumption for propulsion** | 240 l (twin engines) | 80 l | 75 l | 120 l |
| **Fuel consumption by 2.8kW DG sets** | 60 l | - | - | - |
| **Fuel costs at Rs. 90/l** | Rs. 27,000 | Rs. 7,200 | Rs. 6,750 | Rs. 10,800 |

| Parameter | Houseboat | Shikhara | Motor boat | Speed boat |
|---|---|---|---|---|
| **Fixed running costs (labour/maintenance)** | Rs. 20,000 | Rs. 5,000 | Rs. 5,000 | Rs. 8,000 |
| **Avg. cost/day** | Rs. 47,000 | Rs. 12,200 | Rs. 11,750 | Rs. 18,800 |

*Source : Author*

From the comparison, it is clear that houseboats generate the highest absolute daily profits, despite having the highest operational costs. Their luxury appeal and overnight accommodation services allow them to charge premium rates. Speed boats offer the second-highest profit margins, benefiting from relatively high earnings compared to their moderate costs. Shikharas and motor boats, though operating at lower costs, also generate lower profits, positioning them as steady but smaller income options.

**TABLE 13: AVERAGE COST INCURRED FOR BOAT OPERATIONS**

| Boat Type | Avg. Earnings/Day (Peak Season) | Avg. Cost/Day | Profit/Day | Boat Type |
|---|---|---|---|---|
| **Houseboat** | Rs. 75,000 | Rs. 47,000 | Rs. 28,000 | Houseboat |
| **Shikhara** | Rs. 16,000 | Rs. 12,200 | Rs. 3,800 | Shikhara |
| **Motor boat** | Rs. 15,000 | Rs. 11,750 | Rs. 3,250 | Motor boat |
| **Speed boat** | Rs. 24,000 | Rs. 18,800 | Rs. 5,200 | Speed boat |

*Source : Author*

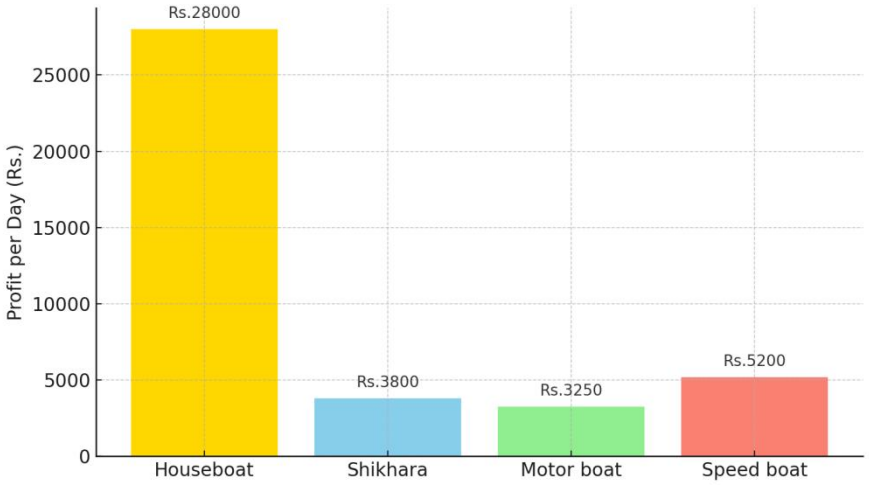



**FIGURE 67: DAILY PROFIT COMPARISON ACROSS BOAT TYPES**

*Source : Author*

#### 3.7.3.6.3 CARBON FOOTPRINT

The data highlights the urgent need for greener boating technologies and better fuel efficiency practices in Vembanad's tourism to minimize ecological impacts. Houseboats are the largest contributors to $CO_2$ emissions, producing about $6.4 \times 10^7$ kg of carbon dioxide annually, owing to their high daily fuel consumption and large number. Shikharas and Motor boats have significantly lower emissions, but still contribute non-negligibly, especially during the peak tourist season. Speed boats have the lowest emissions, but given their smaller numbers and higher speeds, their per-boat emissions are quite substantial. During the peak season, the $CO_2$ load is considerably higher, indicating that tourist influx significantly exacerbates environmental pressures. With an average of 12,00,000 tourists visiting the Vembanad, 62.75 kg of CO2 is emitted per tourist footfall.

**TABLE 14: CARBON FOOTPRINT DUE TO BOAT OPERATIONS**

| Parameter | Houseboat | Shikhara | Motor boat | Speed boat |
|---|---|---|---|---|
| **Fuel consumption/boat/day** | 300 l | 80 l | 75 l | 120 l |
| **$CO_2$ emissions/day (2.8 kg/l)** | 840 kg | 224 kg | 210 kg | 336 kg |
| **Parameter** | Houseboat | Shikhara | Motor boat | Speed boat |
| **Fuel consumption/boat/day** | 300 l | 80 l | 75 l | 120 l |
| **Peak Season: 3 months (Dec-Feb)** | | | | |
| **Average no. of boats daily** | 500 | 200 | 100 | 30 |
| **$CO_2$ (all boats - 1 day)** | $4.2 \times 10^5$ kg | $0.45 \times 10^5$ kg | $0.21 \times 10^5$ kg | $0.10 \times 10^5$ kg |
| **$CO_2$ (all boats - peak season)** | $3.8 \times 10^7$ kg | $0.41 \times 10^7$ kg | $0.19 \times 10^7$ kg | $0.09 \times 10^7$ kg |
| **Lean Season: 5 months (Mar-May, Oct-Nov)** | | | | |
| **Average no. of boats daily** | 250 | 100 | 50 | 10 |
| **$CO_2$ (all boats - 1 day)** | $2.1 \times 10^5$ kg | $0.22 \times 10^5$ kg | $0.10 \times 10^5$ kg | $0.03 \times 10^5$ kg |
| **$CO_2$ (all boats - lean season)** | $2.6 \times 10^7$ kg | $0.30 \times 10^7$ kg | $0.09 \times 10^7$ kg | $0.05 \times 10^7$ kg |
| **Total $CO_2$ in one year** | **$6.4 \times 10^7$ kg** | **$0.71 \times 10^7$ kg** | **$0.28 \times 10^7$ kg** | **$0.14 \times 10^7$ kg** |

*Source : Author*

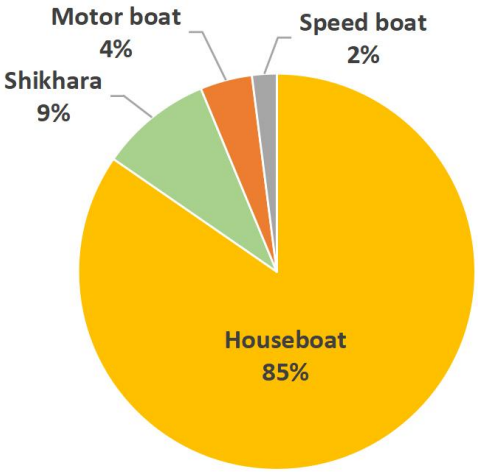



**FIGURE 68: PERCENTAGE OF $CO_2$ EMITTED PER YEAR BY EACH BOAT TYPE**

*Source : Author*

### 3.7.3.6.4 WASTE GENERATION

Sewage on houseboats is collected in bio-tanks on the boats. Every three months, the boats are taken to the sewage treatment plant to get the tanks cleaned. Houseboat license renewed on the basis of entry in the sewage treatment plant log book. A huge volume of sewage and wastewater (2,32,500 litres daily) is produced due to tourism activities, emphasizing the critical need for proper wastewater treatment facilities to prevent contamination of Vembanad's sensitive water ecosystems.

**TABLE 15: AVERAGE QUANTITY OF WASTES GENERATED DUE TO TOURISM**

| Particulars | Avg. quantity generated per day |
|---|---|
| **Biodegradable solid wastes** | 1500 kg |
| **Recyclable plastic waste** | 700 kg |
| **Wastes to be incinerated:** | 100 kg |
| **Fuel consumption/boat/day** | 300 l |

*Source : Author*

To separate solid and liquid waste and the end product would be clear water. The sludge would undergo secondary treatment. Treated water will be discharged suitably, while the solid waste will be transported to a treatment facility and converted into fertilizer.

MOBILE SEPTAGE TREATMENT UNIT :

Capacity = 1.00.000 litres
Charge = Rs. 2,000 per 1,000 litres

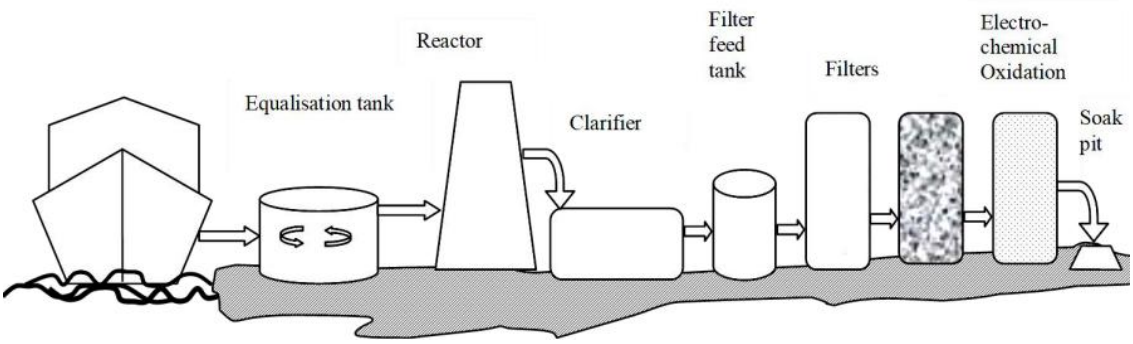



**FIGURE 69: LAYOUT OF DTPC SEWAGE TREATMENT PLAN**

*Source : Alappuzha DTPC*

### 3.7.3.7 WILLINGNESS TO PAY

#### 3.7.3.7.1 ECO-FRIENDLY ACCOMMODATION FACILITIES

The willingness to pay analysis highlights the difference in price sensitivity between foreign and domestic tourists. It shows that foreign tourists exhibit relatively inelastic demand — even as prices increase from ₹100 to ₹4600, a high percentage (around 75–80%) remain willing to pay for eco-friendly stays. This indicates that foreign tourists place significant value on sustainable tourism experiences and are less deterred by higher costs. In contrast, domestic tourists are much more price-sensitive; their willingness to pay declines steeply after ₹1600, with very few willing to pay beyond ₹3100. This suggests that while eco-friendly accommodations can command premium pricing for foreign visitors, more affordable or flexible pricing models are necessary to attract and retain domestic tourists. Pricing strategies should therefore be carefully differentiated to maximize reach and profitability across both segments.

The "Price Elasticity of Demand for Eco-Friendly Accommodation" graph illustrates how sensitive foreign and domestic tourists are to price changes. The blue line for foreign tourists shows that their demand remains relatively inelastic across the price range, with elasticity values close to zero — indicating that price increases have only a small negative effect on their willingness to pay. Conversely, the red line for domestic tourists drops sharply after ₹1600, reaching highly elastic values (around -1.0), suggesting that domestic tourists are very sensitive to price hikes. As prices rise beyond ₹2000, domestic tourists' demand contracts significantly, reflecting a steep drop in their affordability and willingness to pay. This analysis confirms that foreign tourists are a more stable market segment for higher-priced

eco-friendly accommodation, while domestic tourists require more price-sensitive offerings to maintain their interest.

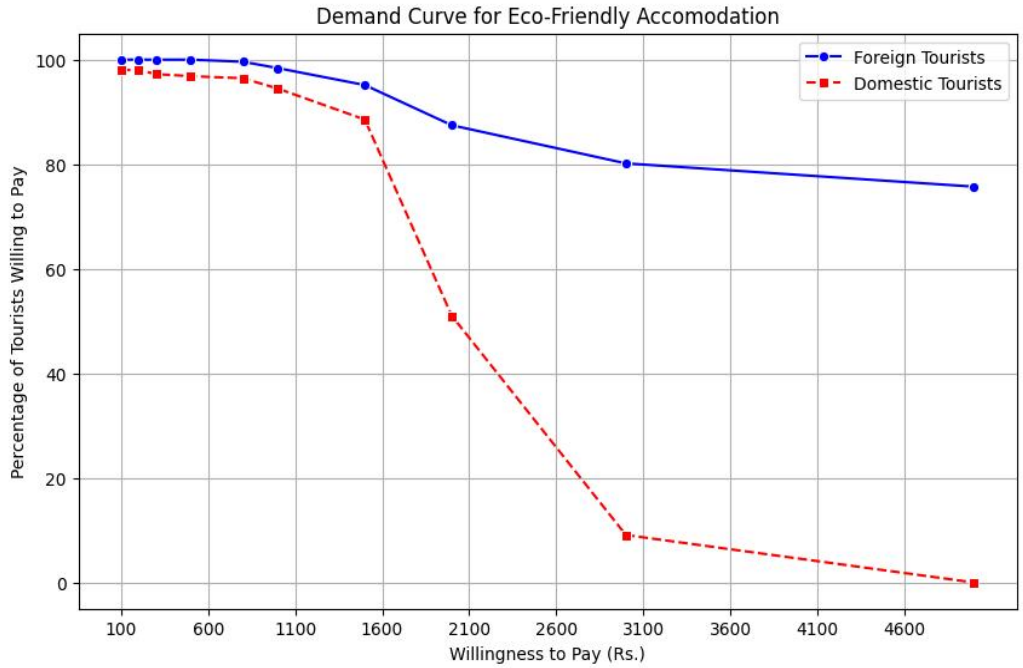



**FIGURE 70: DEMAND CURVE FOR ECO-FRIENDLY ACCOMMODATION FACILITIES**

*Source : Author, primary survey*

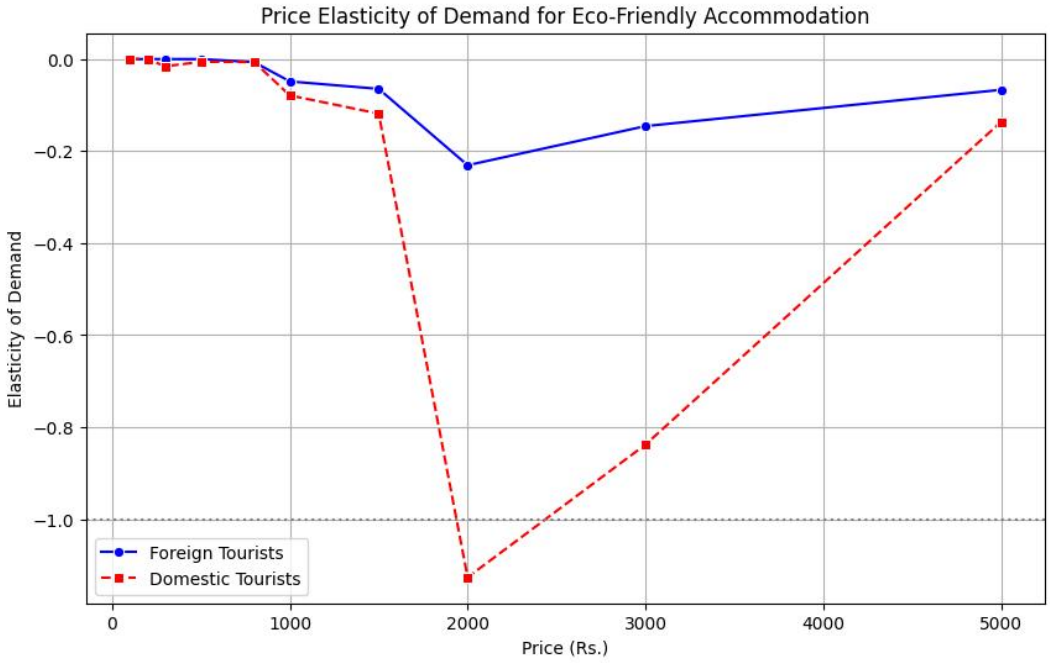



**FIGURE 71: PRICE ELASTICITY FOR DEMAND FOR ECO-FRIENDLY ACCOMMODATION FACILITIES**

*Source : Author, primary survey*

### 3.7.3.8 ECO-FRIENDLY BOATING FACILITIES

The "Demand Curve for Eco-Boats" graph shows the willingness of foreign and domestic tourists to pay different prices for eco-boat services. Foreign tourists (blue line) exhibit a gradual decline in demand as prices increase, indicating relatively steady interest even at higher price points. In contrast, domestic tourists (red line) display a sharp drop-off in willingness to pay as prices rise. While almost all tourists are willing to pay ₹50, by ₹250, less than 20% of domestic tourists remain willing, and above ₹400, virtually none are willing to pay. This suggests that foreign tourists are more resilient to price increases for eco-boat experiences, whereas domestic tourists are much more price-sensitive, requiring affordable pricing to maintain high participation rates.

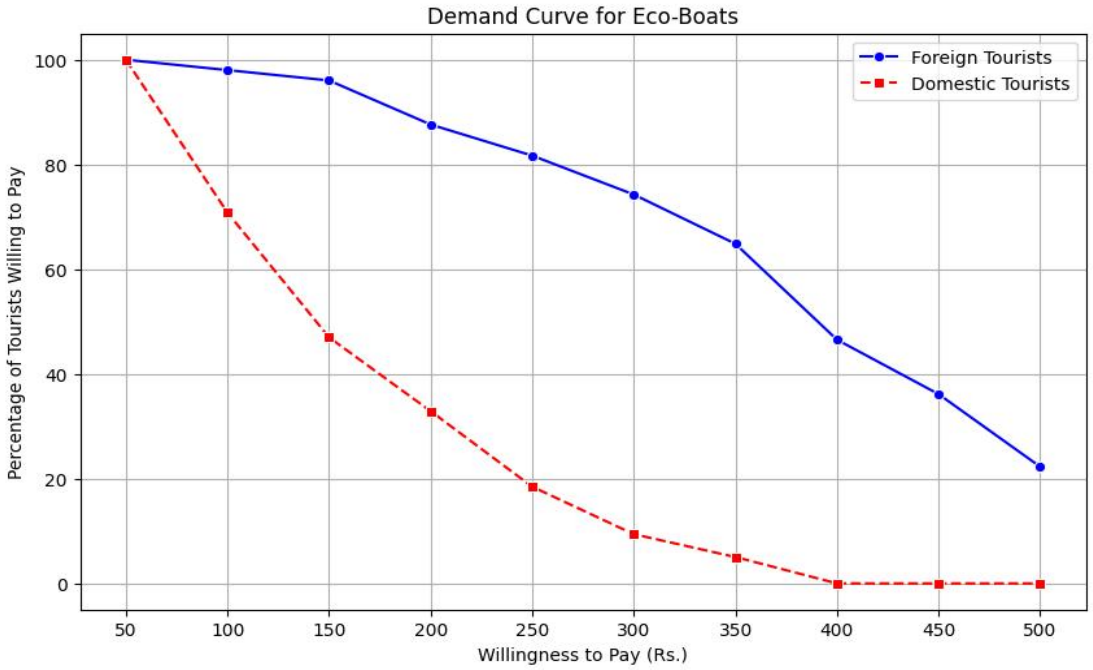



**FIGURE 72: DEMAND CURVE FOR WILLINGNESS TO PAY FOR ECO-FRIENDLY BOATING FACILITIES**

*Source : Author, primary survey*

The "Price Elasticity of Demand for Eco-Friendly Accommodation" graph shows how sensitive foreign and domestic tourists are to price changes for eco-friendly boat services. Foreign tourists (blue line) show a greater elasticity, especially beyond ₹350, where the elasticity drops sharply below -1, indicating highly elastic demand — meaning small price increases cause large drops in demand. Domestic tourists (red line), however, show relatively inelastic demand throughout most of the price range, with elasticity values staying between 0 and -0.6. Their demand is less sensitive to moderate price changes, except at lower prices where it is almost perfectly inelastic (elasticity close to 0). Overall, the chart suggests that

foreign tourists are much more price-sensitive at higher price points compared to domestic tourists, who are somewhat more consistently willing to pay within the observed range.

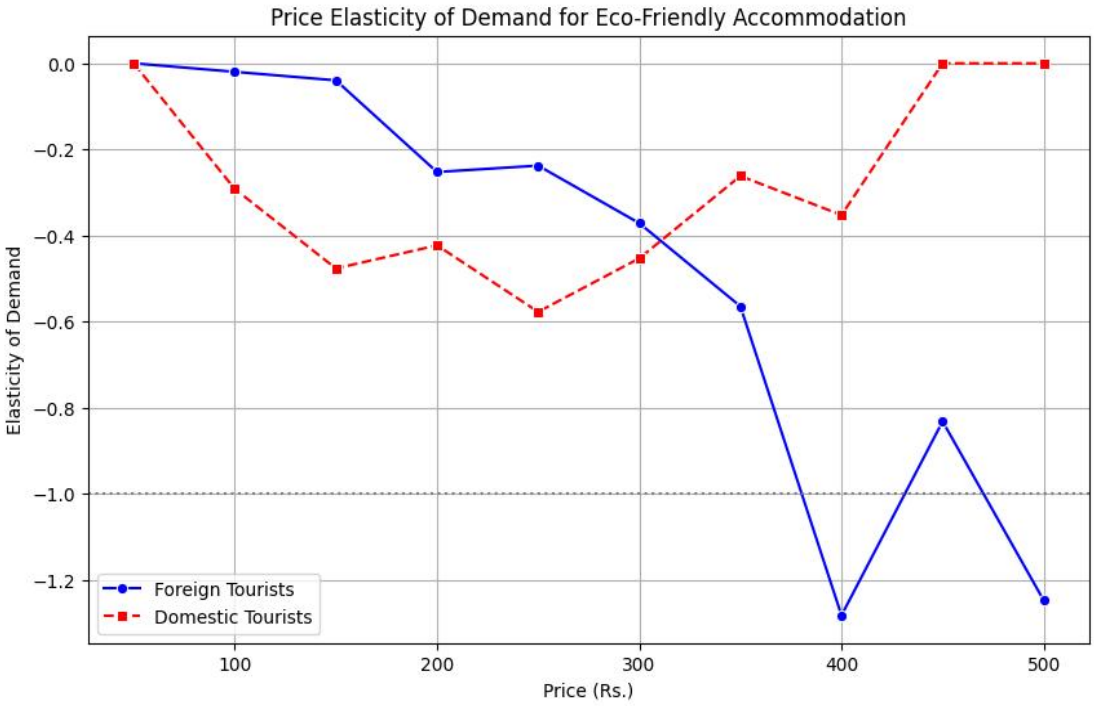



**FIGURE 73: PRICE ELASTICITY FOR DEMAND FOR ECO-FRIENDLY BOATING FACILITIES**

*Source : Author, primary survey*

# 3.8 ENVIRONMENTAL ASSESSMENT

## 3.8.1 TOURIST AWARENESS

Being a naturally vulnerable region, insights into tourists' awareness and attitudes towards eco-friendliness and sustainability is especially crucil. A significant portion (47%) of respondents is only somewhat aware that Vembanad is a RAMSAR site, while another 47% are not aware at all, indicating low overall awareness. When it comes to prioritizing eco-friendly accommodations while traveling, 54% never prioritize it, showing a clear gap between sustainable awareness and practice. Similarly, 71% of respondents do not take action when they observe unsustainable practices. Regarding engagement in nature-based activities, 53% report never participating, suggesting limited interaction with environmental experiences. However, when asked about the importance of sustainability, 44% rated it as "somewhat important" and 35% as "important," demonstrating that although sustainability is valued by many, it is not yet deeply integrated into behavior. This points to a crucial need for greater education, awareness, and motivation to turn sustainability concern into action.

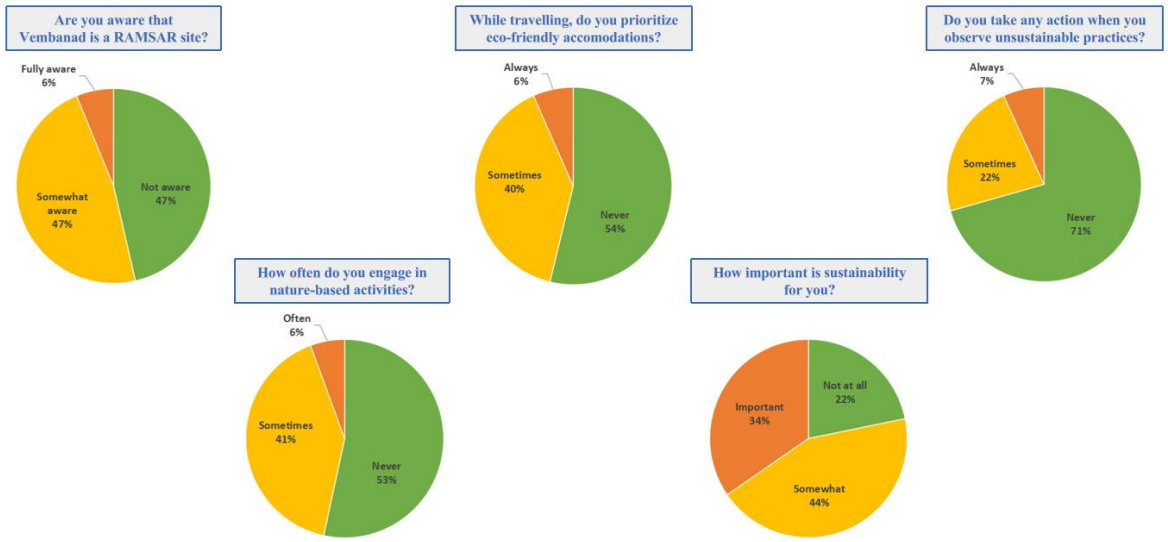



**FIGURE 74: TOURIST AWARENESS SURVEY**

*Source : Author, primary survey*

## 3.8.2 BIODIVERSITY

### 3.8.2.1 MANGROVES AND MARSHES

Mangroves and marshes around Vembanad Lake are vital ecosystems that play a crucial role in maintaining the region's ecological balance. Mangroves, with their dense root systems, protect the shoreline from erosion, act as natural barriers against storms, and provide rich breeding grounds for fish, crabs, and other aquatic life. They also help in filtering pollutants and improving water quality. Similarly, the marshes of Vembanad serve as important wetlands that support a wide variety of bird species, both resident and migratory, while also playing a key role in groundwater recharge and flood control. Unfortunately, rapid urbanization, tourism pressures, and pollution have led to the significant degradation of these habitats.

**TABLE 16: EXTENT OF MANGROVES IN THE VEMBANAD**

| District | Homogeneous (sq.km.) | Heterogeneous (sq.km.) | Total (sq.km.) | % Share |
|---|---|---|---|---|
| **Ernakulam** | 2.674 | 4.269 | 6.153 | 31.5 |
| **Alappuzha** | 0.487 | 0.551 | 1.038 | 5.32 |
| **Kottayam** | 0.565 | 0.42 | 0.985 | 5.04 |

*Source : Pillai et. al. (2018)*


**FIGURE 75: TREE COVER OF THE REGION (2019)**

*Source : Author*

1) **Mangrove species:** *Kandelia kandel, Rhizophora mucronata, Rhizophora apiculata, Bruguiera gymnorrhiza, Sonneratia caseolaris, Avicennia officinalis and Excoecaria agallocha*
2) **Major mangrove associates:** *Calophyllum inophyllum, Hibiscus tiliaceus, Thespesia populnea, Cerbera odollam, Clerodendrum inerme and Acrostichum aureum.*

**TABLE 17: RECORDED MANGROVE SPECIES IN THE VEMBANAD (2009)**

| Type | No. of species |
|---|---|
| **Mangrove** | 16 |
| **Mangrove associates** | 24 |

*Source : Kerala Forest Research Institute*

### 3.8.2.2 WATERBIRD COUNT

The waterbird count in the Vembanad region has shown a significant decline over the years, as depicted in Figure 38. After peaking at around 60,000 birds in 2015, the population has steadily decreased, falling below 15,000 by 2024, with the trend line indicating a persistent downward trajectory. This decline signals possible degradation in habitat quality, pollution, or disturbances from tourism and development.

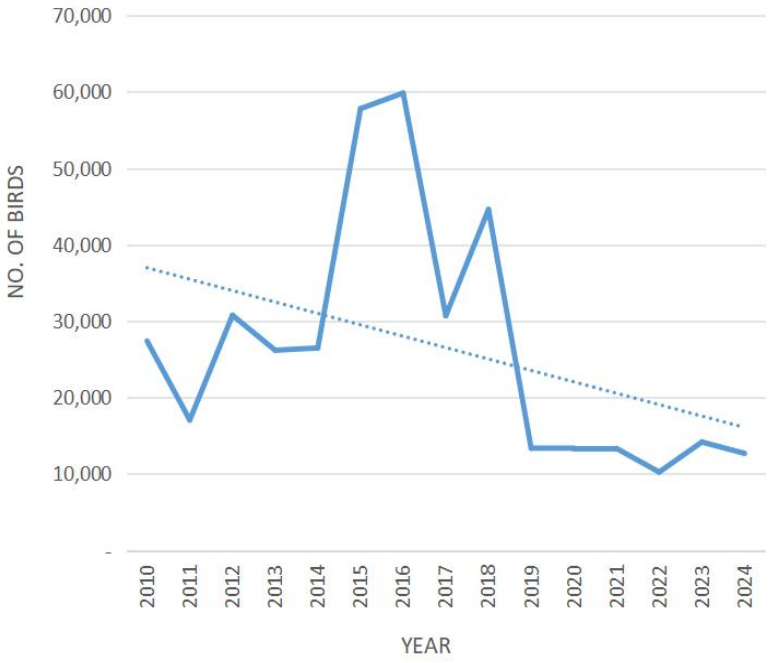



**FIGURE 76: WATERBIRD COUNT IN THE VEMBANAD**

*Source : Kottayam Nature Society*

The major waterbird hotspots are still found around Alappuzha and parts of Kumarakom, but fewer sites show high bird and species diversity compared to earlier years. Areas near Alappuzha and central Vembanad host relatively more species, though overall densities are lower.

During the wet season, there is a slightly greater diversity of species, especially in the central and southern parts around Kumarakom and Alappuzha. These areas show a higher concentration (21–40 species) compared to others. In the dry season, there is a general reduction in species numbers across most areas, visible as more yellow and light orange zones. This suggests that seasonal changes impact biodiversity, with some species likely migrating or becoming dormant during drier periods.

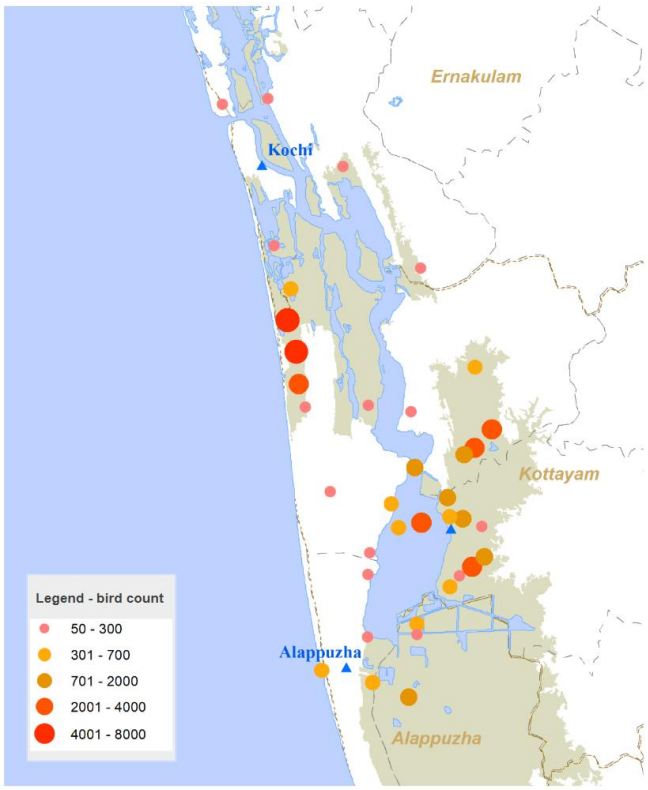



**FIGURE 77: WATERBIRD HOTSPOTS IN THE VEMBANAD (2024)**

*Source : Author, eBird*

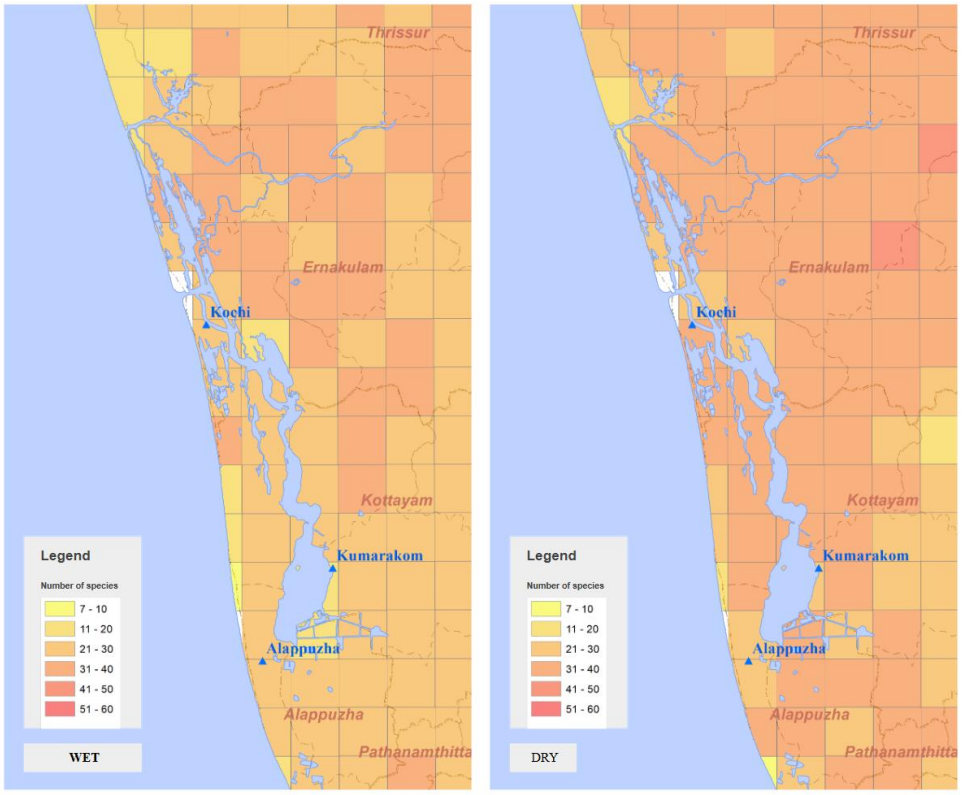



**FIGURE 78: SPECIES COUNT FOR WET AND DRY SEASONS (2015 - 2020)**

*Source : Author, eBird*

## 3.8.3 WATER QUALITY EVALUATION

### 3.8.3.1 SEASONAL VARIATION IN PH LEVELS

The seasonal water quality evaluation of the Vembanad Lake for 2023 reveals notable variations in both pH levels and water temperature across different seasons. As shown in Figure 41 and 42, pH levels fluctuate between 6.5 and 7.2, with a noticeable dip in May, likely due to higher runoff and organic matter input during pre-monsoon. Spatially, lower pH zones (acidic) are concentrated near the central and northern stretches of the lake, especially in pre- and post-monsoon periods, which may reflect pollution.

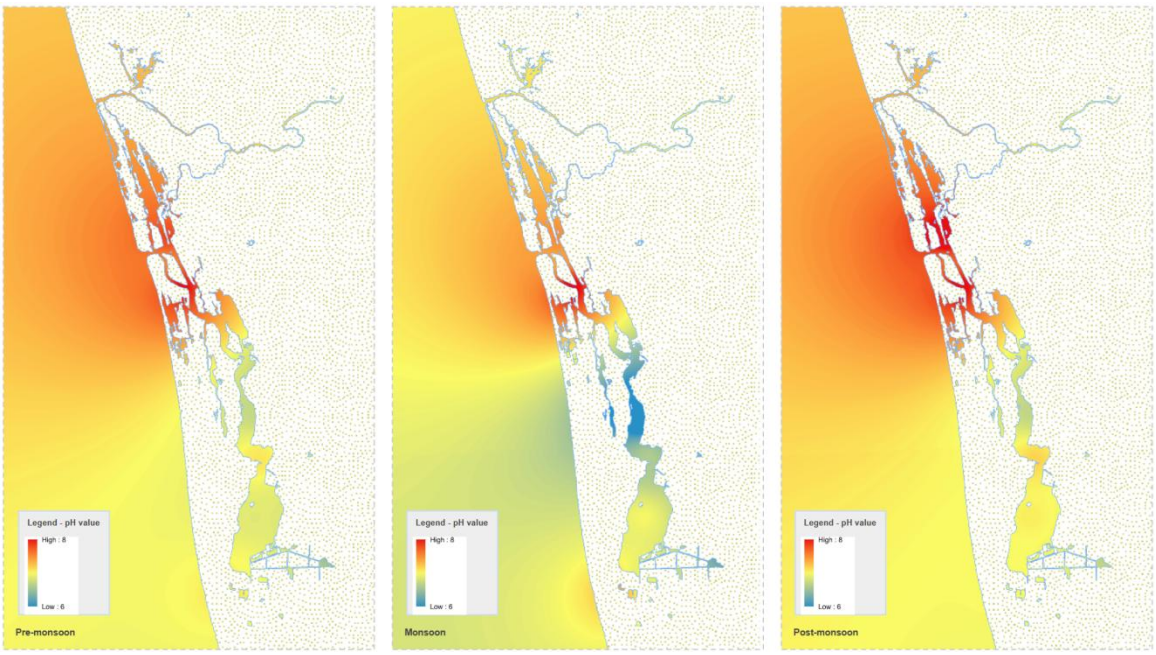



**FIGURE 79: PH LEVELS IN THE VEMBANAD (2023)**

*Source : Author, KSPCB*

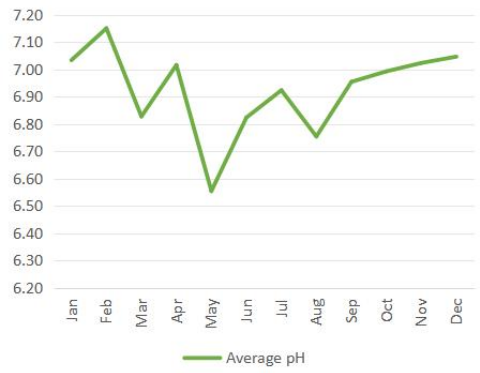



**FIGURE 80: MONTHLY VARIATION OF PH LEVELS**

*Source : Author, KSPCB*

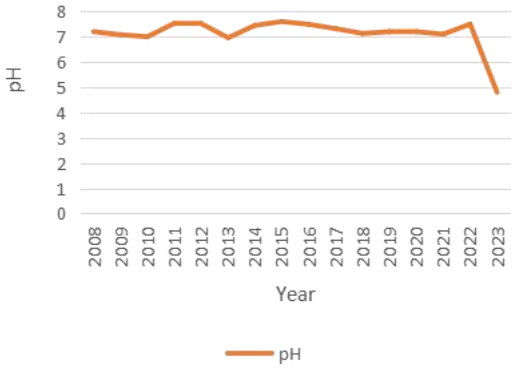



**FIGURE 81: YEARLY VARIATION OF PH LEVELS**

*Source : Author, KSPCB*

### 3.8.3.2 SEASONAL VARIATION IN WATER TEMPERATURE LEVELS

W water temperatures range between 26.5°C and 28.7°C, peaking during April–May and remaining relatively high through the post-monsoon season. The southern regions of the lake tend to record higher water temperatures, particularly in the pre-monsoon period. These variations in pH and temperature could significantly impact aquatic biodiversity and ecosystem health, potentially altering breeding patterns, species composition, and dissolved oxygen levels. Regular monitoring and seasonal mitigation strategies are essential to preserve water quality and sustain ecological balance in the Vembanad.

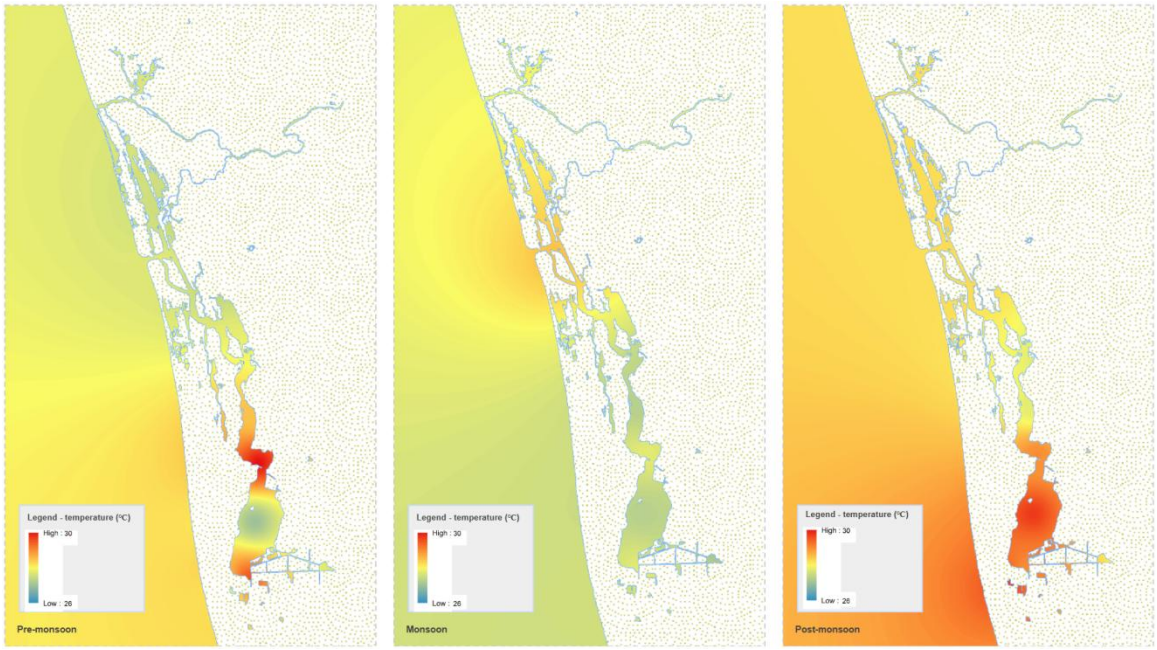



**FIGURE 82: WATER TEMPERATURE IN THE VEMBANAD (2023)**

*Source : Author, KSPCB*

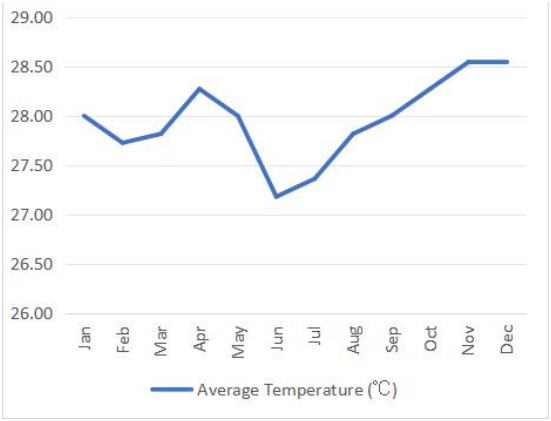



**FIGURE 83: MONTHLY VARIATION OF WATER TEMPERATURE (2023)**

*Source : Author, KSPCB*

### 3.8.3.3 SEASONAL VARIATION IN TURBIDITY LEVELS

The seasonal analysis of water quality in the Vembanad Lake for 2023 shows notable variations in turbidity and Biochemical Oxygen Demand (BOD) levels. As illustrated in Figure 46, turbidity peaks sharply in March, reaching nearly 7 NTU, likely due to increased sediment inflow during pre-monsoon and declining thereafter. Spatial maps reveal higher turbidity near Kochi, especially during the pre- and post-monsoon seasons.

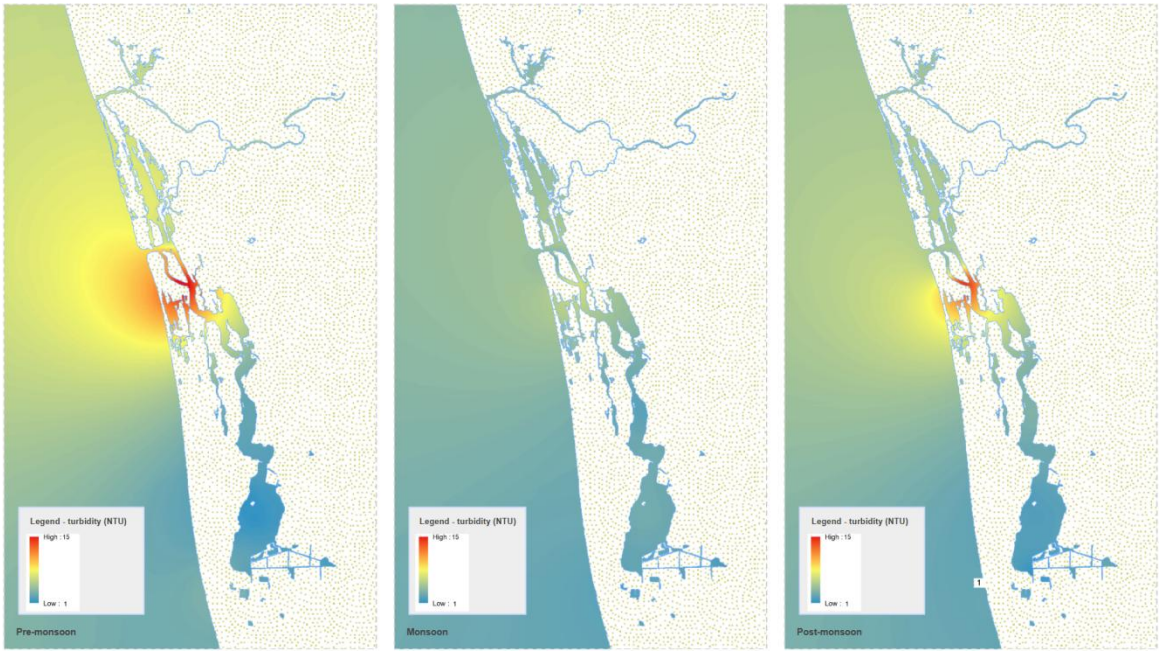



**FIGURE 84: TURBIDITY LEVELS IN THE VEMBANAD (2023)**

*Source : Author, KSPCB*

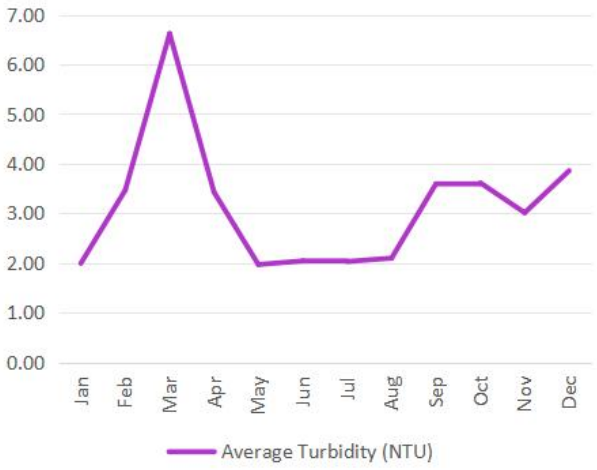



**FIGURE 85: MONTHLY VARIATION OF TURBIDITY LEVELS (2023)**

*Source : Author, KSPCB*

### 3.8.3.4 SEASONAL VARIATION IN BOD LEVELS

Meanwhile, BOD levels show moderate fluctuations between 1.5–2.0 mg/L throughout the year, with slight increases observed in May and December. Elevated BOD levels in localized southern hotspots during post-monsoon suggest organic pollution, possibly from agricultural runoff or untreated sewage. The sustained levels above 1.5 mg/L may impact aquatic life by reducing dissolved oxygen availability. Overall, these indicators signal moderate ecological stress in the lake, calling for stricter wastewater regulation and catchment management to preserve water quality.

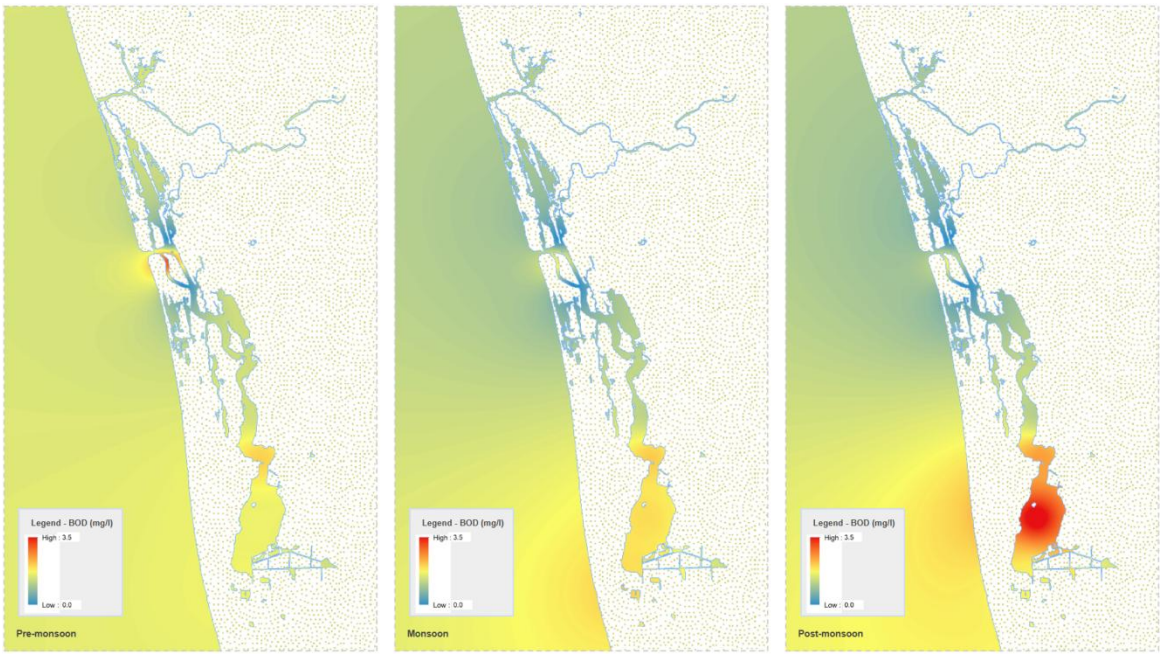



**FIGURE 86: BOD LEVELS IN THE VEMBANAD (2023)**

*Source : Author, KSPCB*

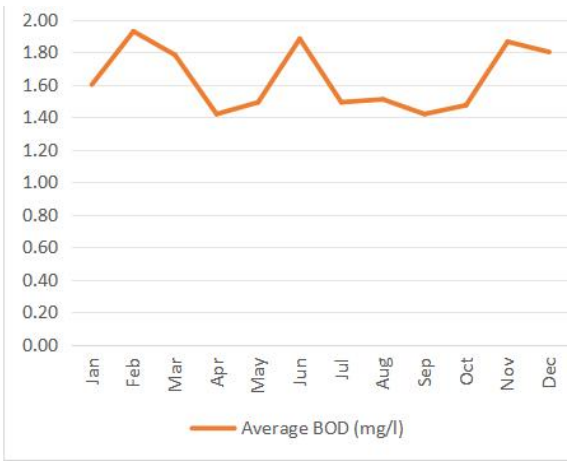



**FIGURE 87: MONTHLY VARIATION OF BOD LEVELS**

*Source : Author, KSPCB*

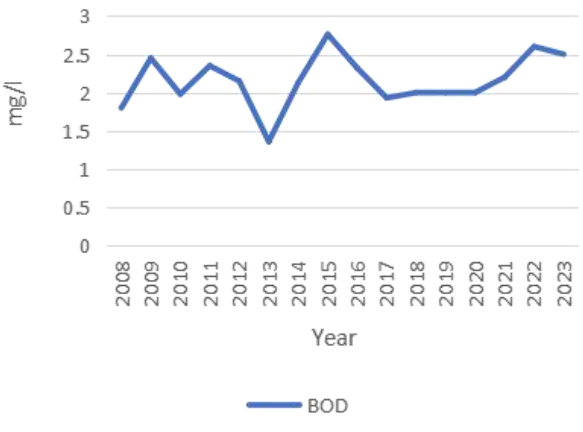



**FIGURE 88: YEARLY VARIATION OF BOD LEVELS**

*Source : Author, KSPCB*

### 3.8.3.5 SEASONAL VARIATION IN FECAL COLIFORM LEVELS

The seasonal analysis of fecal coliform (FC) levels in the Vembanad Lake during 2023, as shown in Figure 49, indicates serious microbial contamination concerns. FC concentrations exceed 1,000 MPN/100ml during all three seasons, with the highest levels observed in the pre-monsoon period, likely due to reduced dilution and increased sewage inflow. The hotspot maps highlight central and northern zones as the most affected areas, particularly near densely populated and urbanized stretches. The accompanying graph shows sharp monthly fluctuations, with peaks in January, March, and July, suggesting episodic pollution possibly from domestic wastewater and stormwater runoff.

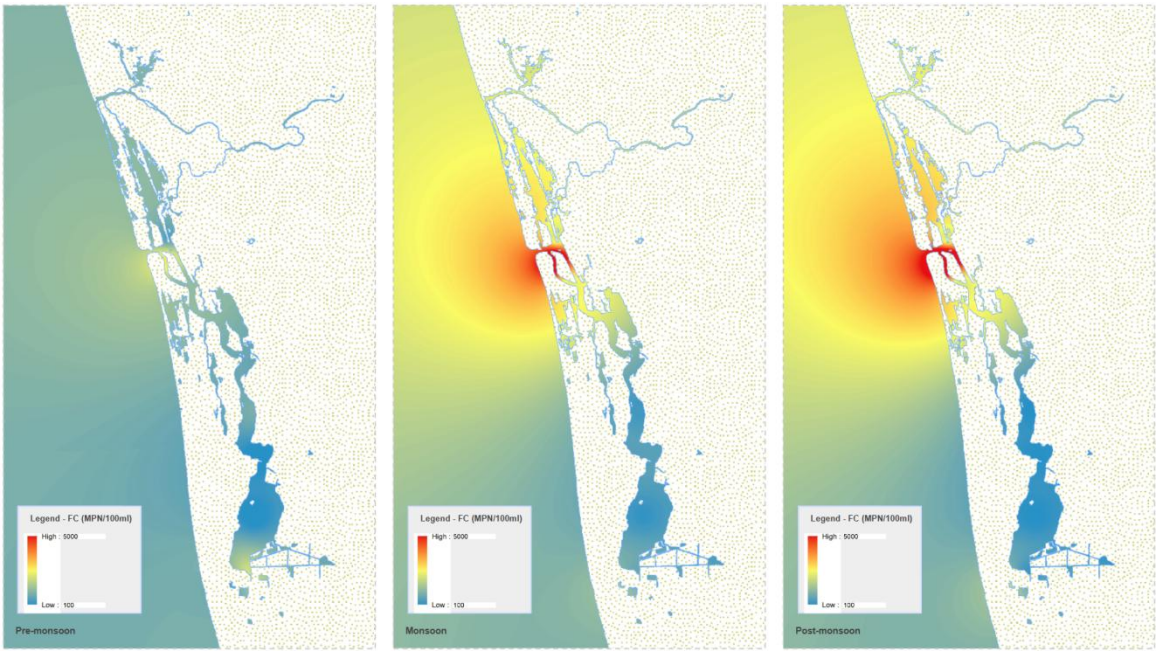



**FIGURE 89: FC LEVELS IN THE VEMBANAD (2023)**

*Source : Author, KSPCB*

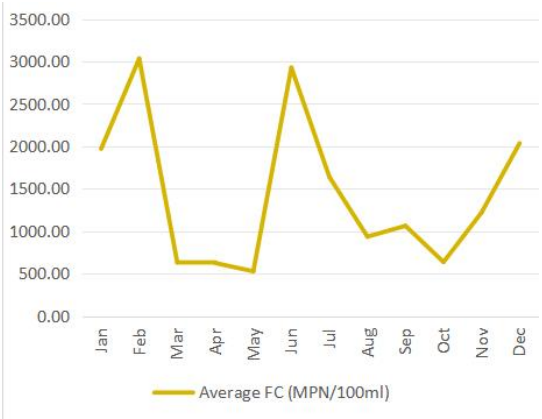



**FIGURE 90: MONTHLY VARIATION OF FC LEVELS**

*Source : Author, KSPCB*

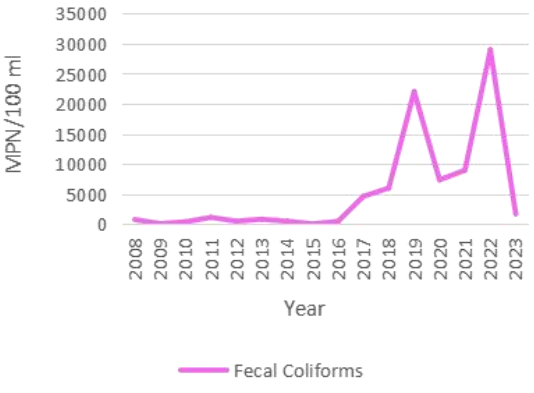



**FIGURE 91: YEARLY VARIATION OF FC LEVELS**

*Source : Author, KSPCB*

## 3.8.4 AIR QUALITY EVALUATION

### 3.8.4.1 SEASONAL VARIATION IN SOX LEVELS

During the pre-monsoon season, there is a noticeable hotspot of $SO_2$ concentration, indicated by the darker brown area, suggesting higher levels of air pollution, possibly due to industrial activities or reduced rainfall. In contrast, during the monsoon season, the $SO_2$ levels are significantly lower and more evenly spread, likely because of the cleansing effect of heavy rains which wash away atmospheric pollutants. In the post-monsoon season, the $SO_2$ concentrations remain low and stable, similar to the monsoon period, indicating that the monsoon rains have a lasting positive impact on air quality.

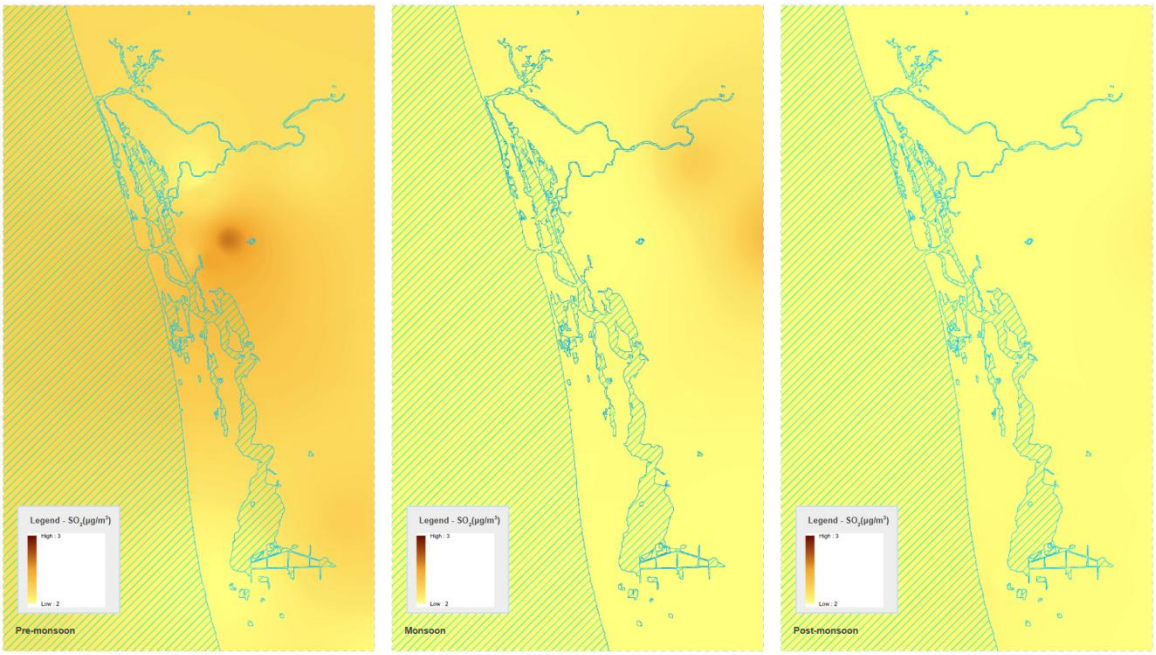



**FIGURE 92: $SO_2$ LEVELS IN THE VEMBANAD (2023)**

*Source : Author, KSPCB*

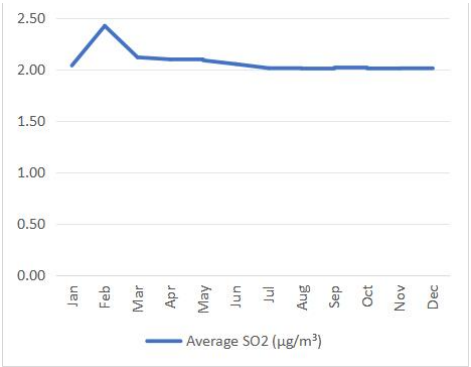



**FIGURE 93: MONTHLY VARIATION OF $SO_2$ LEVELS**

*Source : Author, KSPCB*

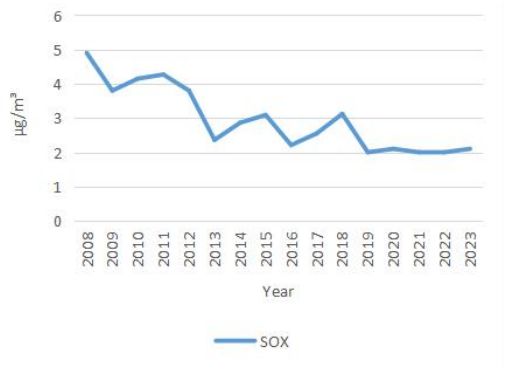



**FIGURE 94: YEARLY VARIATION OF $SO_2$ LEVELS**

*Source : Author, KSPCB*

### 3.8.4.2 SEASONAL VARIATION IN NOX LEVELS

The air quality assessment in the Vembanad region reveals moderate but spatially concentrated pollution levels. $NO_2$ levels are highest in pre-monsoon and post-monsoon periods, peaking around 9 µg/m³ in November, with central urban zones exhibiting the most intense concentrations. This suggests vehicular emissions and industrial activities as likely contributors. Seasonal $NO_2$ fluctuations appear mild toward the year-end.

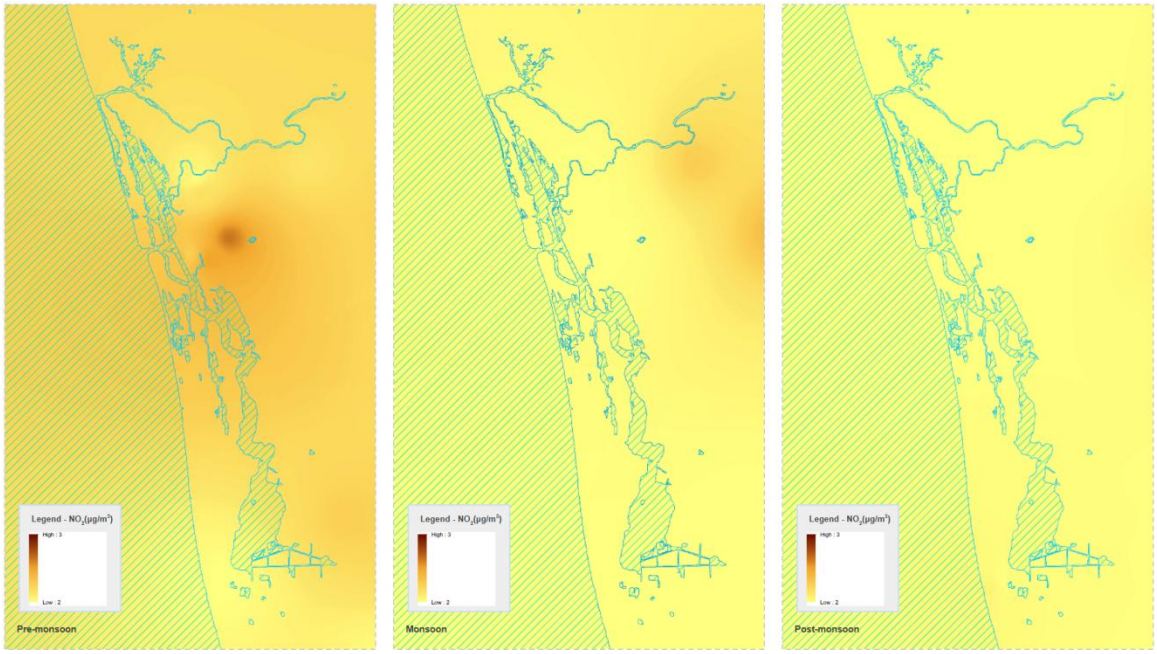



**FIGURE 95: $NO_2$ LEVELS IN THE VEMBANAD (2023)**

*Source : Author, KSPCB*

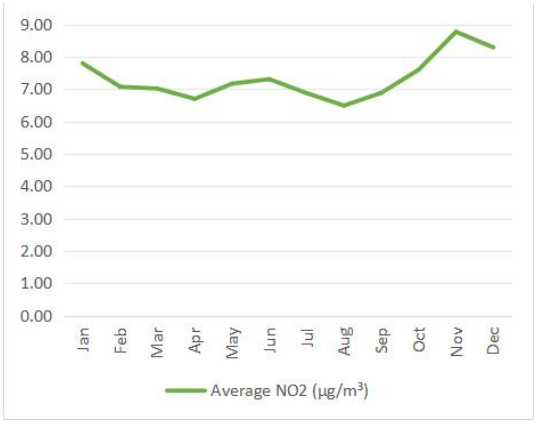



**FIGURE 96: MONTHLY VARIATION OF $NO_2$ LEVELS**

*Source : Author, KSPCB*

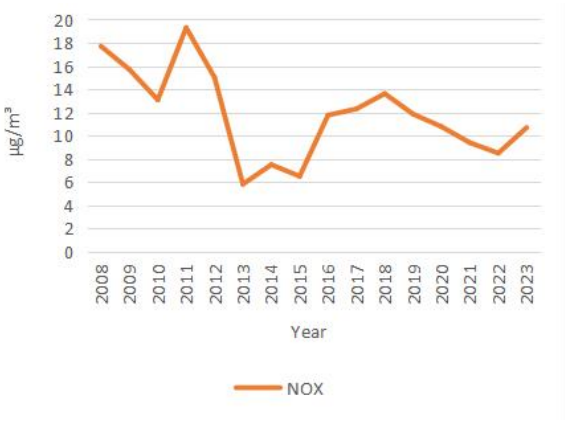



**FIGURE 97: YEARLY VARIATION OF $NO_2$ LEVELS**

*Source : Author, KSPCB*

### 3.8.4.3 SEASONAL VARIATION IN RSPM LEVELS

RSPM (Respirable Suspended Particulate Matter) levels shows spatial hotspots near urban clusters, with higher concentrations during pre-monsoon, likely due to drier weather, construction, and traffic-related dust. The average RSPM levels remain below critical thresholds but indicate air quality stress in localized zones, particularly in areas with dense settlement and road networks. These trends call for air pollution mitigation strategies focused on transportation, waste burning, and dust control in the Vembanad urban periphery.

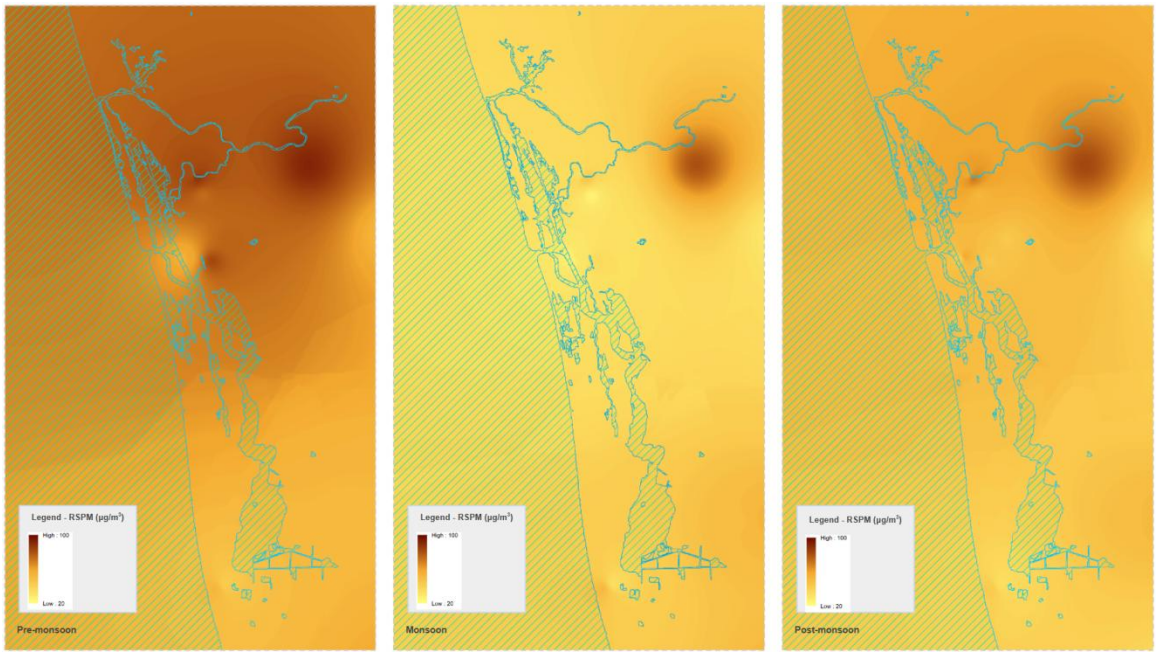



**FIGURE 98: RSPM LEVELS IN THE VEMBANAD (2023)**

*Source : Author, KSPCB*

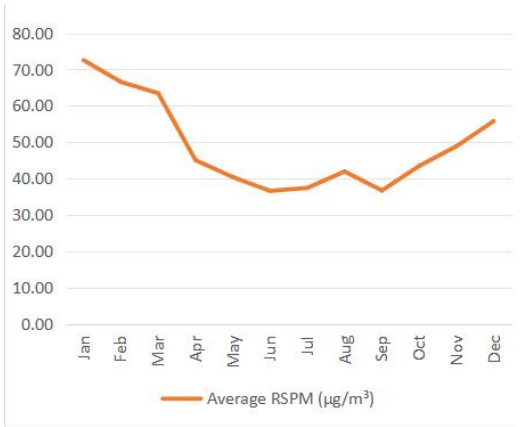



**FIGURE 99: MONTHLY VARIATION OF RSPM LEVELS**

*Source : Author, KSPCB*

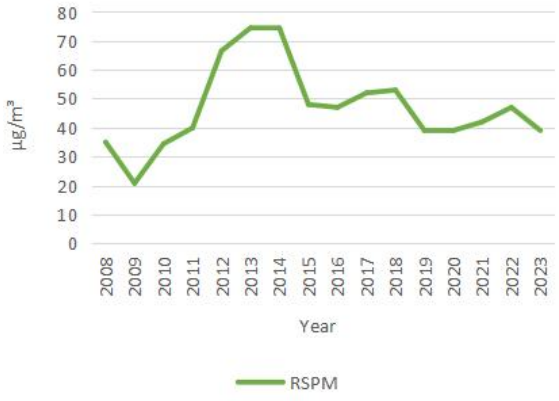



**FIGURE 100: YEARLY VARIATION OF RSPM LEVELS**

*Source : Author, KSPCB*

### 3.8.4.4 SEASONAL VARIATION IN PM2.5 LEVELS

Although PM2.5 remains within the annual permissible limit on average, seasonal spikes pose serious health risks, particularly to vulnerable populations. These findings emphasize the need for targeted air quality interventions during peak pollution months, focusing on transport emissions, solid waste burning, and dust control. The consistently higher PM2.5 levels in early months also coincide with increased tourism and festival-related activities, potentially contributing to localized air pollution. The central Vembanad belt, especially near urban hubs like Kochi and Alappuzha, remains a persistent hotspot throughout the year.

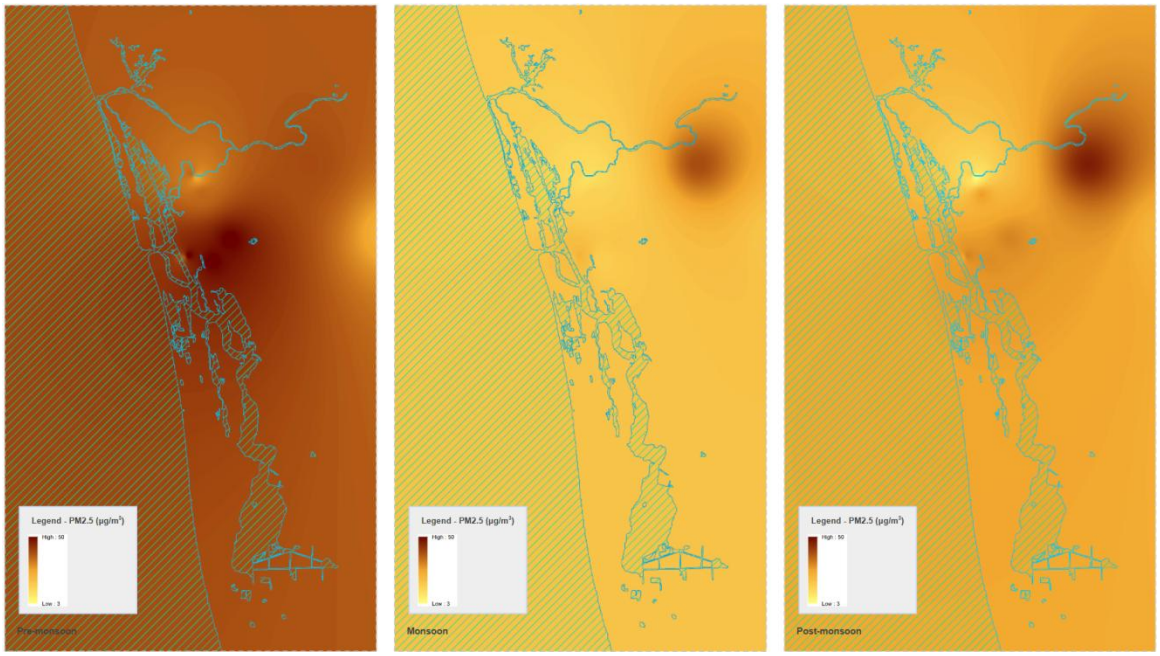



**FIGURE 101: PM2.5 LEVELS IN THE VEMBANAD (2023)**

*Source : Author, KSPCB*

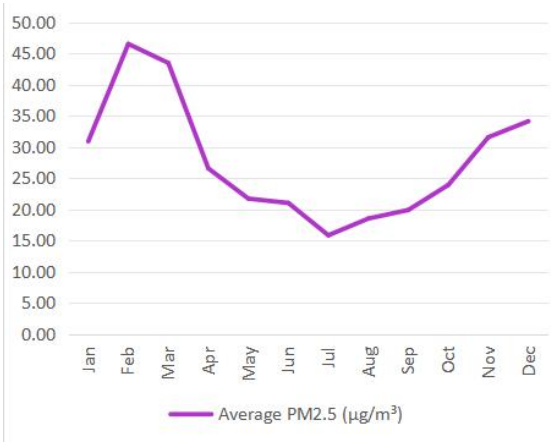



**FIGURE 102: MONTHLY VARIATION OF PM2.5 LEVELS**

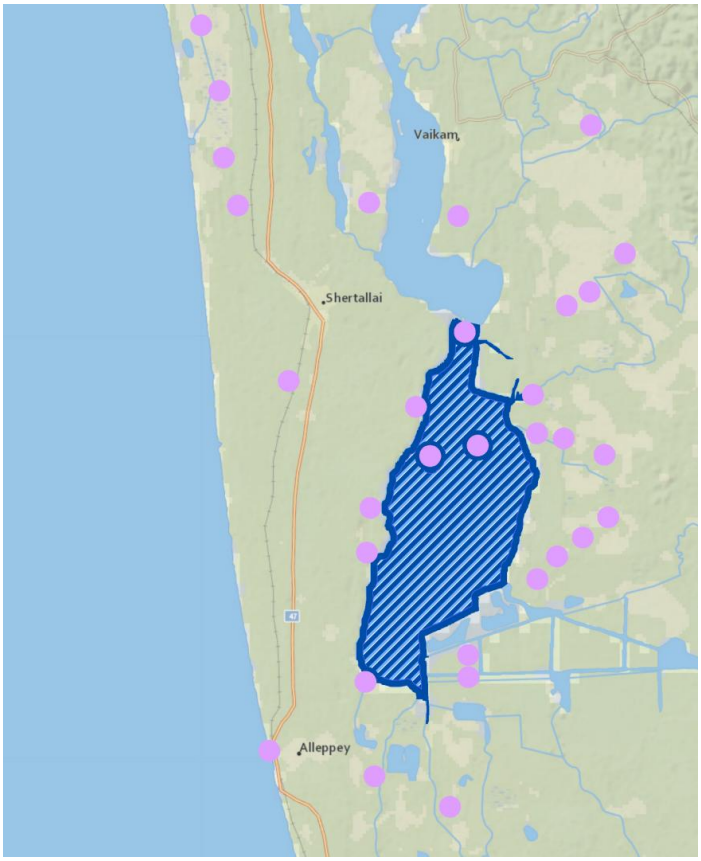
*Source : Author, KSPCB*

# 4 CARRYING CAPACITY ANALYSIS

This section deals with the analyses of the present situation of the study area pertaining to the current status of the host population and development of tourism in the region. This information was finally utilized to arrive at the tourism carrying capacity, which may exist at the horizon year.

## 4.1 LAKE CARRYING CAPACITY

The carrying capacity evaluation of the Vembanad Lake indicates that the sustainable maximum permissible number of boats operating simultaneously should be 368 boats, considering a net surface area of 16,017 acres. Based on boat type, their average percentage share during peak seasons, and the suggested density standards (acres per boat) have been considered.




**Gross Surface Area = 19,062 acres**
**Net Surface Area = 16,017 acres**

Net Surface Area has been considered after a buffer of 10m from the water edge and 8m from bird congregation zones

**FIGURE 103: POPULATION PRESSURE ($P_1$)**

*Source: Author*

**TABLE 18: PERMISSIBLE BOAT NUMBERS IN THE LAKE**

| Boat type | Avg. number daily (peak season) | % share | Suggested density | Maximum permissible number by boat mix |
|---|---|---|---|---|
| **Houseboat** | 500 | 60% | 50 acres/boat | 221 |
| **Shikhara** | 200 | 25% | 30 acres/boat | 92 |
| **Motor boat** | 100 | 12% | 30 acres/boat | 44 |
| **Speed boat** | 30 | 3% | 80 acres/boat | 11 |
| **Total** | 830 | 100% | - | 368 |

*Source: Author*

Let total number of boats be N.
(0.60N x 50) + (0.25N x 30) + (0.12N x 30) + (0.03N x 80) = 16,017 acres
⇒ 30N + 7.5N + 3.6N + 2.4N = 16,017 acres
⇒ 43.5N = 16,017 acres
**∴ N = 368 boats**

The current operations, however, show a significant excess of boating activity: with over 830 boats operating daily and approximately 4,36,977 tourists visiting monthly during peak seasons, the lake is catering to almost 2,44,737 tourists more than its calculated sustainable capacity of 1,92,240 tourists per month. Thus, the analysis clearly establishes that the physical carrying capacity of the lake is being exceeded substantially during peak tourism seasons, putting immense pressure on the lake's ecological and socio-economic environment. Immediate regulatory interventions are needed to cap boat numbers and control tourist inflow to protect the lake's health and ensure long-term sustainability of tourism activities.

## 4.2 STATE OF CARRYING CAPACITY

The pressure-support mechanism was used to ascertain state of carrying capacity of each local body within the delineated area based on the following pressure and support indicators.

**TABLE 19: PRESSURE AND SUPPORT INDICATORS**

| Pressure | Support |
|---|---|
| Total population | Total land area |

| Pressure | | Support | |
|---|---|---|---|
| *Population* ***( $P_1$ )*** | | *Resources* ***( $S_1$ )*** | |
| | Population density (persons/sqkm) | | Area under wetland/vegetation |
| | Population growth rate (%) | | Area under agriculture |
| | Percentage of non-workers (%) | | Per capita production of crops |
| *Built-up* ***( $P_2$ )*** | Percentage area under built-up (%) | *Infrastructure* ***( $S_2$ )*** | Road density (km/hectare) |
| | Conversion to built-up (sqkm) | | HH with access to treated water (%) |
| *Disaster* ***( $P_3$ )*** | Flood susceptibility (index) | *Institutional* ***( $S_3$ )*** | Budget provisions to local govt. |

*Source : Author*

The following equations were used to quantify the cumulative pressure-support of each local body to arrive at its state of carrying capacity.

$$P_i = \sum_{j=1}^{n} P'_{ij}\, w_j^p \quad \text{.....(1)}$$

$$S_i = \sum_{j=1}^{n} S'_{ij}\, w_j^s \quad \text{.....(2)}$$

$$C_S = \frac{S_i}{P_i} \quad \text{.....(3)}$$

Here, $S'_{ij}$ and $P'_{ij}$ are the normalized values of the $j^{th}$ support and pressure indicator for $i^{th}$ city in the region, respectively. Also, $w_j^p$ and $w_j^s$ are the weights of the support and pressure indicators. The state of carrying capacity is denoted by $C_S$ .

### 4.2.1 CALCULATING INDICATOR WEIGHTS

The weights of pressure and support indicators were calculated using the Entropy weight Method (EWM). Each subsystem has multiple indicators. Since not all indicators contribute equally to the overall system, EWM is used to calculate the weight of each indicator based on data variability, rather than subjective judgment.

**1)** ***Data Standardization:***

$$X_i = \frac{x_{ij} - x_{\min j}}{x_{\max j} - x_{\min j}}$$

**2)** ***Calculate the Entropy $e_j$ for each indicator:***

$$e_j = -\frac{1}{\ln n}\sum_{i=1}^{n} X_{ij} \ln(X_{ij})$$

Where, n is the number of towns. This measures the dispersion or uncertainty in the indicator's data. If an indicator has more variation across the regions, it has more information, so lower entropy.

### 3) *Calculate the Degree of Divergence $d_j$ :*

$$d_j = 1 - e_j$$

This reflects how important the indicator depending on the variation in data across the region, the more influence it has.

### 4) *Determine Weights:*

$$w_j = \frac{d_j}{\sum_{j=1}^{m} d_j}$$

These weights are then used in calculating the composite index for each subsystem.

**TABLE 20: INDICATOR WEIGHTS**

| **Pressure indicators** | | $e_j$ | $d_j$ | $w_j$ |
|---|---|---|---|---|
| *Population* | Total population | 0.8436 | 0.1564 | 0.3171 |
| | Population density (persons/sqkm) | 0.9472 | 0.0528 | 0.1072 |
| | Population growth rate (%) | 0.9821 | 0.0179 | 0.0362 |
| | Percentage of non-workers (%) | 0.9713 | 0.0287 | 0.0583 |
| *Built-up* | Percentage area under built-up (%) | 0.9660 | 0.0340 | 0.0689 |
| | Conversion to built-up (sqkm) | 0.8783 | 0.1217 | 0.2468 |
| *Disaster* | Flood susceptibility (index) | 0.9185 | 0.0815 | 0.1654 |

| **Support indicators** | | $e_j$ | $d_j$ | $w_j$ |
|---|---|---|---|---|
| ***Resources*** | Total land area | 0.9552 | 0.0448 | 0.0485 |
| | Area under wetland and vegetation | 0.8492 | 0.1508 | 0.1634 |
| | Area under agriculture | 0.9147 | 0.0853 | 0.0924 |
| | Percapita production of food crops | 0.7719 | 0.2281 | 0.2470 |
| ***Infrastructure*** | Road density (km/hectare) | 0.9611 | 0.0389 | 0.0421 |
| | Households with access to treated water (%) | 0.8877 | 0.1123 | 0.1216 |
| ***Institutional*** | Budget provisions to local govt. | 0.7369 | 0.2631 | 0.2850 |

*Source : Author*

## 4.2.2 REGIONAL PRESSURE ANALYSIS

The pressure in the region reflects in the burgeoning population numbers, status of land under built-up and the susceptibility of the region to frequent floods.

### 4.2.2.1 POPULATION PRESSURE

The cumulative population pressure in the region arising out of the four selected indicators for each local body was quantitifed.

$$P_1 = \sum_{j=1}^{n} p_i \; w_j$$

Here, $p_i$ are the normalized population parameter of $i^{th}$ city in the region $w_j$ corresponds to the weight of the pressure indicator.

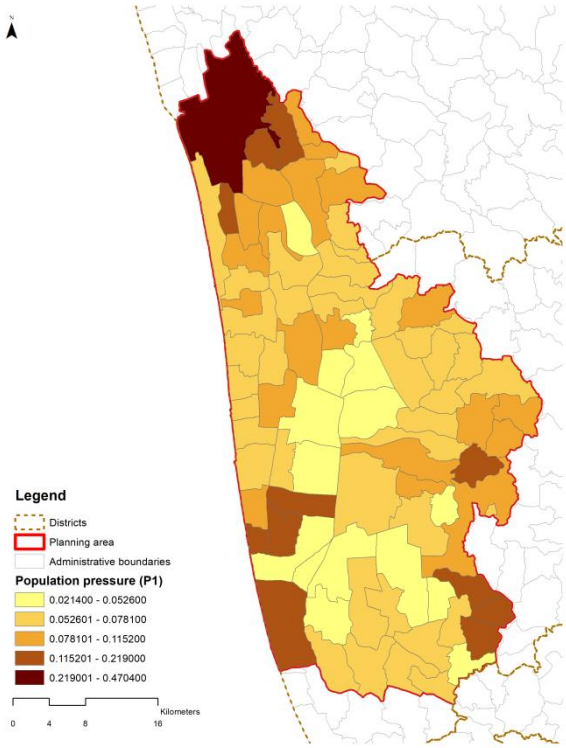



**FIGURE 104: POPULATION PRESSURE ($P_1$)**

*Source: Author*

### 4.2.2.2 BUILT-UP PRESSURE

The cumulative pressure of expanding area under built-up in the region arising out of the two selected indicators for each local body was quantitifed.

$$P_2 = \sum_{j=1}^{n} b_i \; w_j \qquad \text{.....(1)}$$

Here, $b_i$ are the normalized built-up parameter of $i^{th}$ city in the region $w_j$ corresponds to the weight of the pressure indicator.

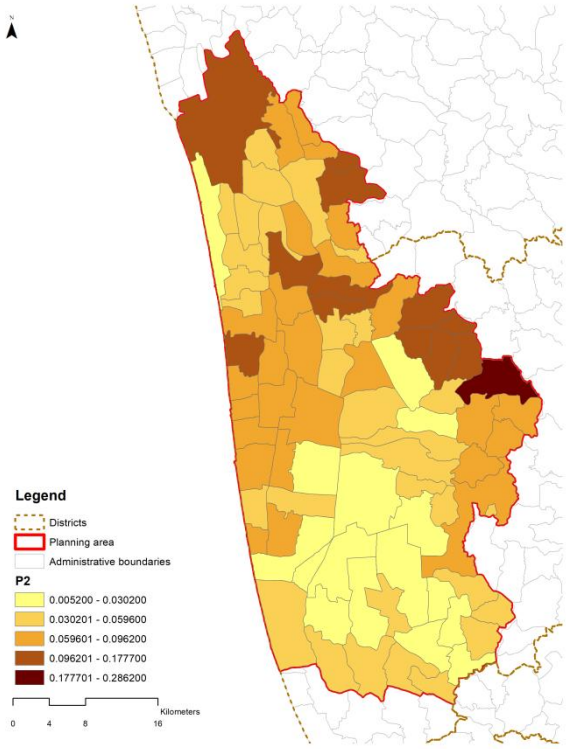



**FIGURE 105: BUILT-UP PRESSURE ($P_2$)**

*Source: Author*

### 4.2.2.3 FLOOD SUSCEPTIBILITY

The flood susceptibility of the region was quantitifed through a Flood Susceptibility Index using two parameters, percentage area inundated under floods with returns periods and 10 years, 25 years, and 50 years and the corresponding flood depth. The percentage area captures the extent of the disaster and the flood depth captures the severity of the same.

$$FSI = \sum_{r=1}^{3} w_r \, P_r \, D_r \qquad \text{.....(1)}$$

Here, $P_r$ is the percentage of village area inundated under flood return period r (for 10, 25, and 50 years), $D_r$ is the normalized flood depth for return period i (scaled from 0 to 1, using max depth observed), and $w_i$ is weight assigned to return period to reflect severity (1 for 10 years return period, 2 for 25 years return period and 3 for 50 years return period).

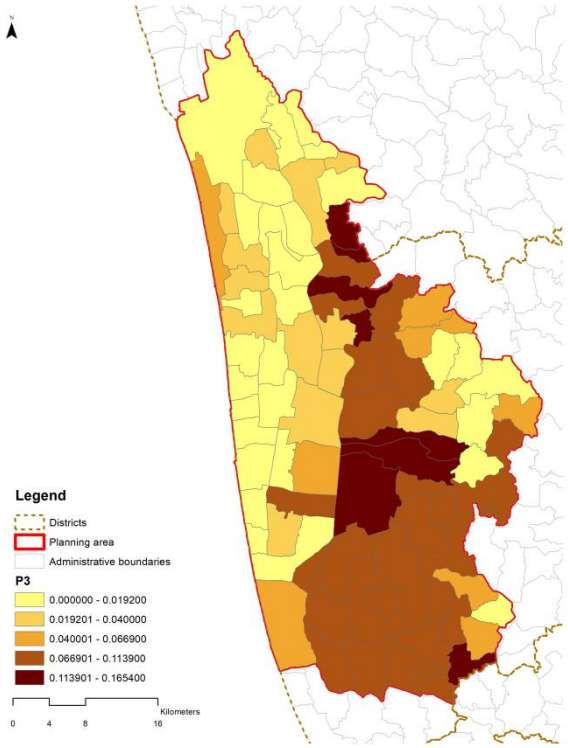



**FIGURE 106: FLOOD SUSCEPTIBILITY ($P_3$)**

*Source: Author*

## 4.2.3 REGIONAL SUPPORT ANALYSIS

The strenght of the support systems in the region reflects in the available resources, developmental infrastructure and instituional support.

### 4.2.3.1 RESOURCE AVAILABILITY

The cumulative resource avilability in the region is quantitifed by analysing available land for development, wetlands and vegetation for carbon sequestration, and agriculture and food productivity that ensures regional food security.

$$S_1 = \sum_{j=1}^{n} r_i \; w_j$$

Here, $r_i$ are the normalized resource parameter of $i^{th}$ city in the region and $w_j$ corresponds to the weight of the pressure indicator.

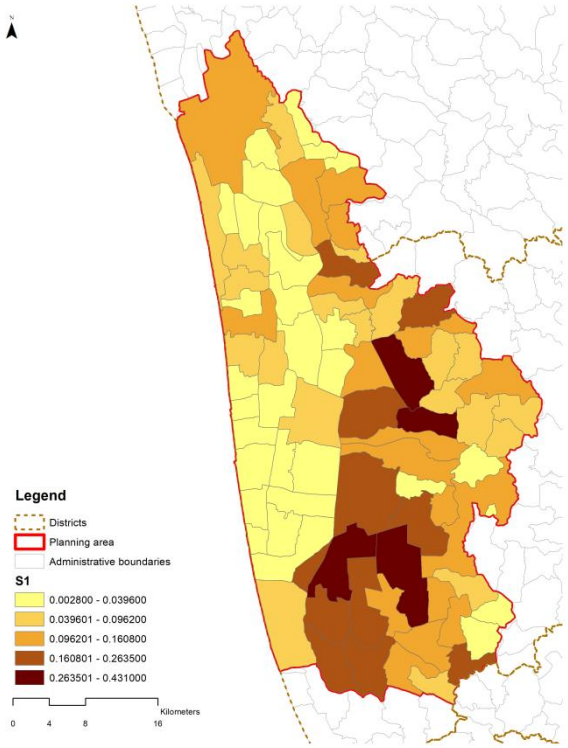



**FIGURE 107: RESOURCE AVAIBILITY ($S_1$)**

*Source: Author*

### 4.2.3.2 INFRASTRUTURE DEVELOPMENT

The cumulative infrastructure support in the region is quantitifed by extent of road infrastructure and avaiability of water treated drinking water to households.

$$S_2 = \sum_{j=1}^{n} d_i \; w_j$$

Here, $d_i$ are the normalized infratructure parameter of $i^{th}$ city in the region and $w_j$ corresponds to the weight of the pressure indicator.

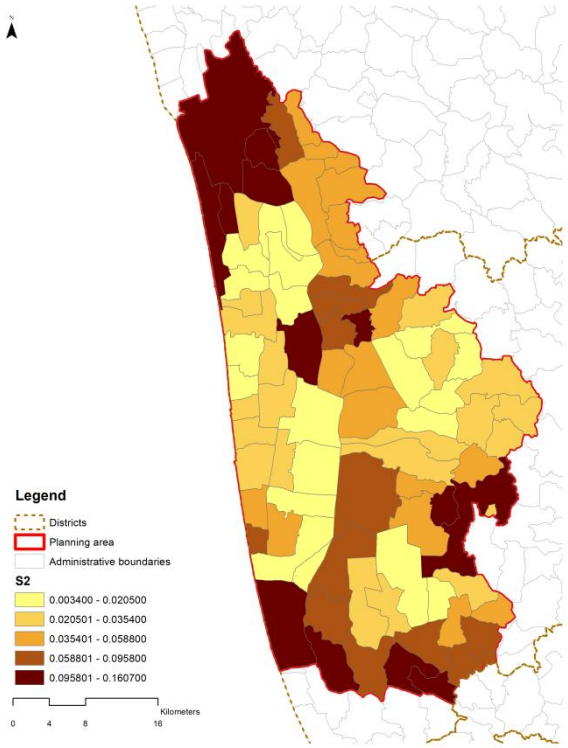



**FIGURE 108: INFRASTRUCTURE DEVELOPEMENT ($S_2$)**

*Source: Author*

### 4.2.3.3 INSTITUTIONAL SUPPORT

The institutional support in the region is quantitifed by analysis budget provisions and grants provided to each local body by international, central and state authorities for maintenance and construction of developemental assets in the financil year 2024-2025.

$$S_3 = \sum_{j=1}^{n} m_i \; w_j$$

Here, $m_i$ are the normalized budget grants received by the $i^{th}$ city in the region and $w_j$ corresponds to the weight of the pressure indicator.

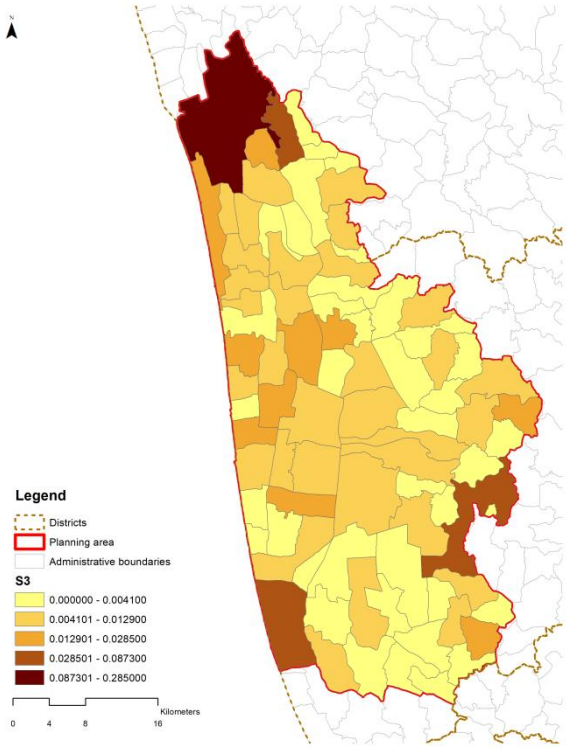



**FIGURE 109: INSTITUTIONAL SUPPORT ($S_3$)**

*Source: Author*

## 4.2.4 CUMULATIVE PRESSURE-SUPPORT ANALYSIS

The state of carrying capacity is determined by the ration of support to pressure. Areas with higher support and low pressure has a higher state of carrying capacity compared to those with higher pressure and low support.

The following equations were used to quantify the cumulative pressure-support of each local body to arrive at its state of carrying capacity.

$$P_i = \sum_{j=1}^{n} P'_{ij}\, w_j^p \quad \text{.....(1)}$$

$$S_i = \sum_{j=1}^{n} S'_{ij}\, w_j^s \quad \text{.....(2)}$$

$$C_S = \frac{S_i}{P_i} \quad \text{.....(3)}$$

Here, $S'_{ij}$ and $P'_{ij}$ are the normalized values of the $j^{th}$ support and pressure indicator for $i^{th}$ city in the region, respectively. Also, $w_j^p$ and $w_j^s$ are the weights of the support and pressure indicators. The state of carrying capacity is denoted by $C_S$ .

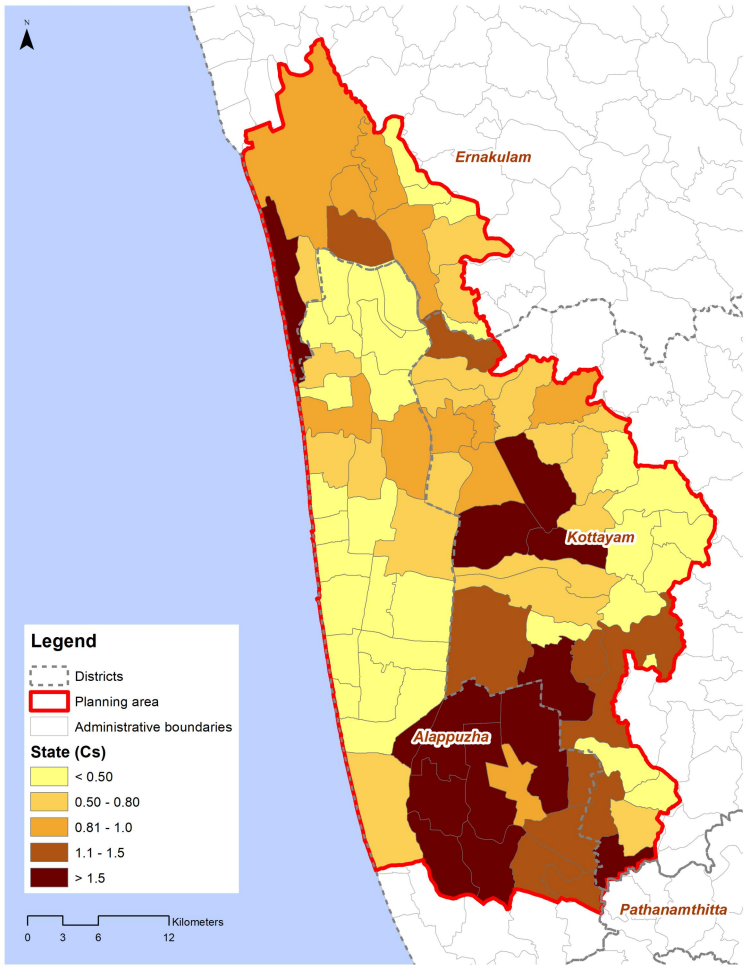



**FIGURE 110: CARRYING CAPACITY STATE ($C_S$)**

*Source: Author*

## 4.3 PHYSICAL CARRYING CAPACITY

Physical carrying capacity (PCC) calculations give an estimate of the maximum number of people that can be accommodated in the region based on various parameters like water availability, availability of accommodation units, and so on. Here, PCC has been calculated taking into consideration the available developable land and acceptable density norms as per URDPFI.

$$PCC_i = \frac{\text{Total developable land}}{\text{Gross density (as per settlement type based on population)}} \quad \text{.....(4)}$$

Here, $PCC_i$ denotes Physical Carrying Capacity or the maximum population the town can support depending on the available developable land. Thus, the region has pockets with high or low PCC and balanced or imbalanced state of carrying capacity.

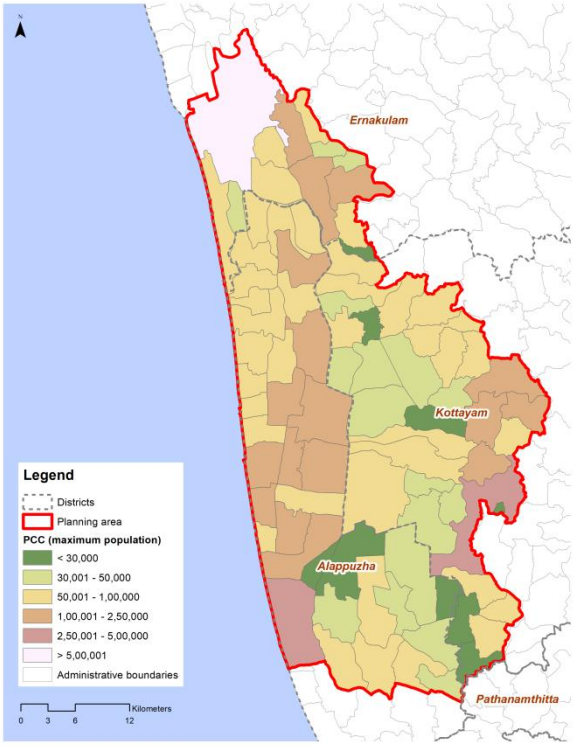



**FIGURE 111: MAXIMUM PERMISSIBLE POPUALTION (PCC)**

*Source: Author*

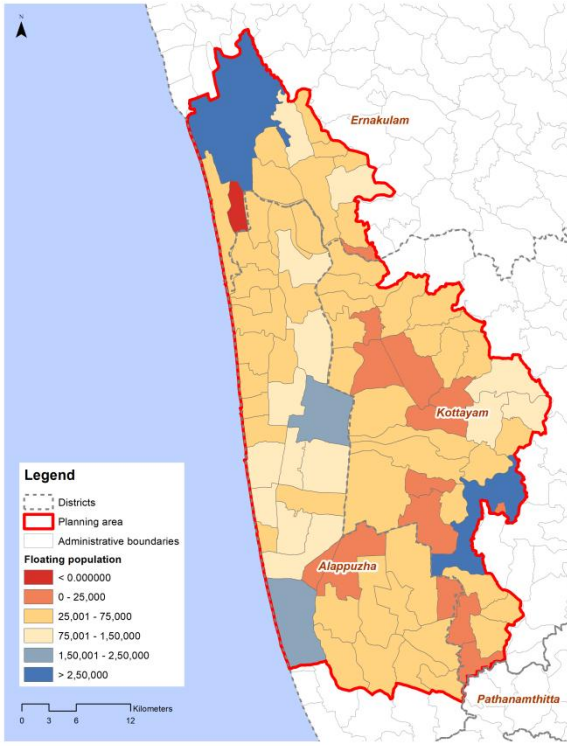



**FIGURE 112: MAXIMUM PERMISSIBLE FLOATING POPULATION (PCC)**

*Source: Author*

## 4.4 REAL CARRYING CAPACITY

The Real Carrying Capacity (RCC) is an advanced measure of the actual number of visitors an area can sustainably accommodate after accounting for local limiting factors. It is derived by adjusting the Physical Carrying Capacity (PCC) with correction coefficients that reflect specific environmental and management constraints. The general formula for calculating RCC is:

$$RCC_i = PCC_i \times Cf_1 \times Cf_2 \times \ldots\ldots\ldots \times Cf_n \quad \ldots\ldots\ldots\ldots (5)$$

In this case, two important correction factors have been considered:

1) **β-index :** It represents accessibility and connectivity constraints within the site (e.g., limitations due to poor infrastructure, or fragmented routes).
2) **Flood Susceptibility Index (FSI) :** It accounts for the percentage of the site area that is prone to flooding, thus reducing the safely usable area for tourism activities.

Each correction coefficient (expressed as a decimal between 0 and 1) reduces the PCC proportionally based on the severity of the limiting factor.

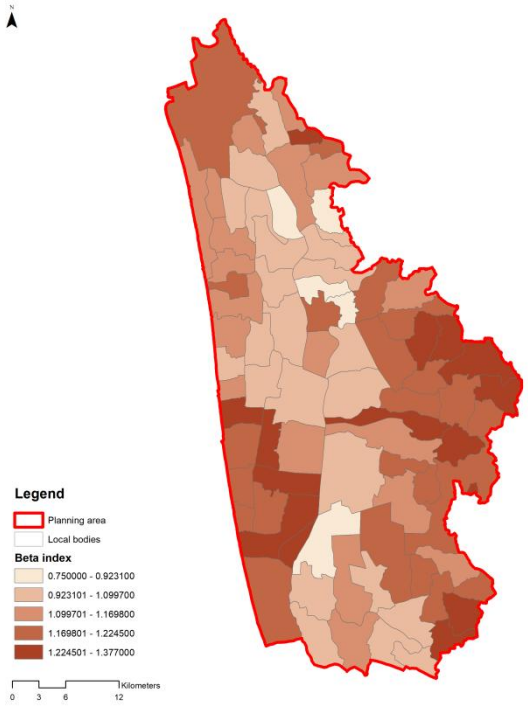



**FIGURE 113: BETA INDEX CENTRALITY MAP**

*Source: Author*

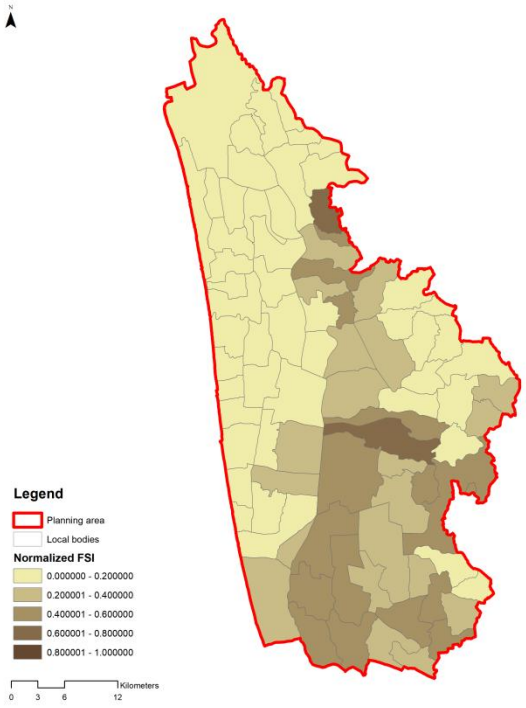



**FIGURE 114: FLOOD SUSCEPTIBILITY MAP**

*Source: Author*

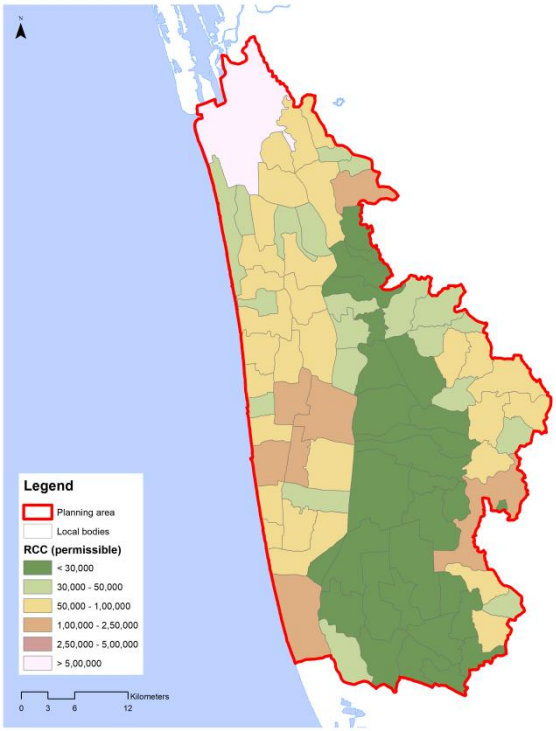



**FIGURE 115: MAXIMUM PERMISSIBLE POPUALTION (RCC)**

*Source: Author*

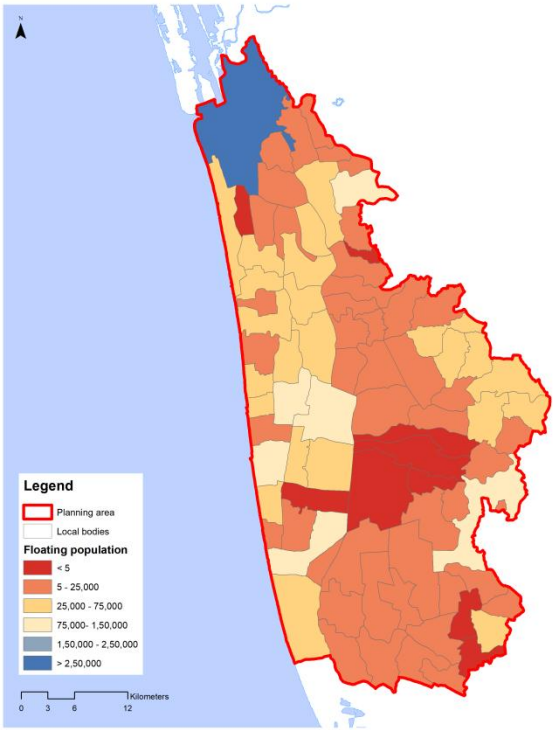



**FIGURE 116: MAXIMUM PERMISSIBLE FLOATING POPULATION (RCC)**

*Source: Author*

# 4.5 TOURISM CARRYING CAPACITY

The Tourism Carrying Capacity (TCC) is calculated through a two-step process that refines the Real Carrying Capacity (RCC) by accounting for the current State of Carrying Capacity and applying an additional control to define the sustainable visitor population.

***Step 1: Determining Acceptable Floating Population***

First, the RCC is multiplied by a coefficient based on the assessed State of Carrying Capacity, which reflects the site's current management condition as per the following:

**TABLE 21: STATE DEPENDEDNT CORRECTION FACTORS**

| S Range | Status | Correction Factor ($Cf_s$) | Interpretation | RCC Adjustment |
|---|---|---|---|---|
| **S >1.5** | Very Good | 1.00 | System highly resilient — can absorb the whole permissible RCC | → No change |
| **1.2 < S ≤1.5** | Healthy | 0.8 | Stable and sustainable — need to maintain status quo | ↓ Reduce by 20% |
| **0.8 < S ≤ 1.2** | Acceptable | 0.6 | Balanced, but showing some early signs of pressure | ↓ Reduce by 40% |
| **0.5 < S ≤0.8** | Vulnerable | 0.4 | Degrading, needs monitoring and management | ↓ Reduce by 60% |
| **S ≤ 0.5** | Critical | 0.2 | Severely degraded — requires urgent intervention | ↓ Reduce by 80% |

*Source : Author*

Thus, acceptable floating population ($P_f$) is given by:

$$P_f = RCC_i \times Cf_s \quad \text{.....(6)}$$

***Step 2: Calculating Tourism Carrying Capacity (TCC)***

The TCC is then defined as 50% of the acceptable floating population, providing an extra safety buffer to ensure long-term sustainability.

$$TCC_i = P_f \times 0.5 \quad \text{.....(6)}$$

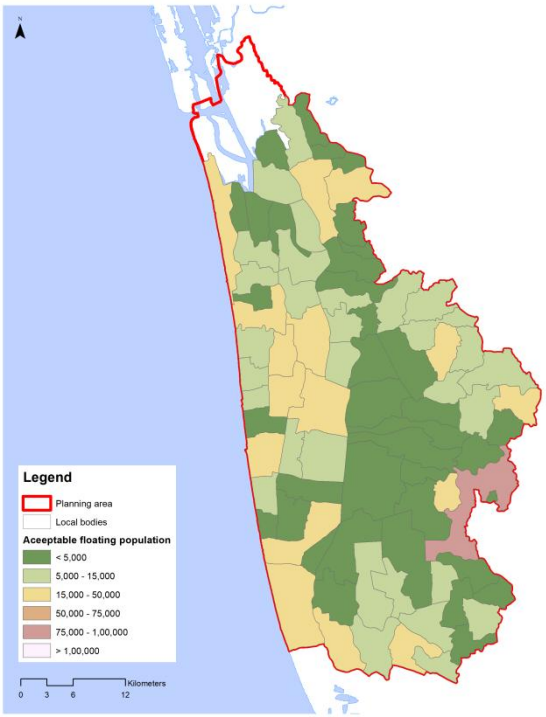



**FIGURE 117: ACCEPTABLE FLOATING POPULATION**

*Source: Author*

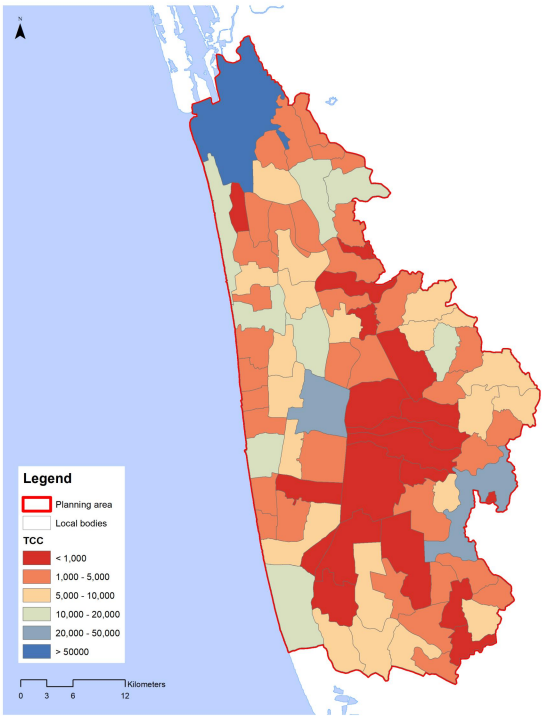



**FIGURE 118: ACCEPTABLE TOURIST POPULATION**

*Source: Author*

# 5 PROPOSALS

The proposals seeks to take inputs from the carrying capacity evaluations of the region. By doing so, it aims to support the formulation of sustainable tourism strategies that are context-sensitive. The study will investigate the nature and distribution of tourism in the region, identify key stakeholders, assess current tourism pressures, and explore the balance between visitor experience and community resilience.

## 5.1 VISION AND STRATEGIES

The broad vision of for tourism developemnt in the region is to ***capitalise on the unique social and cultural ecosystem that exist in the wetland without crossing the carrying capacity thresholds***. This calls for a departure from the mass tourism model the Kerala followed in the early 20th century and move towards a form of niche tourism.

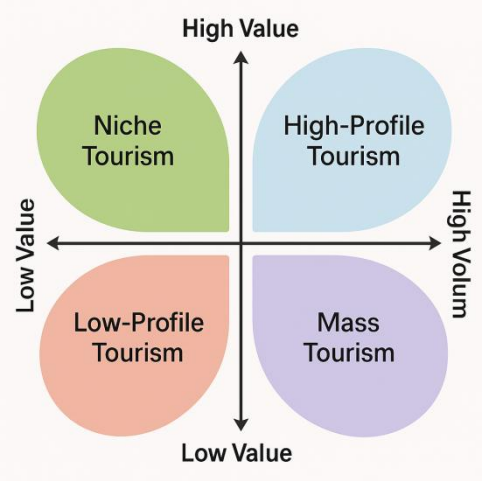



**FIGURE 119: CONCEPT OF NICHE TOURISM**

*Source: Ebrary*

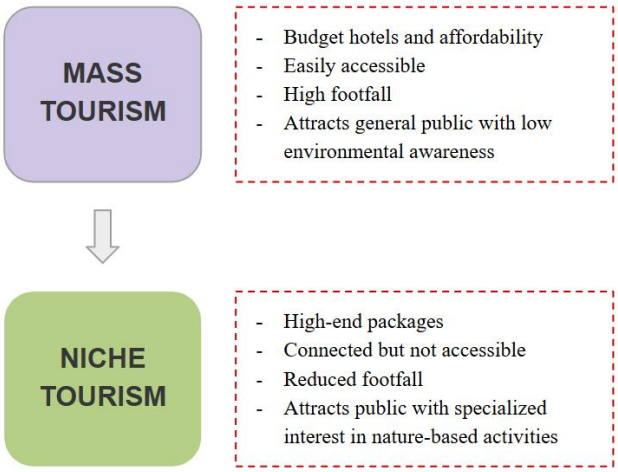



**FIGURE 120: TOURISM DEVELOPEMNT STRATEGY**

*Source: Author*

Thus, the vision is to create a sustainable, inclusive, and immersive tourism experience in the Vembanad region by creating a culturally rooted and ecologically sensitive circuit that connects diverse livelihood landscapes, empowers local communities, and enriches visitor engagement—while ensuring the long-term resilience of the estuarine ecosystem.

**TABLE 22: MISSION STATEMENTS AND KEY STRATEGIES**

| Mission theme | Key strategies |
|---|---|
| **1) Diversify tourism products offered in the region** | 1. Define tourism districts based on dominant socio-economic landscapes.<br>2. Establish secondary anchor points/gateway towns in the region.<br>3. Formulate an integrated regional tourism circuit. |
| **2) Enhance tourism-based livelihood alternatives** | 1. Promote opportunities for local and cooperative-led tourism projects.<br>2. Create an annual calendar of cultural festivals.<br>3. Plan for haats/markets for selling of local products. |
| **3) Catalyze responsible tourism growth within carrying capacity limits** | 1. Offer tax breaks and subsidies for eco-tourism facilities.<br>2. Impose auctioning of tourist permits<br>3. Allow for tourist holidays to make way for ecological rejuvenation |

*Source : Author*

# 5.2 REGIONAL INTERVENTIONS

## 5.2.1 NEW TOURISM DISTRICTS

The primary contribution of the carrying capacity analysis and baseline analysis is the delineation of new tourism districts based on dominant local livelihoods and cultural landscapes, with the objective to promote more equitable and sustainable tourism in the Vembanad region. Rather than relying solely on conventional geographic or administrative boundaries, these livelihood-based districts would reflect the unique socio-economic fabric of the estuary—such as fishing communities, coir-making clusters, farming zones, and artisanal craft villages. By aligning tourism development with these existing practices, the approach not only preserves local traditions and supports income diversification but also creates more immersive and meaningful visitor experiences.

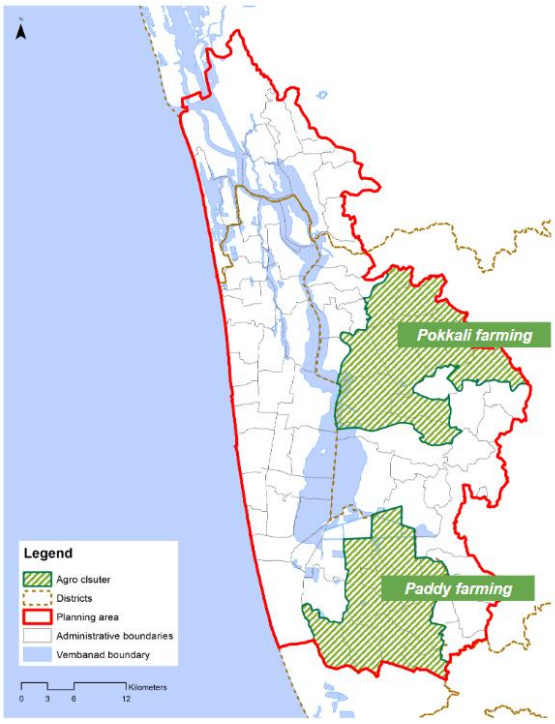



**FIGURE 121: POTENTIAL AGRO CLUSTER**

*Source: Author*

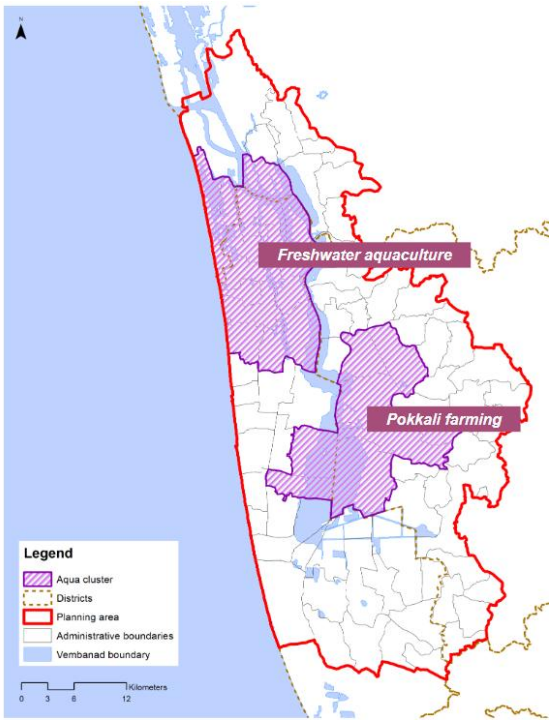



**FIGURE 122: POTENTIAL AQUA CLUSTER**

*Source: Author*


**FIGURE 123: POTENTIAL COIR AND BOAT-MAKING CLUSTER**

*Source: Author*

The potential clusters within the Vembanad region have been regrouped and redelineated based on two primary criteria:

1) Geographical contiguity
2) Predominant livelihood landscapes

This approach recognizes the organic patterns of land use, cultural practices, and economic activity that shape the region. Clusters have been delineated to reflect areas where specific livelihoods—such as inland fishing, paddy cultivation, toddy tapping, coir production, or boat-making—are spatially concentrated and form the dominant socio-economic identity of the landscape. By doing so, the proposed clustering framework allows for more targeted tourism strategies that are aligned with the character and capacity of each area, enabling the development of niche tourism circuits that support both conservation and community-based economic development.

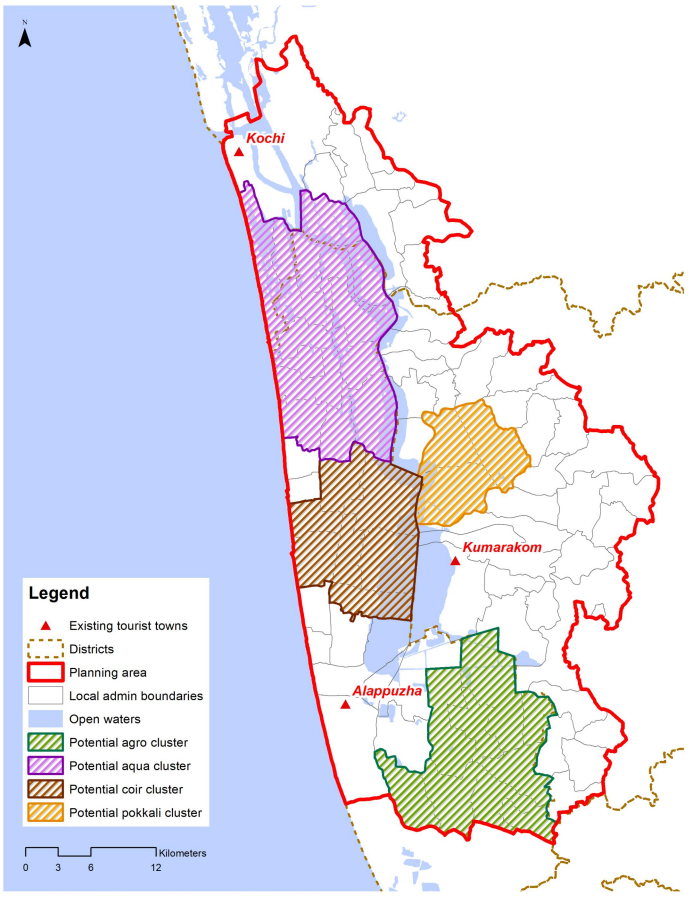



**FIGURE 124: PROPOSED TOURISM DISTRICTS**

*Source: Author*

## 5.2.2 REGIONAL TOURISM CIRCUIT

The creation of a new tourism circuit that weaves together the distinct livelihood-based clusters across the Vembanad estuary. The proposed circuit is designed to offer a holistic journey through the cultural and ecological mosaic of the region. The circuit is integrated with the major regional tourist routes of central Kerala and passes through the coir-making villages of Alappuzha, moving through the paddy cultivation belts and traditional toddy-tapping hamlets, continuing to the inland fishing communities round Chellam, and culminating in the artisanal boatyards and heritage hotspots near Kochi. This interconnected route would allow tourists to engage with the everyday rhythms of local life while distributing tourism benefits more evenly across the landscape. The circuit also has the potential to diversify tourism offerings—from backwater cruises and farm-stay experiences to cultural workshops and guided ecological tours—thereby fostering sustainable livelihoods and deepening tourist appreciation for the region's heritage and environmental significance.

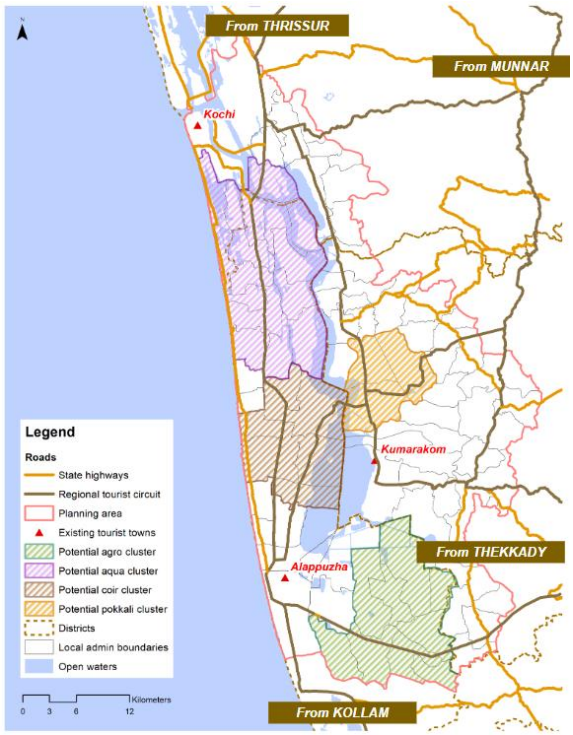



**FIGURE 125: EXISTING TOURIST CIRCUIT**

*Source: Author*

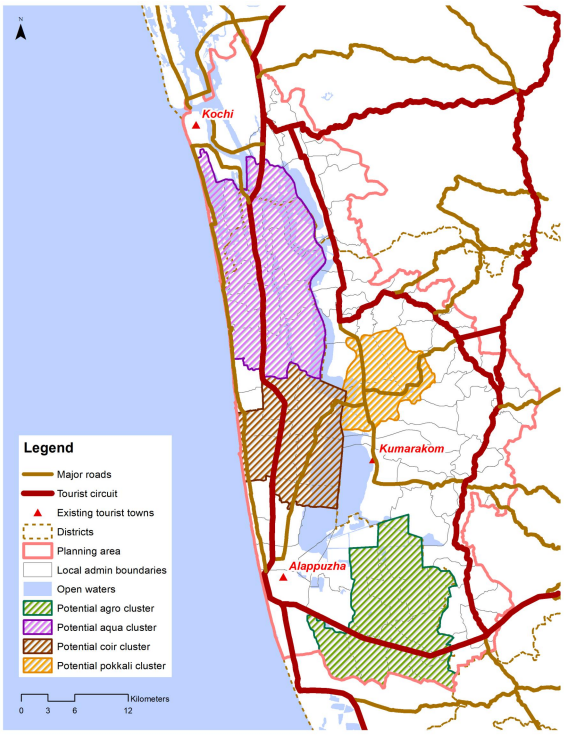



**FIGURE 126: PROPOSED TOURIST CIRCUIT**

*Source: Author*

## 5.2.3 GATEWAY TOWNS

To effectively manage the flow of tourists and ensure a balanced distribution of visitor pressure across the Vembanad region, the concept of gateway towns has been introduced.

These towns serve as strategic entry points that intercept and channel tourists arriving from adjoining regional landscapes. The identification of these gateways is based on:

1) spatial analysis of major transport nodes
2) connectivity assessment using the beta index

The beta index, which measures the degree of network connectivity by comparing the number of links to nodes, has been employed to evaluate accessibility and centrality within the regional transport network. Towns with higher connectivity scores and nodal importance emerge as optimal locations for these gateways.

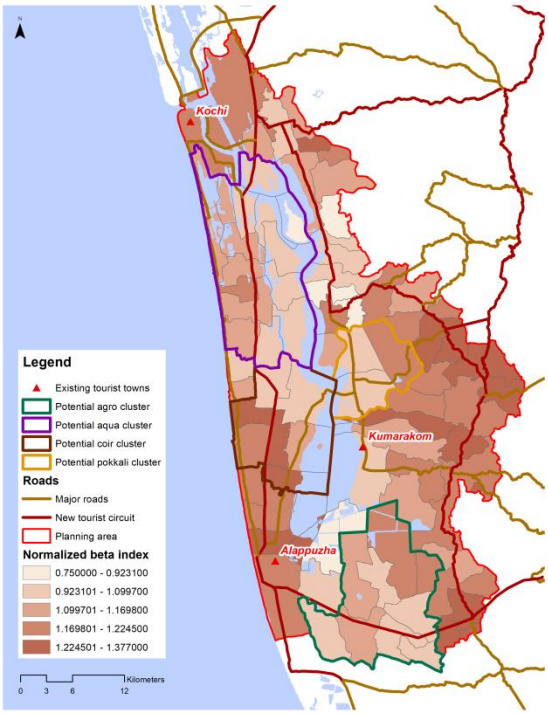



**FIGURE 127: EXISTING CONNECTIVITY MAP**

*Source: Author*

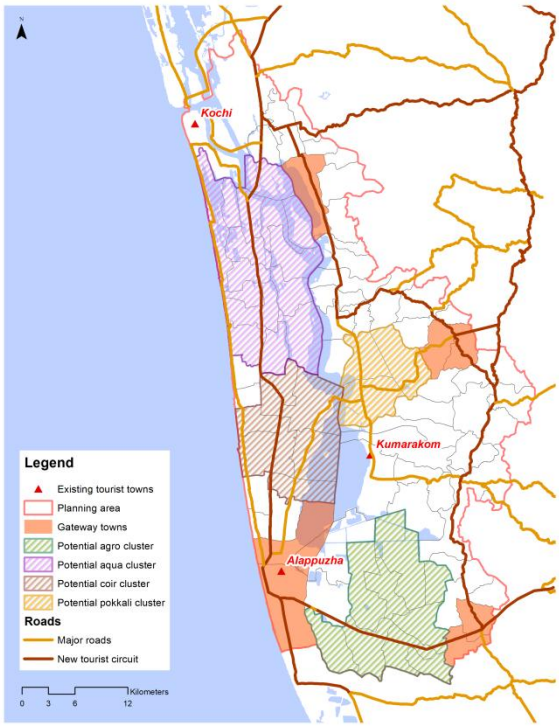



**FIGURE 128: PROPOSED GATEWAY TOWNS**

*Source: Author*

To ensure that gateway towns can effectively serve as transition zones between regional landscapes and the core tourism clusters of the Vembanad estuary, it is essential to strengthen their physical and service infrastructure. These towns must be equipped to handle high volumes of visitors while also offering meaningful orientation and facilitating smooth dispersal into the surrounding clusters. The following table outlines key infrastructure interventions necessary to support the gateway towns in fulfilling their role as entry points and anchors of the proposed tourism circuit.

**TABLE 23: INFRASTRUCTURE REQUIREMNTS FOR GATEWAY TOWNS**

| Category | Intervention | Description |
|---|---|---|

| | | |
|---|---|---|
| **Transport Infrastructure** | Multimodal Transit Hubs | Integrated hubs connecting rail, road, and water-based transport with last-mile connectivity options. |
| **Visitor Orientation** | Tourist Interpretation Centres | Facilities providing curated information on the ecology, culture, and tourism circuits of the region. |
| **Tourist Services** | Digital & Physical Tourist Kiosks | Equipped with interactive maps, brochures, QR codes for bookings, and multilingual assistance. |
| **Retail & Local Economy** | Local Craft and Produce Markets | Dedicated retail spaces showcasing local handicrafts, food products, and eco-souvenirs. |
| **Wayfinding & Signage** | Smart Signage Systems | Multilingual digital and static signage offering real-time travel updates, maps, and safety info. |
| **Public Amenities** | Washrooms & Rest Areas | Well-maintained, accessible, gender-inclusive facilities with shaded seating and child-friendly zones. |
| **Mobility & Access** | Bicycle/E-Bike Rental Zones | Eco-mobility options for local exploration, with parking stations and repair support. |
| **Cultural Infrastructure** | Performance & Exhibition Spaces | Small open-air stages or galleries for cultural events, art exhibitions, and community interaction. |
| **Accommodation Interface** | Booking Desks for Acoomodation | Help desks to assist tourists in booking locally run accommodations within various clusters. |
| **Safety & Health** | First Aid & Emergency Information Booths | Staffed booths offering basic medical assistance and emergency contact points. |
| **Green Infrastructure** | Landscaping & Green Corridors | Tree-lined walkways, bioswales, and shaded paths along the route at key sites. |
| **Waste Management** | Segregated Waste Disposal Units | Clearly marked and regularly serviced units promoting zero-waste tourism practices. |

*Source : Author*

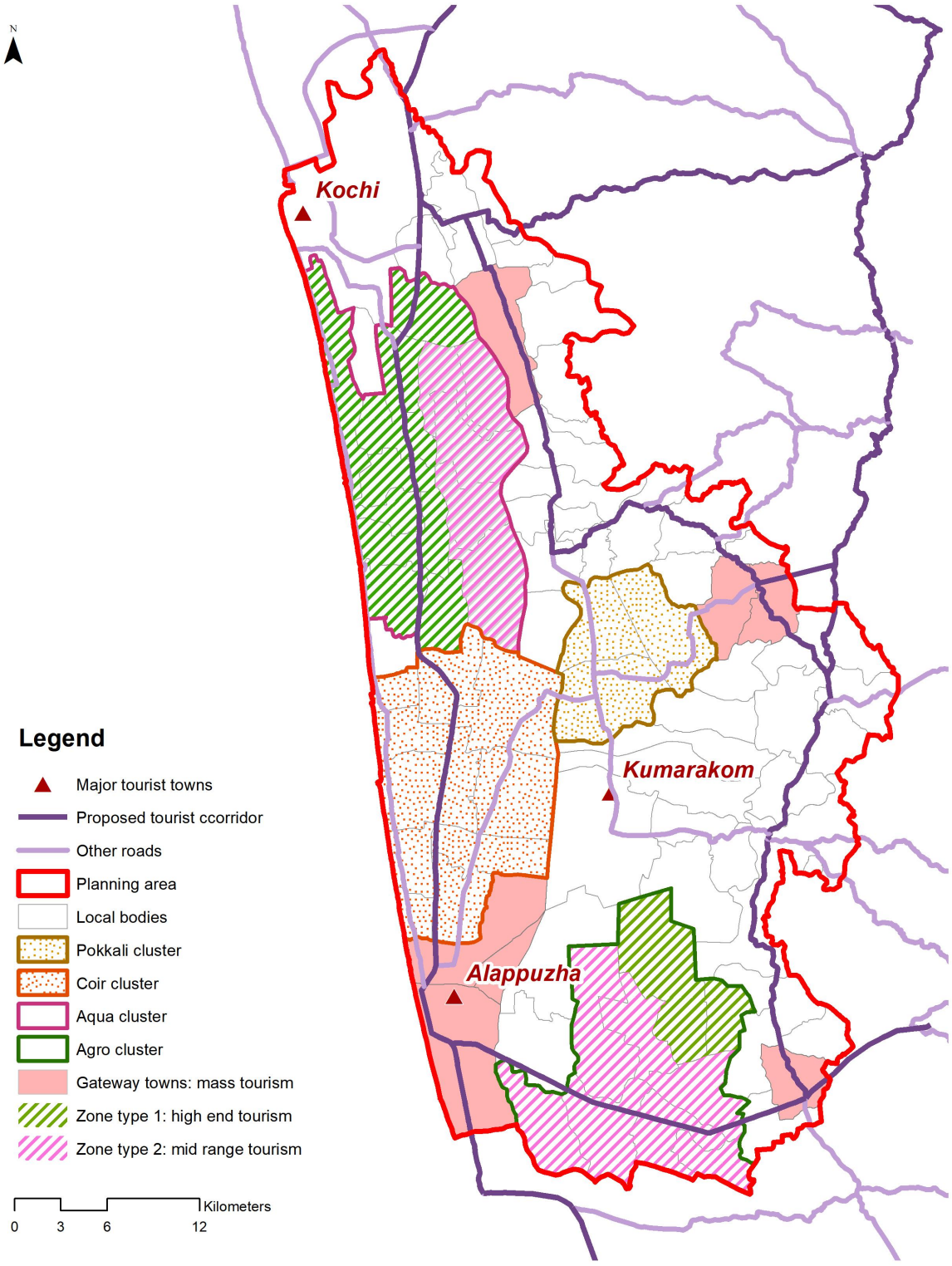



**FIGURE 129: PROPOSED TOURISM DISTRICTS AND CIRCUITS**

*Source: Author*

### 5.2.4 ADMINISTRATIVE RESTRUCTURING

The Destination Management Unit in each of the chosen destinations would be an entity with a balanced board with the District Collector as the Chairman. The Tourism Manager would act as the CEO of the entity.

**TABLE 24: DESTINATION MANAGEMENT MODELS**

| Ownership | Investment | Operations |
|---|---|---|
| **Govt. / Community** | CSR + NGO + Govt + Private | Private + Community |

*Source : Author*

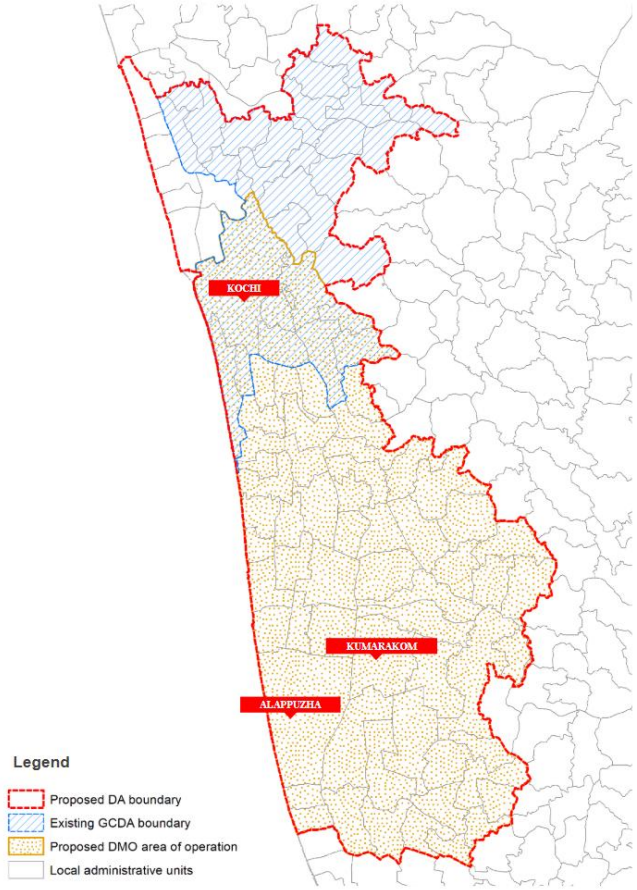



**FIGURE 130: DMA AND DA JURISDICTION BOUNDARIES**

*Source: Author*

## 5.3 CLUSTER BASED INTERVENTIONS

This segment presents cluster-specific proposals aimed at establishing the nature of tourism within the zone, infrastructure requirements for the same, and the estimated cost.

These interventions are designed to align with the landscape's carrying capacity, celebrate local heritage, and support sustainable economic development at the grassroots level.

## 5.3.1 AQUA CLUSTER

The aqua cluster represents a network of communities within the Vembanad region whose lives and livelihoods are intimately tied to the estuary's aquatic ecosystems. Comprising traditional inland fishing settlements, clam and mussel harvesters, and backwater navigators, this cluster embodies the dynamic relationship between people and water. It is characterized by its rich aquatic biodiversity, vibrant fishing culture, and knowledge systems rooted in sustainable water use practices. As a tourism node, the Aquacluster holds immense potential for promoting responsible water-based tourism experiences—such as guided fishing tours, estuarine ecology trails, and interactive sessions with local fishers.

### 5.3.1.1 TOURISM ZONES AND TYPE

The aqua cluster was delineated based on the extent of aquatic livelihoods and backwater access. The cluster was further divided into three primary tourism zones, based on a connectivity analysis and landscape capacity.

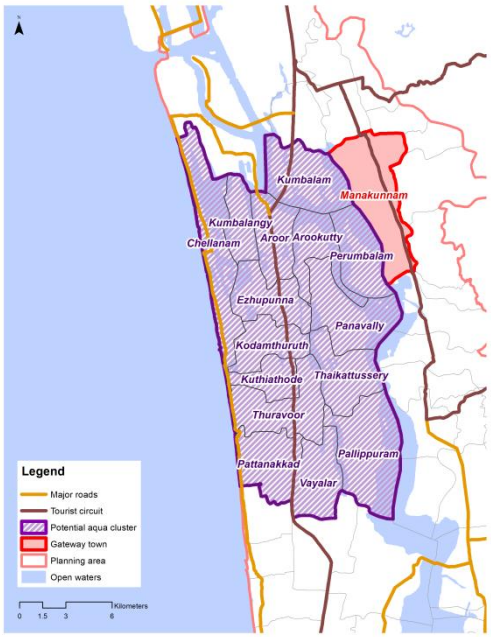



**FIGURE 131: AQUA CLUSTER VILLAGES**

*Source: Author*

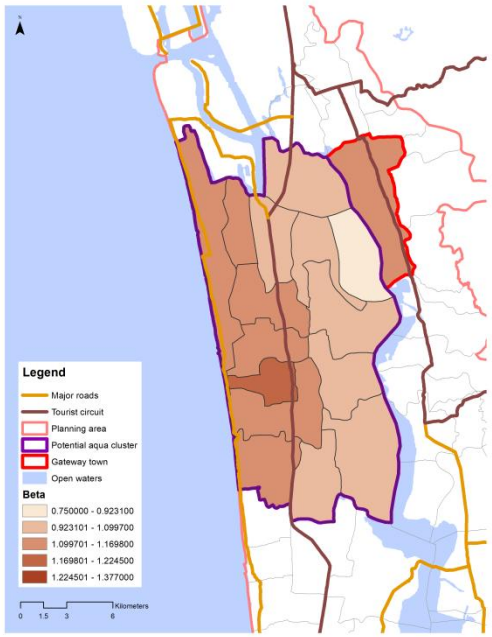



**FIGURE 132: AQUA CLUSTER CONNECTIVITY MAP**

*Source: Author*

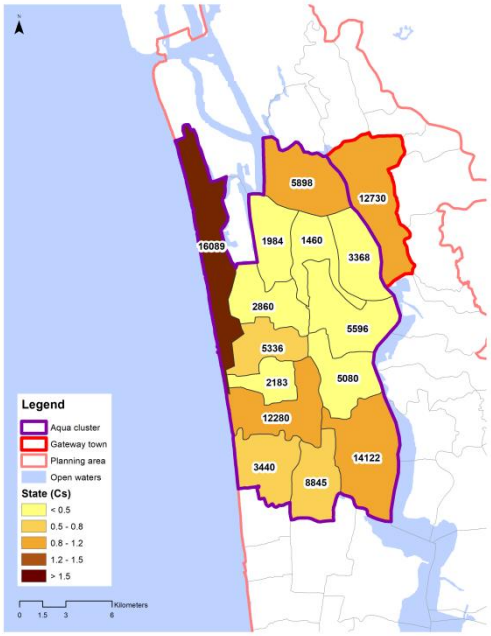



**FIGURE 133: AQUA CLUSTER TCC NUMBERS**

*Source: Author*

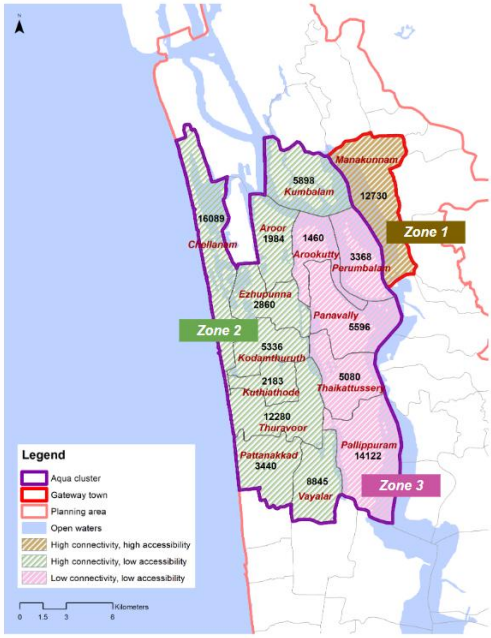



**FIGURE 134: AQUA CLUSTER TOURISM ZONES**

*Source: Author*

Given the accessibility and the carrying capacity criteria, the specific nature of tourism in each of the zones has been outlined.

**TABLE 25: PROPOSED ZONES AND INFRASTRUCTURE REQUIREMENTS FOR AQUA CLUSTERS**

| Tourist zone | Nature of tourism | Length of stay | Proposed Activities | Required infrastructure |
|---|---|---|---|---|
| **Zone 1: Gateway & Transit Zone (High Connectivity)** | Transit-oriented, information-rich hub for short visits | Less than a day | - Orientation tours<br>- Cultural exhibitions<br>- Quick boat rides<br>- Shopping & café hopping | - Multimodal transport hubs<br>- Interpretation centre<br>- Tourist info kiosks<br>- Retail outlets & cafés<br>- Offices for tour operators |
| **Zone 2: Experiential Aquaculture Zone (Fish Farm Tourism)** | Immersive, experiential tourism with a focus on aquaculture | 1–2 days | - Farm tours<br>- Fishing experiences<br>- Cooking demos<br>- Dining at fish-based restaurants<br>- Participating in seasonal fish festivals | - Fish farms integrated with tourism amenities<br>- Stationary houseboats<br>- Niche waterfront restaurants<br>- Open grounds for festivals<br>- Homestays or eco-lodges |

| | | | | |
|---|---|---|---|---|
| **Zone 3: Eco-Camping Zone (Remote Stay Experience)** | Nature-centric, rustic stay in eco-sensitive locations | Overnight (1 day) | - Kayaking or canoeing<br>- Birdwatching<br>- Night camping & stargazing<br>- Guided nature walks | - Elevated or floating campsites<br>- Basic sanitation & water facilities<br>- Solar lighting<br>- Nature trails & watch towers<br>- Trained eco-guides |

*Source : Author*

### 5.3.1.2 DEVELOPMENT POLICIES

A set of mix regulatory tools, financial incentives, and urban design strategies have been proposed for each zone to foster sustainable tourism, empower local communities, and ensure environmental stewardship. The following section outlines zone-specific proposals to guide development, manage tourist flows, and enhance the overall visitor experience.

**TABLE 26: DEVELOPMENTAL POLICIES FOR AQUA CLUSTERS ZONE 1**

| Category | Policy intervention |
|---|---|
| **Investment Model** | Public-Private Partnership (PPP) model for development of multimodal transport hubs, interpretation centres, and retail zones. Municipal facilitation of single-window clearance for investors. |
| **Subsidies** | Capital subsidies (up to 30%) for local entrepreneurs establishing information centres, cafés, or retail kiosks with local products. |
| **Tourist Permits** | Flexible short-term access permits, possibly via digital kiosks or mobile apps, to streamline day-visits and prevent overcrowding. |
| **Urban Design Schemes** | Transit-Oriented Development (TOD) guidelines with pedestrian-first design, shaded walkways, and water-taxi integration. Interactive signage and cultural QR-code based trails. |
| **Capacity Management** | Establish a real-time monitoring system (e.g., app dashboard) to track footfall and manage daily visitor load. |

*Source : Author*

**TABLE 27: DEVELOPMENTAL POLICIES FOR AQUA CLUSTRERS ZONE 2**

| Category | Policy intervention |
|---|---|

| Category | Policy intervention |
|---|---|
| **Investment Model** | Co-operative models involving local fishers and SHGs (Self Help Groups) to co-manage tourism and aquaculture. Government-backed Aquatourism Development Fund. |
| **Subsidies** | 50% subsidy on retrofitting stationary houseboats with solar panels, bio-toilets, and safety equipment. Support for setting up small fish-based restaurants using local produce. |
| **Tourist Permits** | Limited entry permits via seasonal auctioning system, with preference given to eco-conscious operators and community-run enterprises. |
| **Urban Design Schemes** | Designated aquatourism clusters with floating boardwalks, interpretation signage, and integrated public spaces for fish festivals and cultural showcases. |
| **Skill Development** | Launch of Aquatourism Training Institutes offering capacity-building programs for locals on hospitality, language, and fish-based culinary arts. |

*Source : Author*

**TABLE 28: DEVELOPMENTAL POLICIES FOR AQUA CLUSTRERS ZONE 3**

| Category | Policy intervention |
|---|---|
| **Investment Model** | Eco-concession models where private eco-tour operators bid for rights to operate low-impact campsites under government-set environmental standards. |
| **Subsidies** | Subsidies on green infrastructure – compost toilets, solar panels, rainwater harvesting systems for eco-campsites. |
| **Tourist Permits** | Strict carrying capacity-based permits with daily visitor caps and dynamic pricing to control peak loads. E-permits with GPS tracking for responsible tourism. |
| **Urban Design Schemes** | Implementation of Low-Impact Development (LID) zoning to limit permanent construction. Eco-trails, nature interpretation points, and viewing decks to be pre-approved under a design codebook. |
| **Ecological Monitoring** | Mandate biodiversity audits and carbon-footprint assessments for all operators; establish eco-scorecards to monitor zone health. |

*Source : Author*

## 5.3.2 AGRO CLUSTER

The agro cluster is located in the heart of the fertile agricultural landscapes of the area. This cluster includes small-scale farmers, rice producers, and local artisans who maintain age-old traditions of farming, harvesting, and producing agro-based goods. Characterized by its lush paddy fields and traditional farming practices, the agro cluster reflects a rich cultural and ecological heritage. As a tourism node, it offers immense potential for showcasing sustainable agriculture and offering immersive experiences, such as staying with farmers, participating in harvest festivals, and engaging in hands-on workshops in traditional paddy processing.

### 5.3.2.1 TOURISM ZONES AND TYPE

The extent of farmlands, the diversity in agricultural products and the percentage polutaion involved in agricultural pursuits helped delineate the cluster extent. Based on a connectivity analysis and landscape capacity, the cluster was further divided into three primary tourism zones, each with its unique brand od tourism .

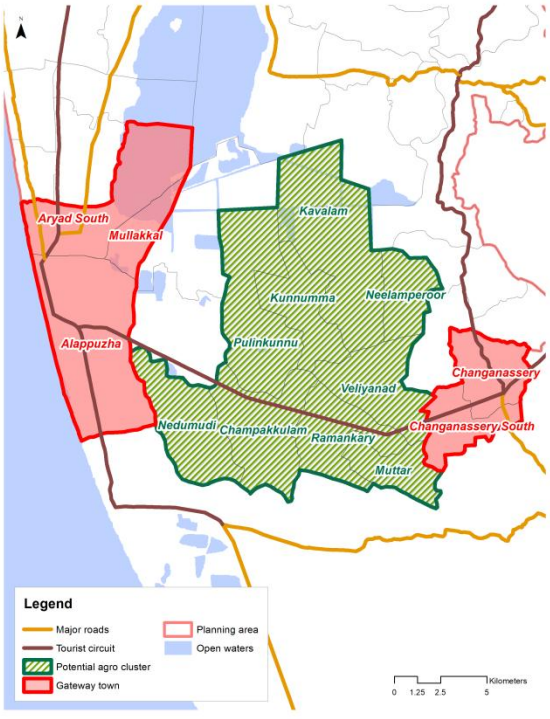



**FIGURE 135: AGRO CLUSTER VILLAGES**

*Source: Author*

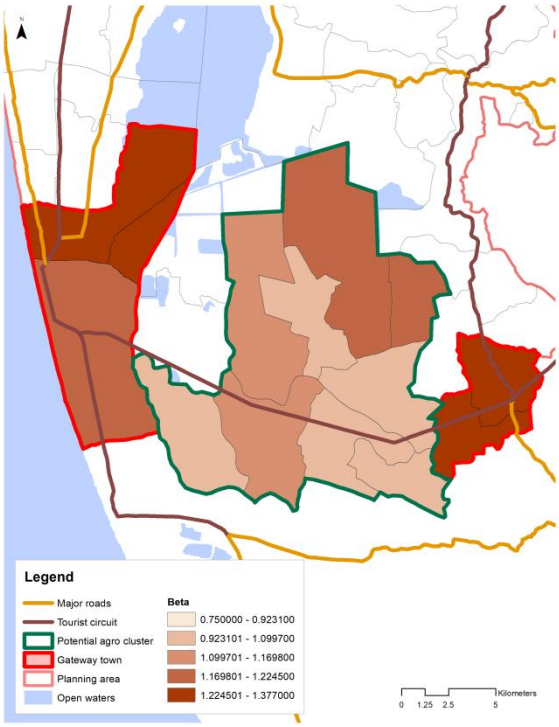



**FIGURE 136: AGRO CLUSTER CONNECTIVITY MAP**

*Source: Author*

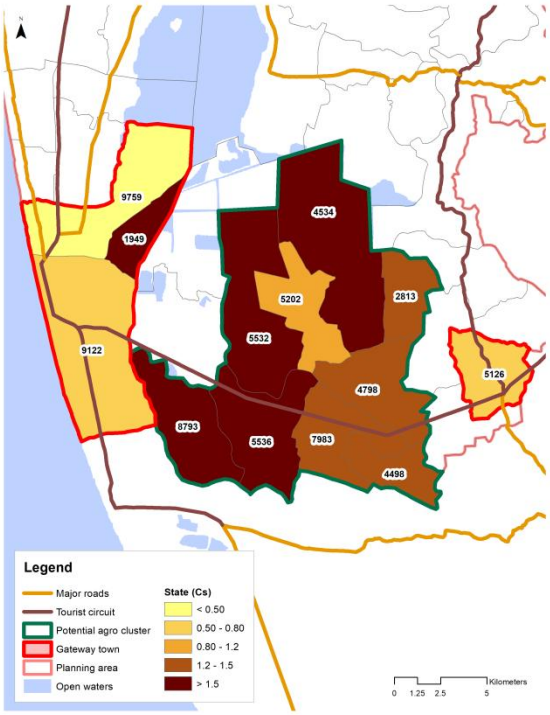



**FIGURE 137: AGRO CLUSTER TCC NUMBERS**

*Source: Author*

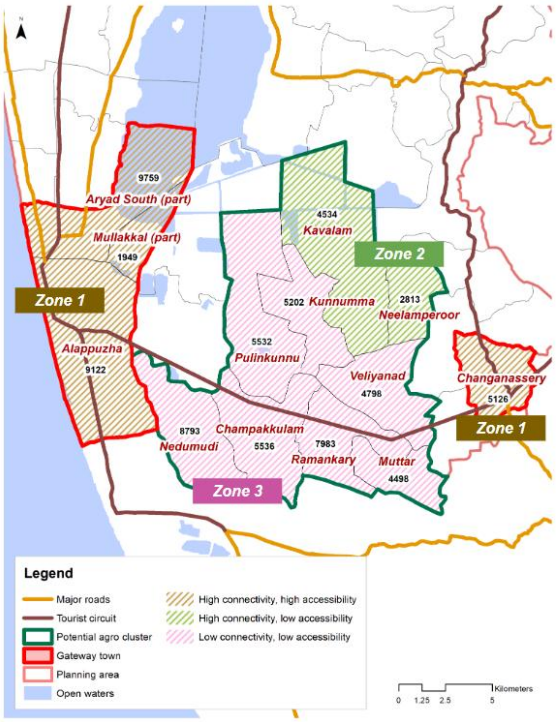



**FIGURE 138: AGRO CLUSTER TOURISM ZONES**

*Source: Author*

Given the accessibility and the carrying capacity criteria, the specific nature of tourism in each of the zones has been outlined.

**TABLE 29: PROPOSED ZONES AND INFRASTRUCTURE REQUIREMENTS FOR AGRO CLUSTERS**

| Tourist zone | Nature of tourism | Length of stay | Proposed Activities | Required infrastructure |
|---|---|---|---|---|
| **Zone 1: Gateway & Orientation Hub (High Connectivity Zone)** | Transit-based, orientation and short visits | Less than 1 day (Half-day or day trips) | - Guided introductions to the agricultural ecosystem<br>- Booking day tours or onward stays<br>- Purchase local agro-products<br>- Attend short interactive displays or AV shows | - Interpretation Centre<br>- Retail outlets for local crafts and agro-products<br>- Multimodal transport hubs (boats, buses, auto-rickshaws)<br>- Tour operator offices<br>- Public amenities (toilets, rest areas, Wi-Fi) |

| | | | | |
|---|---|---|---|---|
| **Zone 2: Immersive Rural Experience (Homestays with Farmers)** | Experiential and participatory agro-tourism | 2–3 days | - Participate in harvest festivals<br>- Cooking traditional meals<br>- Engage in farming activities<br>- Shop at haats<br>- Nature walks and village trails | - Farmer-run homestays<br>- Festival grounds<br>- Farmer haats/markets<br>- Temporary food courts/traditional kitchens<br>- Signage and local guides |
| **Zone 3: Heritage Agro-Industry Retreat (Rural Retreats with Traditional Processing)** | Heritage and cultural agro-tourism | 2–4 days | - Learn paddy processing (manual and mechanical)<br>- Workshop on making rice-based products<br>- Stay in eco-conscious accommodations<br>- Agro-wellness experiences (e.g., rice bran scrubs, herbal baths) | - Rural eco-resorts with decentraliized facilities<br>- Small-scale paddy processing units<br>- Paddy-based product workshops<br>- Interpretation spaces within the resorts<br>- Walking paths, observation decks |

*Source : Author*

### 5.3.2.2 DEVELOPMENT POLICIES

The required mix of regulatory tools, financial incentives, and urban design strategies have been proposed for each zone to foster. The following section outlines zone-specific proposals to guide development, manage tourist flows, and enhance the overall visitor experience.

**TABLE 30: DEVELOPMENTAL POLICIES FOR AGRO CLUSTERS ZONE 1**

| Category | Policy intervention |
|---|---|
| **Subsidized Infrastructure Development Grants** | Provide capital grants to local panchayats and cooperatives for setting up interpretation centres, retail clusters, signage systems, and multimodal connectivity hubs. |
| **Public-Private Partnership (PPP) Investment Model** | Encourage private investments through PPPs in exchange for lease rights on retail spaces and interpretation kiosks under Design-Build-Operate models. |
| **Zoning for Transit-Tourism Uses** | Designate specific land-use zones near transport corridors (boat jetties, bus terminals) for tourism support functions, easing development permissions and providing FAR incentives. |

| Category | Policy intervention |
|---|---|
| **Auction-Based Tourist Guide Licenses** | Issue a limited number of annual licenses for certified tour operators through competitive auctioning, with preference given to local youth trained under skill development schemes. |
| **Urban Design Guidelines** | Enforce a cohesive design language for facades, kiosks, wayfinding signage, and pedestrian-friendly streetscapes, promoting a unified visitor experience. |

*Source : Author*

**TABLE 31: DEVELOPMENTAL POLICIES FOR AGRO CLUSTERS ZONE 2**

| Category | Policy intervention |
|---|---|
| **Subsidies for Homestay Upgradation** | Offer financial incentives and soft loans for farmers to upgrade rooms into tourist-compliant homestays with sanitation and safety standards. |
| **Harvest Tourism Permit Scheme** | Introduce short-term tourism permits for individual farms participating in festival and seasonal tourism events (e.g., Harvest Trails), ensuring regulatory oversight and quality control. |
| **Cluster-Based Cooperative Model** | Form local tourism cooperatives to manage bookings, share revenues, and conduct collective training in hospitality, ensuring local ownership. |
| **Agro-Education Integration** | Promote partnerships between universities/agriculture colleges and the local community for agro-tourism curriculum, research internships, and joint knowledge events. |
| **Temporary Rural Pop-up Zones** | Permit temporary but regulated “pop-up” haats, cuisine stalls, and performance spaces during festivals using flexible zoning and modular infrastructure. |

*Source : Author*

**TABLE 32: DEVELOPMENTAL POLICIES FOR AGRO CLUSTERS ZONE 3**

| Category | Policy intervention |
|---|---|
| **Artisanal Tourism Incentive Scheme** | Provide grants for setting up traditional small-scale rice milling, processing, and value-addition units as tourism attractions, especially by SHGs and women's groups. |
| **Eco-Resort Zoning Policy** | Introduce an "Agro-Eco-Tourism Zone" land-use classification with guidelines on maximum buildable area, low-carbon materials, water use, and landscape integration. |

| Category | Policy intervention |
|---|---|
| **Carbon Offset Certification for Resorts** | Mandate or incentivize certification of eco-resorts as carbon-neutral through local offsetting initiatives like paddy methane capture or tree planting in buffer zones. |
| **Heritage Permit Auction System** | Auction a limited number of annual "heritage-tourism permits" for resorts operating traditional processing units open to tourists—ensuring exclusivity and quality standards. |
| **Design Review Boards** | Set up local design review panels to assess resort and infrastructure proposals for vernacular architecture, landscape integrity, and visitor capacity thresholds. |

*Source : Author*

## 5.4 TOURISM EVENT CALENDAR

The event calender is a cultural celebration framework designed to align with the key agricultural and aquacultural cycles of a region, promoting traditional livelihoods through festivals. It brings together various community clusters—Agro (Paddy), Pokkali, Coir, and Aqua—to celebrate the peaks of production and the rhythms of nature.

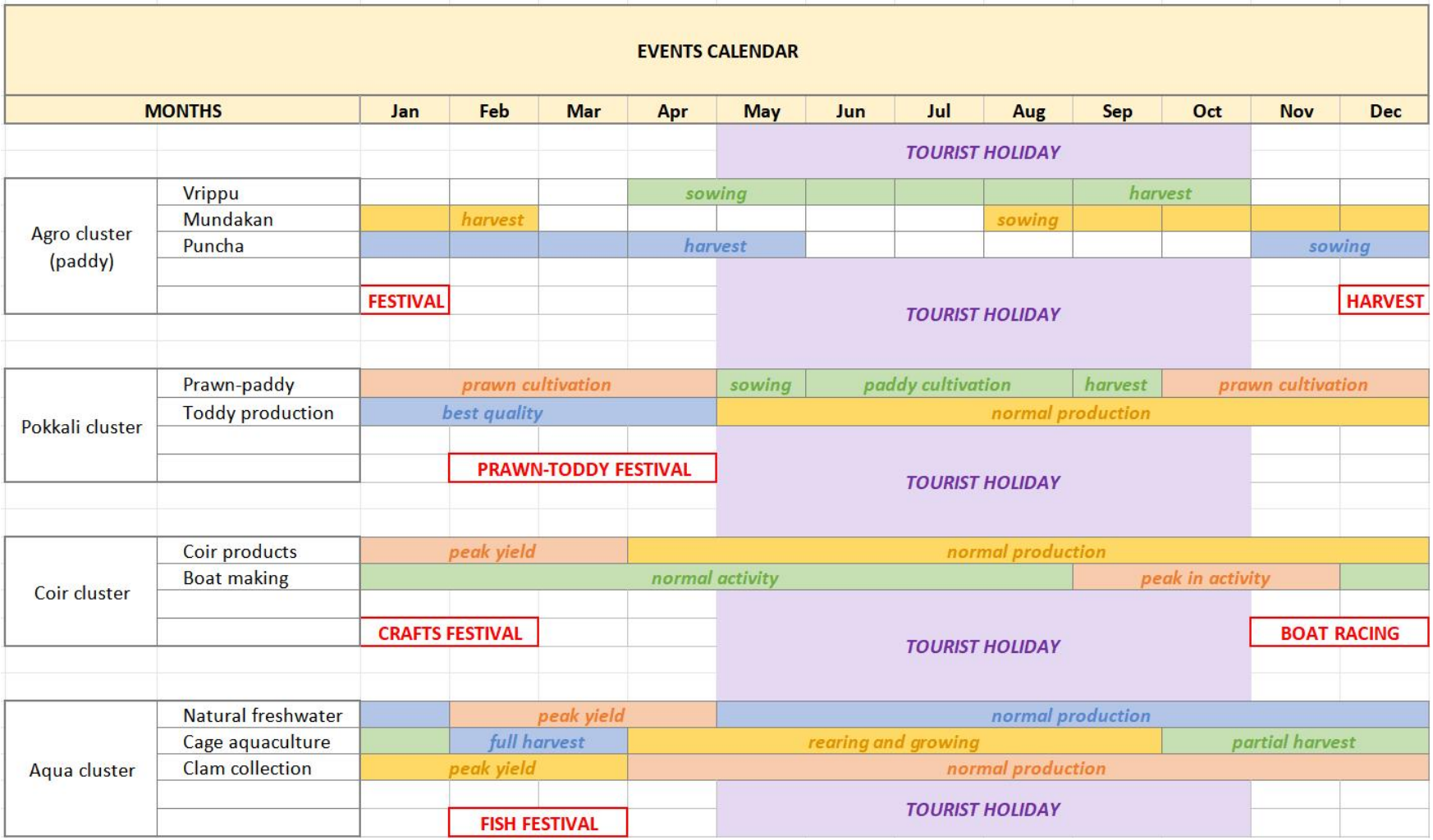



**FIGURE 139: PROPOSED TOURIST CALENDAR**

*Source: Author*

# 5.5 BRANDING AND MARKETING

The event calender is a cultural celebration framework designed to align with the key agricultural and aqua cultural cycles of a region, promoting traditional livelihoods through festivals. It brings together various community clusters—Agro (Paddy), Pokkali, Coir, and Aqua—to celebrate the peaks of production and the rhythms of nature.

## 5.5.1 BRAND NARRATIVE

The new tourism brand will prioritize nature and community. For too long, tourism here has been framed through the lens of leisurely houseboats and luxury retreats, often divorced from the land, the life, and the legacy that this region holds.The narrative will promote the wetland as a living ecosystem and shed limelight onto its culture,community and biodiversity. The brand will champion the following themes:

1) Sustainability
2) Community-driven
3) Slow, immersive experiences
4) Cultural authenticity
5) Eco-conscious luxury

## 5.5.2 BRAND IDENTITY ELEMENTS

The brand identity elements reinforce the brand values and play a key role in disseminating awareness among tourists, reinforcing eco-sensitive tourist behaviour.

**1)** ***Logo and tagline:***

The logo should maintain minimalism with earthy colors (greens, browns, and blues) and organic forms, resonating with an eco-conscious, slow tourism ethos.

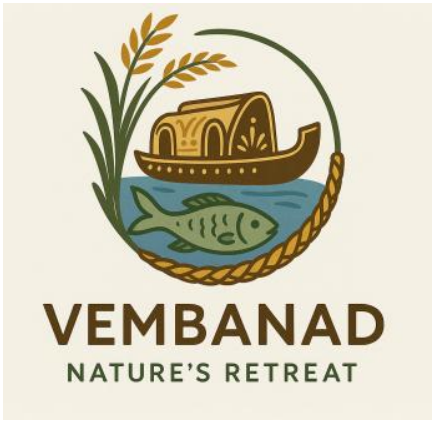



**FIGURE 140: WETLAND TOURISM LOGO (SAMPLE)**

*Source: Author*


**FIGURE 141: PRODUCT BRANDING**

*Source: Author*

### 2) *Strategic partnerships*

Partnerships will help forge collaborations that enhance conservation-driven tourism while empowering local communities. These partnerships would ensure:

a) Economic incentives are aligned with conservation

b) Marketing and visibility extend to ecologically sensitive travel segments

c) Policy advocacy is backed by community voices and data.

**TABLE 33: PROPOSED STRATEGIC COLLABORATIONS**

| Partner type | Organisations | Role in partnership | Expected outcomes |
|---|---|---|---|
| **Academic & Research Institutions** | CUSAT, KUFOS,SACON | Provide scientific input for environmental monitoring, capacity studies, and sustainable tourism guidelines. | - Data-driven decision-making, ongoing ecosystem assessment<br>- Academic validation |
| **Eco-Certification Bodies** | Green Globe, Kerala RT Certification | Certify and validate responsible practices followed by tourism operators and stakeholders. | - Build credibility and attract eco-conscious travelers. |
| **Non-Governmental Organizations (NGOs)** | ATREE, MS Swaminathan Foundation, WWF-India | Facilitate community mobilization, conservation awareness, and livelihood training. | - Empowered local communities<br>- Assist in grassroots-level implementation<br>- strengthened conservation-tourism linkage |

*Source : Author*

### 3) *Community-led ambassadors*

The idea is to position local communities as ambassadors of their own heritage, this initiative fosters a tourism model deeply rooted in authenticity, lived experience, and ecological stewardship. Their involvement ensures that tourism revenues are equitably distributed, skills are locally developed, and the region's fragile ecosystem is respected through collective custodianship.

**TABLE 34: TOURISM AMBASSADORS AND KEY ROLES**

| Ambassador group | Role description |
|---|---|
| **Fisherfolk** | Sharing stories of backwater life, traditional fishing techniques, and the rhythm of the tides. |
| **Farmers** | Guiding visitors through pokkali fields and explaining saline-resistant rice cultivation practices. |

| Ambassador group | Role description |
|---|---|
| **Coir Artisans** | Hosting interactive workshops on coir-making and promoting sustainable, heritage crafts. |
| **Youth Groups** | Leading eco-guiding activities, bird watching tours, and mangrove interpretation for biodiversity awareness. |
| **Women's Self-Help Groups (Kudumbashree)** | Running eco-stays, cooking classes, and homestays to provide authentic local hospitality experiences. |

*Source : Author*

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# ANNEXURE A. SURVEY FORMATS

## A.1 TOURIST SURVEY

**SURVEY PROFORMA**

**Conducted by - Tushita Basak**

*Department of Architecture and Regional Planning*

*Indian Institute of Technology, Kharagpur*

***Part 1: Personal Details***

1) Name: _____

2) Age: ☐ Below 20 ☐ 21-30 ☐ 31-40 ☐ 41-50 ☐ Above 50

3) Sex: ☐ Male ☐ Female ☐ Other

4) Nationality: _____

5) Income Level: ☐ < $10k ☐ $10k-$30k ☐ $30k-$50k ☐ > $50k

***Part 2: Visit Characteristics***

6) Where are you coming from? _____

7) Where are you headed after this visit? _____

8) Is this your first visit to Vembanad? ☐ Yes ☐ No

9) Purpose of Visit: ☐ Leisure ☐ Business ☐ Education ☐ Social

10) Duration of Stay: ☐ 1 day ☐ 2-3 days ☐ 4-7 days ☐ More than a week

11) Travel Arrangements made by: ☐ Self ☐ Tour Operator

12) Mode of Arrival: ☐ Air ☐ Train ☐ Road ☐ Combination

***Part 3: Spending Pattern***

13) Rank your expenditure (1-5; 1=Least, 5=Most)

Accommodation: ____ Travel: ____ Food: ____ Shopping: ____ Recreational Activities: ____ Other: _____

***Part 4: Satisfaction with Services/Facilities***

14) Rate your satisfaction with the following (1-Very Unsatisfied to 5-Very Satisfied):
Accommodation: ____ Transport: ____ Food: ____ Shopping: ____
Recreational Activities: ____

15) Facilities to be developed/improved:
☐ Accommodation ☐ Transport ☐ Shopping ☐ Food ☐ Recreational Activities ☐ Other (Specify): _____

***Part 5: Environmental Awareness***

16) Are you aware that Vembanad is an ecologically sensitive area? ☐ Yes ☐ No

17) Did you consider environmental impact while planning your visit? ☐ Yes ☐ No

18) During your stay, did you: ☐ Avoid littering ☐ Use eco-friendly products ☐ Support local eco-tourism operators ☐ Participate in conservation activities

19) Do you think tourists should be more sensitized about protecting Vembanad's ecosystem? ☐ Agree ☐ Neutral ☐ Disagree

***Part 6: Destination Image and Suggestions***

20) How did you learn about Vembanad?
☐ Friends/Family ☐ Travel Operator ☐ Magazine/TV ☐ Online Sources ☐ Other: _____

21) What attracted you most?
☐ Scenic Beauty ☐ Monuments ☐ Local Culture ☐ All

22) Would you visit again? ☐ Yes ☐ No

23) Would you recommend it to others? ☐ Yes ☐ No

24) Bottlenecks for Tourism Development: (Select all that apply)
☐ Poor connectivity ☐ No first-aid/health safety ☐ Water supply and sanitation ☐ Garbage disposal issues ☐ Accommodation issues ☐ Travel booking problems ☐ Crime ☐ Pollution ☐ High costs ☐ Congestion

## A.2 LOCAL LIVELIHOOD EARNERS

**SURVEY PROFORMA**

**Conducted by - Tushita Basak**

*Department of Architecture and Regional Planning*

*Indian Institute of Technology, Kharagpur*

***Part 1: Personal and Livelihood Details***

1) Name (Optional): _____

2) Age Group: ☐ Below 20 ☐ 21-30 ☐ 31-40 ☐ 41-50 ☐ Above 50

3) Occupation: ☐ Fisherman ☐ Cord Maker ☐ Handicrafts ☐ Tourism-related services ☐ Others (Please specify): _____

4) Average annual income: ☐ Below ₹50k ☐ ₹50k-₹100k ☐ Above ₹100k

5) Peak Business Periods: _____

6) Lean Business Periods: _____

***Part 2: Impact of Tourism on Livelihood***

1) Does your income increase during peak tourist seasons?

☐ Yes ☐ No ☐ Remains Unchanged

2) Rate the impact of tourism on your production/business (mark all that apply):

☐ Increase in demand ☐ Scarcity of raw materials

☐ Shortage of labour during peak seasons ☐ No impact

***Part 3: Environmental Awareness***

1) Are you aware of environmental issues affecting the Vembanad region?

☐ Yes ☐ No

2) Which environmental issues are you most concerned about?

☐ Water pollution ☐ Waste management ☐ Loss of fish population

☐ Deforestation ☐ Others (Please specify): _____

2) Have you participated in any environmental conservation activities?

☐ Yes ☐ No

3) How important is environmental conservation for sustaining your livelihood?

☐ Very Important ☐ Important ☐ Neutral ☐ Not Important

## A.3 LOCAL RESIDENTS

**SURVEY PROFORMA**
**Conducted by - Tushita Basak**
*Department of Architecture and Regional Planning*
*Indian Institute of Technology, Kharagpur*

***Part 1: Demographic Details***

1) Age: _____
2) Years of residence: _____
3) Locality: _____
4) Employment in tourism sector: ☐ Yes ☐ No
5). Part-time income from tourism: ☐ Yes ☐ No
6) Annual income: _____
7) Education level: ☐ Primary ☐ Secondary ☐ Graduate

***Part 2: Tolerance and Interaction with Tourism***

1) How often do you come in contact with tourists?
☐ No contact ☐ Some contact ☐ Frequent contact
2) For residents, are the benefits from tourism are more than the costs?
☐ Yes ☐ No
3) Please rate the following (1 - Strongly Disagree to 5 - Strongly Agree):
- The number of foreign employees in hotels is increasing.
- The number of tourists should continue to increase.
- The government and other tourism stakeholders treat tourists better than locals.

***Part 3: Environmental Awareness***

1) Are you aware of the environmental impact of tourism on the Vembanad estuary?
☐ Yes ☐ No
2) Do you believe tourism contributes to pollution in the Vembanad area?
☐ Yes ☐ No
3) Which environmental issues do you observe most frequently?
☐ Water pollution ☐ Waste disposal problems ☐ Loss of natural habitats
☐ Overcrowding ☐ Other (Please specify): _____
4) Would you support eco-friendly tourism initiatives (like waste management drives, eco-tourism, etc.)? ☐ Yes ☐ No

## A.4 EXPERT SURVEY

**SURVEY PROFORMA**
**Conducted by - Tushita Basak**
*Department of Architecture and Regional Planning*
*Indian Institute of Technology, Kharagpur*

***Part 1: Personal Details and Professional Qualifications***

1) Name: _____

2) Educational Background:

☐ Bachelor's Degree ☐ Master's Degree ☐ Ph.D. ☐ Other: _____

3) Current Profession: _____

4) Years of Experience in Environmental Conservation:

☐ Less than 5 years ☐ 5–10 years ☐ 10–20 years ☐ More than 20 years

5) Familiarity with the Vembanad Estuary:

☐ Regularly work in the region ☐ Occasionally involved in projects in the region ☐ Rarely work in the region

***Part 2: Perceptions of Estuary Health and Risks Due to Tourism***

1) How would you rate the current health of the Vembanad Estuary?

☐ Very healthy ☐ Moderately healthy ☐ Poor ☐ Critical

2) What are the key threats to the estuary's ecosystem caused by tourism?

☐ Waste disposal and littering ☐ Overcrowding of tourist activities

☐ Water pollution from houseboats and tourism infrastructure ☐ Disturbance to local flora and fauna ☐ Unregulated land use changes ☐ Others: _____

3) In your opinion, what are the most significant risks posed by tourism to the

4) estuary's biodiversity? (Rank in order of severity, 1 being the most severe)

_____ Water quality degradation

_____ Habitat loss

_____ Species disturbance

_____ Overuse of natural resources

_____ Other (Please specify): _____

5) How effectively do you think current regulations address these risks?

☐ Very effective ☐ Moderately effective

☐ Somewhat effective ☐ Not effective at all

Have you observed specific examples of damage caused by tourism in the estuary?

If yes, please describe briefly. ☐ Yes: _____ ☐ No

***Part 3: Proposals for Future Development***

1) What measures would you recommend to mitigate the negative impacts of
2) tourism on the estuary? (Select all that apply)

☐ Strict enforcement of waste management regulations
☐ Limiting the number of tourists in sensitive areas
☐ Sustainable houseboat operations
☐ Restoration of degraded habitats
☐ Awareness programs for tourists and stakeholders
☐ Other (Please specify): _____

3) What role can communities play in conserving the estuary alongside tourism?

☐ Leading awareness initiatives
☐ Participating in eco-tourism ventures
☐ Monitoring and reporting environmental violations
☐ Other (Please specify): _____

4) How can tourism activities be made more sustainable in the Vembanad Estuary?
5) What long-term strategies would you suggest for balancing tourism and environmental conservation?

# ANNEXURE B. PLAGIARISM CHECK

ORIGINALITY REPORT

| 9% | 4% | 6% | 2% |
|---|---|---|---|
| SIMILARITY INDEX | INTERNET SOURCES | PUBLICATIONS | STUDENT PAPERS |

PRIMARY SOURCES

| | | |
|---|---|---|
| 1 | "Environmental Best Management Practices for Aquaculture", Wiley, 2008<br>Publication | 3% |
| 2 | www.researchgate.net<br>Internet Source | 1% |
| 3 | Martina Pásková, Geoffrey Wall, David Zejda, Josef Zelenka. "Tourism carrying capacity reconceptualization: Modelling and management of destinations", Journal of Destination Marketing & Management, 2021<br>Publication | <1% |
| 4 | dot.odisha.gov.in<br>Internet Source | <1% |
| 5 | whc.unesco.org<br>Internet Source | <1% |
| 6 | www.therealclub.com<br>Internet Source | <1% |
| 7 | Submitted to Indian Institute of Technology, Kharagpure<br>Student Paper | <1% |
| | www.swak.kerala.gov.in | |