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Climate Vulnerability Analysis for Kerala's Backwater Island Communities

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Abstract
Kerala's backwater islands—specifically Munroe Thuruthu, Perumbalam, and Valiyaparamba—are experiencing intensifying climate stresses driven by recurrent flooding, salinity intrusion, shoreline erosion, and land subsidence. These environmental pressures have raised concerns about whether such islands may become uninhabitable in the future, potentially triggering large-scale climate-induced migration. This dissertation investigates the extent to which climate impacts are influencing patterns of migration and adaptation in Kerala's islands. Using secondary data, 10-year environmental trend analysis (2014–2024), socio-economic indicators, and spatial evidence from scientific and government sources, the study assesses the vulnerability of these islands and the responses of local communities.
To contextualize Kerala's situation, two vulnerable Indian islands—Sagar Island (West Bengal) and Kutubdia Island (Bangladesh)—were examined. While Sagar Island demonstrates a moderate adaptation pathway with low-scale migration, Kutubdia represents a high-risk collapse scenario marked by severe land loss and large-scale displacement. Comparative analysis reveals that Kerala's islands closely resemble Sagar Island's adaptation trajectory rather than Kutubdia's displacement trajectory. Despite rising environmental stresses, migration from Kerala's backwater islands remains low, gradual, and predominantly economic rather than climate-forced.
The findings show that climatic pressures are significant but not yet severe enough to drive mass relocation. Instead, communities continue to adapt through raised housing, embankments, improved drainage, salinity management, mangrove restoration, and diversified livelihoods. Government interventions further strengthen this adaptation capacity. The study concludes that Kerala's backwater islands are currently on an adaptation-dominant pathway, with large-scale climate migration (>75%) unlikely in the near future. The dissertation recommends targeted resilience strategies—such as climate-resilient infrastructure, ecosystem restoration, and localized adaptation planning—to enhance long-term habitability and reduce future displacement risk.

Keywords: Climate Vulnerability, Backwater Islands, Climate-Induced Migration, Salinity Intrusion, Land Subsidence, Coastal Adaptation, Kerala

1. Introduction

Kerala, located along India's southwestern coast, is among the most climate-sensitive regions of the country. Its unique geography—stretching from the Arabian Sea coast to the Western Ghats—makes it vulnerable to both marine and terrestrial climate hazards. Over the past few decades, the state has

experienced rising temperatures, erratic monsoon rainfall, prolonged dry spells, and frequent extreme weather events such as floods, landslides, and coastal erosion. The 2018–2021 series of floods, sea-level rise along the Malabar Coast, and increasing saline intrusion in low-lying areas illustrate how climate change is reshaping Kerala's environment, economy, and settlements. These climatic disruptions are particularly critical for island communities, where livelihoods are closely tied to natural systems. stands as a dynamic and responsive strategy, characterized by its swiftness, cost-effectiveness, and action-orientedness, aimed lchanges, learn from the outcomes, and iteratively shape their environments for the better.

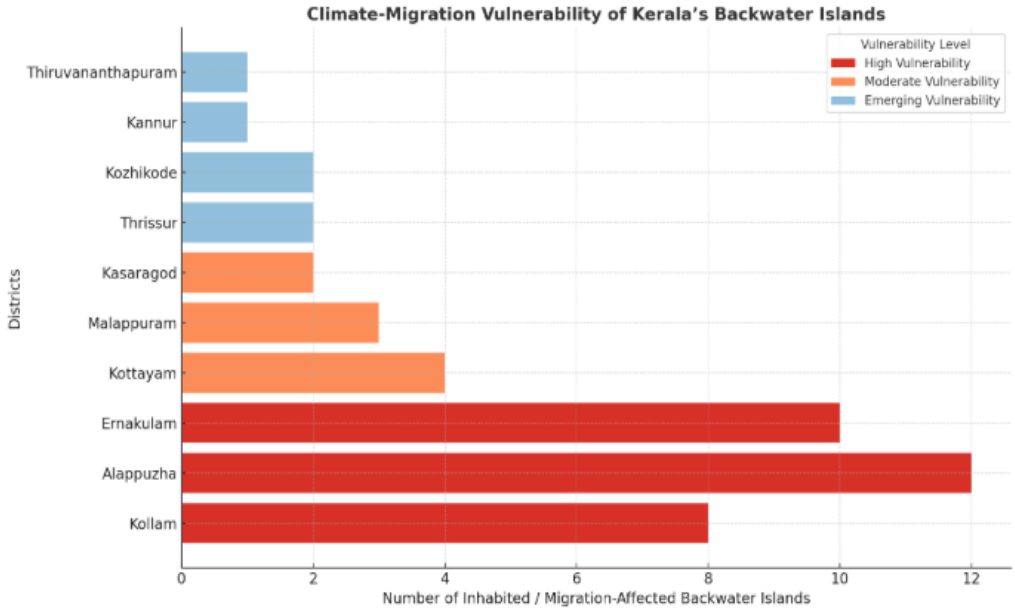
Climate change has intensified environmental instability in coastal and deltaic regions globally. Rising sea levels, erratic rainfall, tidal surges, and ecosystem degradation increasingly affect low-elevation settlements. Kerala, located along India's southwestern coast, is particularly vulnerable due to its unique physiography that stretches from the Arabian Sea to the Western Ghats.

Backwater islands are among the most climate-sensitive landscapes in Kerala. These islands are typically 0.5–1.5 m above mean sea level and are surrounded by estuarine water systems. Their low elevation, poor drainage gradients, and soft alluvial soil increase exposure to tidal flooding and salinity intrusion. Additionally, communities are highly dependent on climate-sensitive livelihoods such as paddy cultivation and fishing.

The central research question addressed in this study is:

Are Kerala's backwater islands entering a climate-driven displacement phase, or do they retain adaptive capacity?

Figure 1: Climate migration vulnerability of kerala backwater island



Climate-Induced Migration

Climate-induced migration refers to the movement of people whose decision to relocate is significantly influenced by environmental change. Migration may occur due to:

- Sudden-onset hazards (floods, cyclones)
- Slow-onset changes (sea-level rise, salinity)

- Livelihood collapse
- Environmental degradation

Globally, the World Bank (2021) projects up to 216 million internal climate migrants by 2050 under high-emission scenarios. In India, over 3.6 million disaster-related displacements were recorded in 2022 (IDMC).

However, migration is rarely solely climate-driven. It is shaped by livelihood resilience, institutional support, infrastructure, and socio-cultural attachment

Table 1: Types of Climate Migration

Types of climate migration	Details
Slow-onset	Gradual movement due to salinity, sea-level rise
Sudden-onset	Evacuation after floods or cyclones
Temporary	Seasonal or circular migration
Permanent	Relocation due to loss of habitability

2. Study Area

Kerala is located along the southwestern coast of India and is characterized by a complex physiographic setting comprising coastal plains, backwaters, estuaries, and the Western Ghats. The state possesses approximately 900 km of interconnected backwater systems distributed across Alappuzha, Kollam, Ernakulam, Kottayam, and Thrissur districts. According to the Coastal Zone Management Plan (CZMP, 2019), Kerala contains 1,826 mapped backwater islands, of which nearly 59% are located in Ernakulam district, followed by Alappuzha and Kollam.

Backwater islands are low-lying sedimentary landforms formed by riverine and marine deposition within lagoon–estuarine systems. These islands typically lie between 0.5–1.5 m above mean sea level and are surrounded by tidal water channels. Due to their minimal elevation, poor natural drainage gradients, and soft alluvial soils, they are highly susceptible to flooding, tidal surges, salinity intrusion, and land subsidence.

2.1 Munroe Thuruthu (Kollam District)

Munroe Thuruthu is located within the Ashtamudi backwater system. The island has reported increasing land subsidence and tidal flooding over the past decade. Salinity intrusion into wells and agricultural lands has significantly affected paddy cultivation and household water security. The island exhibits partial seasonal migration and livelihood diversification.

2.2 Perumbalam Island (Alappuzha District)

Perumbalam lies within the Vembanad Lake system and is predominantly agrarian. The island experiences prolonged inundation during monsoon seasons due to weak drainage connectivity. Salinity and crop loss have reduced agricultural productivity, prompting youth migration to nearby mainland towns.

2.3 Valiyaparamba Island (Kasaragod District)

Valiyaparamba is located in a lagoon–estuarine setting in northern Kerala. The island faces shoreline erosion, fishing instability, and infrastructure vulnerability. Although environmental pressures are evident, permanent migration remains limited.

These three islands were selected based on the following criteria:

- Low elevation and high exposure to tidal influence
- Documented evidence of flooding and salinity intrusion
- Socio-economic dependence on climate-sensitive livelihoods
- Availability of secondary data for analysis

Collectively, these islands represent varying degrees of vulnerability within Kerala's backwater system and provide a comparative base to evaluate adaptation versus migration responses.

Methodology

The study adopts a secondary-data-based analytical framework to assess climate vulnerability and migration tendencies in Kerala's backwater islands. Published datasets and official reports from agencies such as KSDMA, CWRDM, CZMP, and IDMC were reviewed to establish baseline evidence on flood frequency, salinity intrusion, land subsidence, and migration trends. A ten-year environmental trend analysis (2014–2024) was conducted using hydrological records and satellite-based interpretations to identify changes in inundation patterns and shoreline instability. Relevant policy documents—including the CRZ Notification (2019), Wetland Rules (2017), and Kerala Water Policy (Draft 2023)—were examined to evaluate institutional support for adaptation and relocation. Comparative case studies of Sagar Island (India) and Kutubdia Island (Bangladesh) were analyzed to contextualize Kerala's vulnerability within broader deltaic environments. Finally, a thematic parameter matrix was developed to assess key variables—flooding, salinity, subsidence, housing vulnerability, livelihood dependency, policy support, and migration trends—in order to determine whether the islands follow an adaptation-dominant or migration-dominant pathway.

3. Major Climate Stressors

3.1 Flood Frequency and Inundation

Post-2018 floods, flood-prone areas increased by 30–40%. Poor drainage and low elevation result in prolonged waterlogging. Housing foundations weaken, and agricultural productivity declines.

3.2 Salinity Intrusion

Chloride levels exceeding 500 mg/L have been reported in wells. Salinity reduces freshwater availability and agricultural viability.

3.3 Land Subsidence and Erosion

Subsidence rates of 2–5 mm/year have been observed in certain regions. Combined with tidal action, this leads to permanent land loss.

3.4 Livelihood Vulnerability

Over 60% of households depend on fishing or agriculture. Climate variability reduces income stability, increasing distress migration.

Table 2: Vulnerability Parameters in Kerala Backwater Islands

Parameter	Evidence	Impact
Flooding	30–40% increase	Housing damage
Salinity	Chloride >500 mg/L	Crop failure
Subsidence	2–5 mm/year	Land loss
Migration	10–15% partial	Economic relocation

4: Comparative Case Study

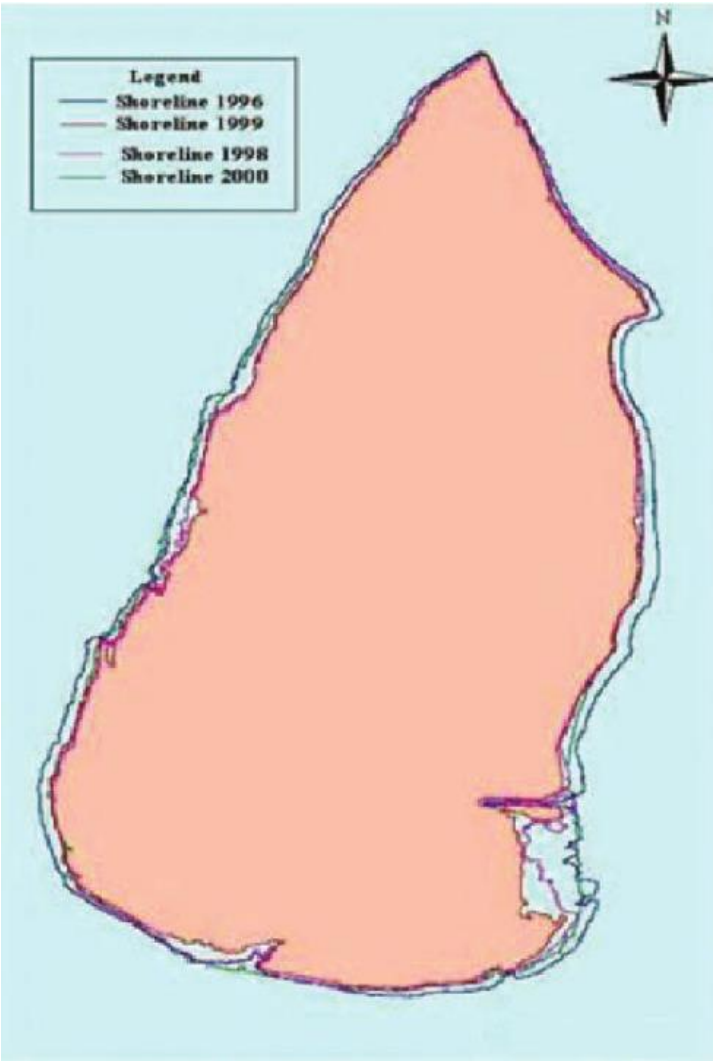
4.1: Sagar Island (India)

Sagar Island in West Bengal is a low-lying deltaic island with similar geomorphology. Approximately 28–30% of its coastline is eroding. Agricultural land declined by 24–25% between 1989 and 2019. Migration increased from 2–5% (2005–2014) to 5–14% (2015–2024), but mass displacement did not occur.

Adaptation strategies include:

- Embankment strengthening
- Mangrove restoration
- Cyclone shelters
- ICZM investments

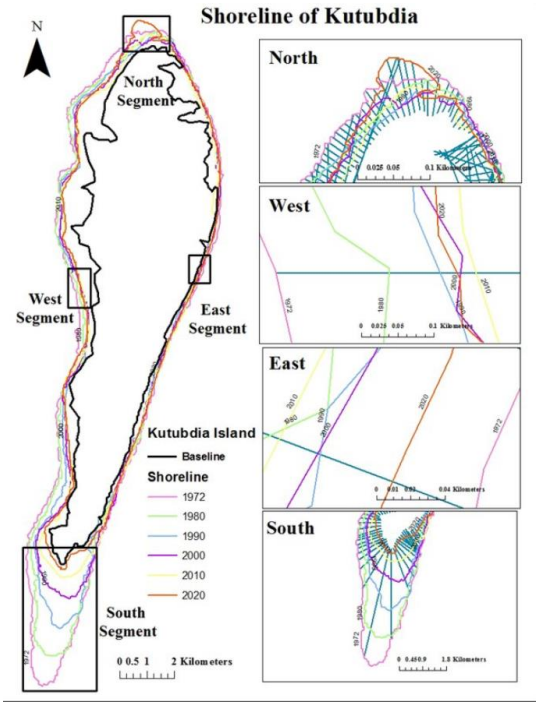
Figure 2: Shoreline Change in Sagar Island



4.2: Kutubdia (Bangladesh)

Kutubdia Island experiences severe shoreline retreat and salinity affecting 45–55% of land. Agricultural collapse and weak adaptation capacity have led to significant displacement.This represents a collapse-driven migration trajectory

Figure 1: Shoreline change in Kutubdia



5. Comparative Analysis

Table 3: Adaptation vs Migration Trajectory

Parameter	Kerala	Sagar	Kutubdia
Flooding	Moderate	High	Severe
Salinity	Moderate	High	Severe
Migration	10–15%	5–14%	High
Adaptation	Strong	Moderate	Weak

6. Conclusion

This study assessed the climate vulnerability and migration tendencies of Kerala's backwater islands through environmental, socio-economic, and policy-based analysis. Findings indicate that while flooding, salinity intrusion, land subsidence, and livelihood instability are intensifying, large-scale climate-forced displacement has not yet emerged. Migration from islands such as Munroe Thuruthu, Perumbalam, and Valiyaparamba remains gradual and predominantly economic rather than purely climate-driven.

Comparative analysis with Sagar Island and Kutubdia Island demonstrates that Kerala's islands currently align with an adaptation-dominant trajectory rather than a collapse-driven displacement pathway. Institutional support, cultural attachment, and localized resilience measures continue to enable in-situ adaptation. However, the absence of structured relocation frameworks and long-term resilience planning presents future risks. Strengthening climate-resilient infrastructure, ecosystem restoration, drainage modernization, and livelihood diversification is essential to sustain long-term habitability and prevent distress-driven migration.

References

1. Centre for Water Resources Development and Management (CWRDM). (2021). *Salinity and hydrological assessment reports*. Government of Kerala.
2. Internal Displacement Monitoring Centre (IDMC). (2022). *Global Report on Internal Displacement 2022*. Norwegian Refugee Council.
3. IPCC. (2022). *Sixth Assessment Report (AR6): Impacts, Adaptation and Vulnerability*. Intergovernmental Panel on Climate Change.
4. Kerala Coastal Zone Management Authority (KCZMA). (2019). *Coastal Zone Management Plan (CZMP), Kerala*. Government of Kerala.
5. Kerala State Disaster Management Authority (KSDMA). (2022). *Climate Risk and Flood Assessment Reports*. Government of Kerala.
6. Rebuild Kerala Initiative (RKI). (2021). *Resilient Kerala Development Program Report*. Government of Kerala & World Bank.
7. World Bank. (2021). *Groundswell Part 2: Acting on Internal Climate Migration*. Washington, DC: World Bank.
8. Bera, A., Meraj, G., Kanga, S., et al. (2022). Vulnerability and risk assessment to climate change in Sagar Island, India. *Water*, 14(5), 823.