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# Remote Sensing Application in the Study of Migration and Offset of Coastal Inlets

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**ABSTRACT**

The coastal zone of Kerala with moderate energy, monsoonal-storm-dominated wave climate, together with a microtidal range, falls under the major tectonic class of the Amero-trailing edge coasts. In order to have an effective management of this coastal zone, one requires detailed information on various types of coastal landforms and the related processes acting on them. Coastal inlets are one among such landforms, which are relatively short and narrow tidal channels connecting bays and lagoons to the ocean. Coastal inlets and the related landforms form an important type of coastal feature. An examination of coastal maps from any area in the world will reveal that coastal inlets are of migratory and offset in nature. In the present study the migration pattern and offset behaviour of some of the inlets of Kerala coast have been examined using IRS-1A LISS II data and Survey of India topographic sheets. The study reveals that geocoded IRS-1A LISS II data could provide accurate geometrical information which may considerably minimise the field check.

## Introduction

The development and evolution of barrier beaches along the world's coastlines have long been a concern of scientists and the lay public engendering considerable debate over possible causes of changes (Kraft *et al.*, 1979). The study of barrier beaches includes the development of associated coastal inlets as a major element in barrier systems. Accelerating construction activities in the coastal zone and increased public awareness of environmental issues, in general, have led to new concern over tidal inlets (Aubrey and Gaines, 1982). Coastal inlets play an important role in the exchange of water between bays/lagoons and ocean. Coastal inlets are the ideal coastal landforms for the construction of minor, intermediate, and major ports, which are playing special role in

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the context of developing economic and industrial activities in the country. Typical dimensions of inlets are: length 500-5000 m, width 100-200 m and depth 2-50 m (Kreeke, 1985). The stability of an inlet is understood to represent a balance between the accretion of sand by littoral drift and the scouring capability of the hydraulic currents generated at the inlet. Remote sensing technique, in conjunction with conventional methods, is the ideal tool for monitoring this fragile environment in an efficient, speedy and cost-effective way and helps in suggesting suitable management techniques for the sustainable development of the coastal ecosystem. The coastal zone of Kerala is a moderate energy with monsoonal-storm-dominated wave climate. This is a micro-tidal zone which falls under the major tectonic and morphologic class of the Amero-trailing edge coasts (Inman and Nordstrom, 1971). The 560 km shoreline of Kerala's coastal zone is characterised by a narrow and low-lying land sandwiched between the Lakshadweep sea to the west and the permeable-impermeable midlands to the east. This NNW-SSE trending Kerala coast is nearly straight with minor offsets at places in the ENE-WSW direction. In general the coast is rocky and has got laterite cliffs with intervening barrier beaches. There are about 41 rivers draining towards the sea. The characteristics and behaviour of many of the coastal inlets of Kerala are less understood.

## Objectives

The objective of the present study is to draw attention to the applicability of the remote sensing techniques in the study of migration and offset of coastal inlets. Similar studies have been made earlier, both along the east and west coasts of India (Nair, 1981; Shaikh *et al.*, 1988; Thrivikramji, 1987).

## Study Area

Three inlets of the southwest coast of India, namely Kayamkulam, Kochi and Ashtamudi have been selected for the present study (Fig. 1.1, 1.2, 1.3). All the three inlets are backed on the shore by lagoon barrier system. The area has a microtidal, monsoonal, wave-dominated environment. Ashtamudi and Kochi inlets have been developed into a fishing harbour and a national port, respectively.

## Data Used and Methodology

Geocoded IRS-1A LISS II (bands 2, 3 & 4) FCC image data (acquisition date: 23 Jan. 1990 for Ashtamudi and 24 Jan. 1990 for Kayamkulam and Kochi inlets) on 1:50,000 scale and Survey of India topographic sheets (1967) of the same scale were used for this study. The inlets configuration has been visually delineated by using light table and a hand lens from the geocoded image and further superimposed on the Survey of India data. The inlet characteristics namely offset, migration, width of the inlet, and inlet elongation/ shortening for Ashtamudi, Kayamkulam and Kochi inlets were determined.

## Results and Discussion

The southwest coast is characterised by a number of inlets of which some are of temporary and some are of permanent nature. Migration and offset of coastal inlets and the associated changes in the adjacent barrier beaches have profound implications on both the geological evolution of inlet system and their short-term stability.

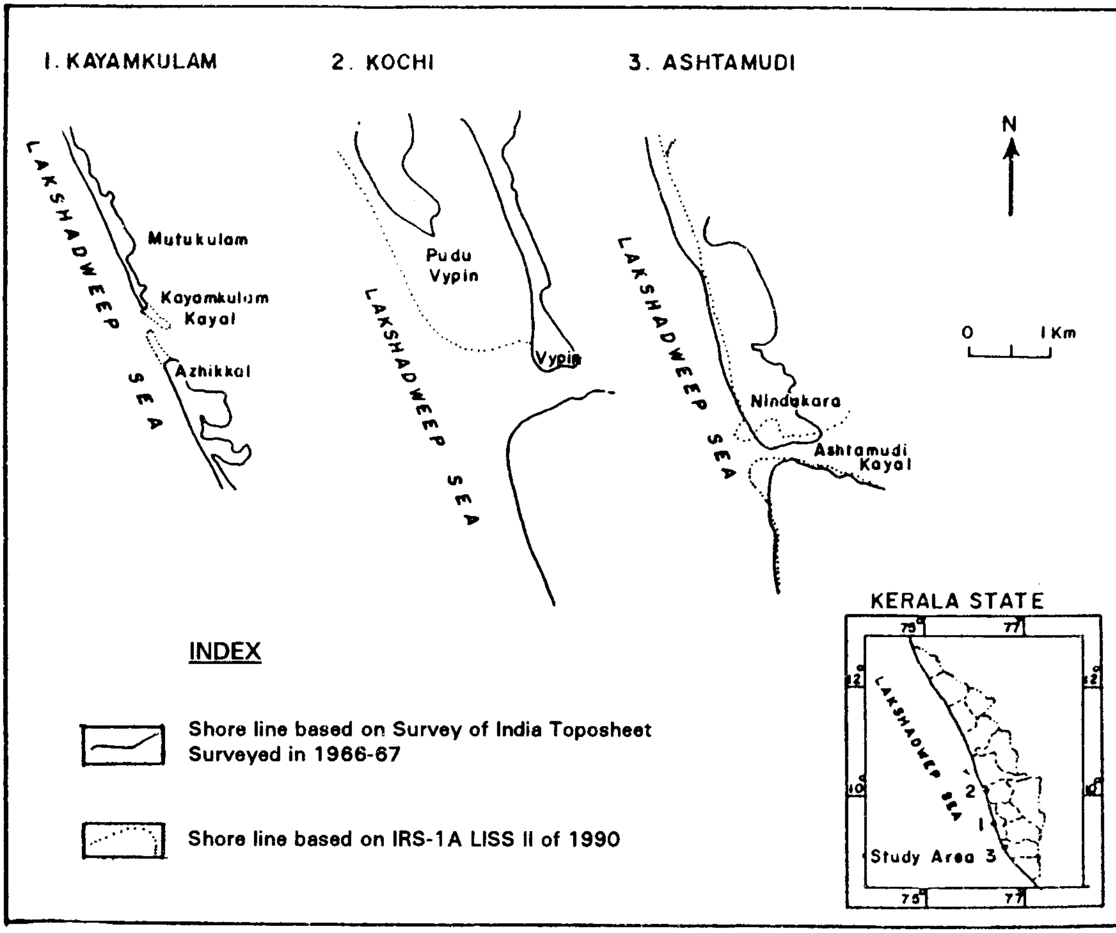


**Fig. 1** Changes in the Inlets Configuration

An examination of coastal maps will show that coastal inlets are rarely symmetrical with respect to the placement of beaches on either updrift on downdrift. The channels of the inlet respond very quickly to storm events and large tidal prisms with changes ~10-15% in cross sectional areas occur within a few days. About 20 out of 48 inlets in Kerala show permanent nature of opening whereas 28 inlets remain open during the monsoonal period only and are listed in Table 1. The inlets appear distinct in the imagery. Analysis of IRS-imagery data (IRS-1A LISS II) and Survey of India topographic sheets (1:50,000 scale) reveal the changes during the last 23 years. The specific facets of changes include offset, migration, variability in the width of the mouth and inlet elongation/shortening. The results for all the three inlets under this study are listed in the Table 2.

**Table-1**

Coastal Inlets of Kerala

| | Temporary | Permanent |
|---|---|---|
| 1. | Mogral | Ullal (Talapady) |
| 2. | Kalanadu (Creek) | Uppala |
| 3. | Kottikulam (Creek) | Shriya-Kumbla |
| 4. | Bekal Hole (Creek) | Chandragiri |
| 5. | Chittari Hole | Karingote |
| 6. | Puthiyngadi - N | Taliparamba (Valapattanam) |
| 7. | Puthiyangadi - S | Anjarakandi |
| 8. | Cannanore Kararinagam | Dharmadam |
| 9. | Iringal | Mahe |
| 10. | Kadalundi | Murat |
| 11. | Puraparamba | Korapuzha |
| 12. | Andakaranazhi | Kallayi |
| 13. | Kottamkulangara | Beypore (Chaliyar) |
| 14. | Kochanakulangara | Ponnani (Bharathapuzha/Tirur) |
| 15. | Kattukada | Veliyankode |
| 16. | Aryad South (1) | Chetwai |
| 17. | Aryad South (2) | Periyar |
| 18. | Tumboli | Cochin/Kochi |
| 19. | Kanjiramchira | Kayamkulam |
| 20. | Vadakkal | Nindakara (Ashtamudi) |
| 21. | Tottapalli | |
| 22. | Paravur pozhi | |
| 23. | Edava | |
| 24. | Muthala pozhi | |
| 25. | Veli | |
| 26. | Panathura | |
| 27. | Karichal | |
| 28. | Puvar | |

**Table-2**
Temporal variation in the inlet configuration

| CONFIGURATION | INLETS<br>**Ashtamudi** | **Kayamkulam** | **Kochi** |
|---|---|---|---|
| **Offset** | North arm 50 m towards west<br>South arm 250 m towards west (North and South) | North arm towards east<br>South arm towards west | Secondary north arm towards 1237.5 m |
| **Migration** | North arm 75 m towards north<br>South arm 100 m towards south | North arm 400 m towards<br>South arm 350 m towards south | Stabilised inlet* |
| **Width** | 300 m | 100 m | 450 m (east) |
| **Inlet Elongation**<br>**Shortening** | North arm Shortening<br>South arm Elongation | North arm Constant<br>South arm Shortening | North arm Elongation<br>South arm Constant |

*A new spit has emerged appox.1250 m long and grown towards south.

Ashtamudi and Kochi inlets are more or less stabilised inlets as both their limbs are controlled by protective structural measures, whereas Kayamkulam inlet is in its virgin state. The northern limb, 1237.5 m long, a secondary spit extending towards south developed during the last 23-year period of the Kochi inlet is an outstanding nearshore landform in the study area. The remarkable growth of 1237.5 m long spit along a coast exposed to micro-tidal range with low to medium wave energy condition suggests that this accretion is as a result of the dredged sediment dumped in the near-shore water which got transported and got deposited so as to form the same. The migratory behaviour of the Ashtamudi inlet suggests that its northern limb extends 75 m further north, whereas the southern limb extends 100 m towards south, keeping the present width of the inlet at 300 m. In the case of Kayamkulam inlet, the northern limb extends 400 m towards north whereas the southern limb extends 300 m further south, keeping the present width of the inlet at 100 m. Kochi inlet has stabilised behaviour and its width has been maintained at 450 m.

The northern and southern limbs of the Ashtamudi inlet have got offset towards west whereas the northern and southern limbs of Kayamkulam inlet have got offset towards east and west, respectively. Now it is evident from the data (Table 2) that inlets acquire their shape and size in response to the processes operating around them. In general, sediments brought by the longshore currents and estuarine channels tend to narrow the passage. In order to maintain equilibrium, the downdrift limb of the inlet gets eroded and the inlet migration occurs laterally. If the accumulation of sediment at the updrift arm completely balances the erosion at the downdrift end, a "straight" inlet develops. In the present study the inlet tends to be nearly "straight" (Fig. 2).

In order to get temporal and spatial data on the migration/offset behaviour of the coastal inlets, it is proposed that remote sensing data of closer time intervals may be used. It is suggested that multitemporal IRS-1A LISS II images with a spatial resolution of 36.25 m may be fully utilised for monitoring coastal inlets prior to taking up of any developmental activities.

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