

PRAVIN GAWLI

Natural processes have the ability to alter the shape and size of a beach. Human actions further accentuate these changes. But sometimes the solutions could lead to new problems.

Indian Beaches Under Threat!

A visit to the beach can be exhilarating. As you lounge carefree on the beach, soaking in its gorgeous surroundings with waves washing all over, you just wish time could stand still.

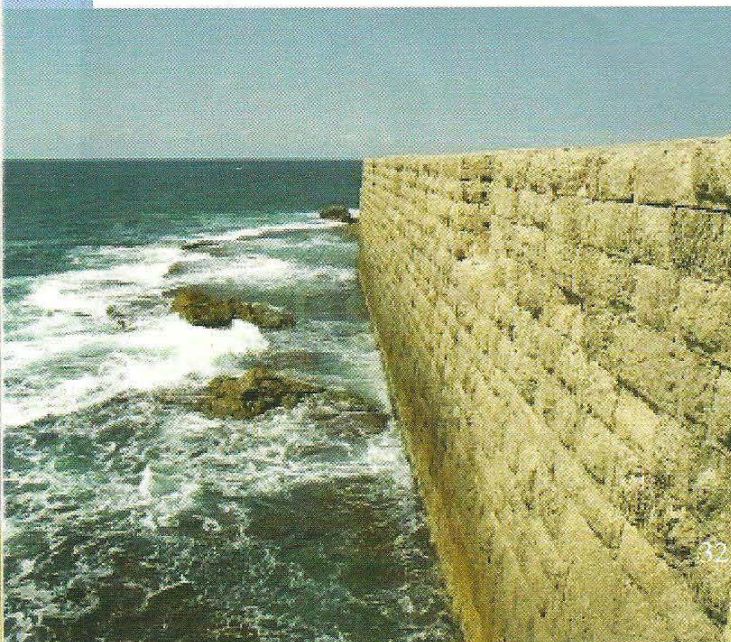
Indian beaches attract millions of visitors from far and wide to partake in their aesthetic beauty and recreational facilities lending a helping hand to the tourism industry as well. However, beaches

can be dangerous and the hazards can arise due to the morphology and dynamics of the areas near the shore. The effects are manifested in the form of breaking waves, bores, nearshore currents (rip currents) and variable water depth, apart from localized perils such as reefs, rocks and shore platforms.

India has a vast coastline that stretches for over 7500 kilometres and has an average population density of 455 persons per square km along this span. The total area occupied by coastal

districts is around 379,610 km². It has to be noted that different tectonic, riverine, coastal and wind processes act in tandem to etch out coastal ecosystems that come in different shades and characteristics.

India has one of the most varied coastlines of the world carved out by wind, wave and tidal processes producing dynamic nearshore current systems. The geological setting of beach environment includes hard and soft rock cliffs, embayed coves, open ocean beaches, river mouths, tidal inlets, estuaries, spits and barriers.



FEATURE ARTICLE

Armoring is done by constructing coastal structures to protect the infrastructure. Plans are then executed to reduce beach erosion rates. This is moderation. Restoration is done by beach nourishment.

The beach environment is in constant flux and its shape and size keep on changing due to natural causes or human impacts. Erosion is destroying many beaches whereas deposition in channels and ports is threatening navigation. Manmade structures such as groins (usually built perpendicular to the shore), breakwaters (shore parallel structures) and sea walls (structures built parallel or nearly parallel to the shoreline to separate an eroding land area from the water area) are altering the shape of the beaches and also the dynamics of the water in the area.

Anthropogenic stresses badgering the beaches also include dredging of minerals, sands and gravels; building of barriers to reduce sediment input and output; construction activities for recreation and settlements that leave the coast vulnerable to normal wave action. Sand mining has claimed scores of beaches and there doesn't seem to be any let up in these activities. Sea reclamation for ports and harbours is also increasing the coastal vulnerability to extreme climatic events.



Coastal erosion is tackled in many ways and the formula adopted for this purpose includes armoring, moderation, restoration, abstention and adaptation.

Transport of Sediments

The material that makes up the beach is supplied and/or taken away from it by currents of water near the shore and also long shore currents. These help sculpt coastal landforms. They also aid in the evolution of the coast. Littoral transport is the movement of sediments taking place in the zone near the shore by the action of waves and currents in the form of sediment transport parallel to the shore (alongshore transport) and perpendicular to the shore (onshore-offshore transport).

The onshore-offshore transport primarily depends on wave steepness, sediment size, and beach slope. Studies carried out on long shore sediment transport indicate that the annual gross sediment transport is variable at different beaches. The rate is high along the south Tamil Nadu coast, whereas the zone between Pondicherry and Point Calimere in Tamil Nadu, and the Maharashtra coast experience negligible annual net transport.

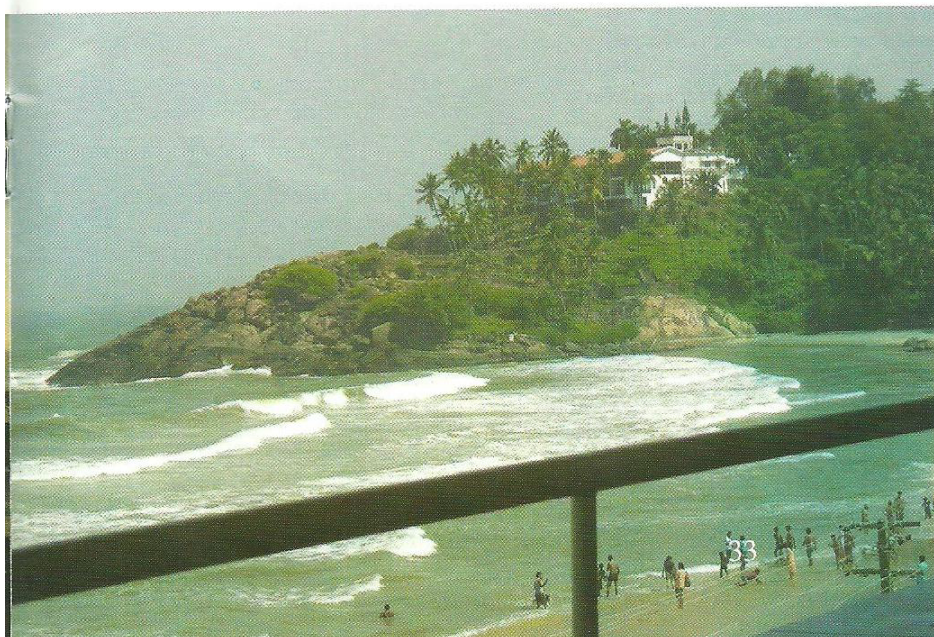
The direction of annual net transport along the east coast is towards the north whereas, along the west coast, it is towards the south except in the south Gujarat coast. The distribution and dispersion of turbid waters on the western continental shelf of India reveals that nearshore waters move towards the north. Longshore sediment transport between Ratnagiri and Mangalore is stable over the annual cycle.

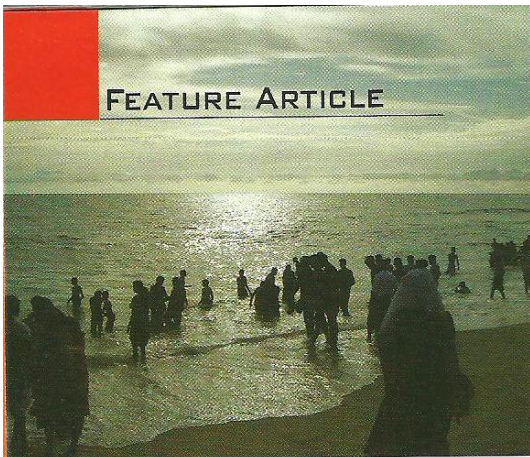
The annual net transport direction varies along the west coast showing southerly at Ratnagiri, Tadri and Mangalore and northerly along Vengurla, Goa and Coondapur. Along Maharashtra coast the sediment transport is bi-directional and season dependent, and the resultant sediment transport is southward, whereas for Karnataka the net major sediment transport is southward. Accumulation or removal of sediment on or offshore is carried out by waves and tides. Convergence or reversal of longshore currents is also responsible for this action.

Threat to Beaches

Natural processes have the ability to alter the shape and size of a beach. But, human interference can hasten that activity. Karwar is a compound type of coast (emergent and submergent type) and the amount of erosion during 2000-2003 (3 yrs) was found to be one and a half times more than the net erosion during 1989-2000 (11 yrs). This happened mainly due to human interference in the form of expansion of settlements, development of industries, mining activity, establishment of the Konkan railway, construction of naval base, influence of dams built across Kali River and other interferences. This is apart from the changing weather and coastal processes.

SCIENCE REPORTER, JANUARY 2012





Indian beaches attract millions of visitors from far and wide to partake in their aesthetic beauty and recreational facilities

The protective structures and breakwaters constructed at Mudga, Harwada, Naval base and Karwar harbour are influencing coastal erosion. Accretion is taking place at the central portion of the Arge beach because of artificial nourishment unleashed by construction activity at the naval base. Binge beach is growing centrally due to opposing longshore currents. At Kodar beach the sediment is found to move from one end in an annual cycle mainly due to shifting/ changing of energy heads along the beach owing to wave refraction and seasonal changes in wind, waves and longshore currents. The Kwada beach sediments circulate within the bay (Kwada bay) owing to seasonal variation in the wind and wave regime and also because of wave refraction.

Belekeri is a highly incised bay giving rise to protection of the coast from major wind and wave directions. These characteristics have made it an ideal natural harbour. The Mudga beach along the Belekeri bay had experienced severe erosion in its northern portion prompting the construction of coastal protection wall during 1990-91. At New Mangalore Port the presence of sand accumulation south of the northern breakwater in an otherwise essentially clay domain is suggestive of a net southerly movement of sediment and the possible deflection of currents carrying the sediments by the breakwater.

Along the Mangalore coast severe erosion takes place during SW monsoon periods, whereas from Kapu to Talapady the erosional areas are found to be migratory in character which are influenced by anthropogenic causes like the seawall near Mulur, the construction of breakwaters for New Mangalore Port, and the seawall built at the tip of Bengre resulting in erosion. At Gangavali, near Gokarn the sediment movement is cyclic and seasonal. The prevailing conditions in this beach are ideal for recreational development.

Most of the beaches are mined for sand, but in Kerala they are mined for 'strategic' minerals. These minerals are used in atomic energy and for defence applications. This sand is rich in heavy minerals like monazite, ilmenite, rutile and zircon. But the unfettered mining in Kerala is lowering the shoreline allowing brackish seawater to mix with onshore freshwater bodies devastating the water table and ecology of the area.

Pondicherry faces the brunt of at least a couple of cyclones every year emanating from the Bay of Bengal. Due to severe erosion the entire beach area of Pondicherry was lost even after building of seawalls, which exacerbated after the construction of the Pondicherry harbour. In fact, a restaurant was destroyed after scouring of its foundation took place.

Finding Solutions

Wave and wind patterns, diurnal (daily) and seasonal climatic fluctuations along with the availability of sediments make the hydrodynamical, sedimentological, geomorphological pattern and longshore littoral transport quite variable along the Indian coasts. The movement of sediment is either towards north or south depending upon wave approach direction and configuration of the coast.

Coastal erosion is tackled in many ways and the formula adopted for this purpose includes armoring, moderation, restoration, abstention and adaptation.

Armoring is done by constructing coastal structures to protect the infrastructure. Plans are then executed to reduce beach erosion rates. This is moderation. Restoration is done by beach nourishment, whereas abstention involves non-intervention in controlling erosion. The last stage is adaptation wherein policies are formulated to protect the coastal system. However, armoring has some downward side to it as well.

The physical effects of seawalls and other barriers, in most instances, adversely impact the fronting beach and nearby properties resulting in greater erosion of adjacent areas. Seawalls degrade beaches by passive loss, placement loss and active loss, which has been observed at Pondicherry. To protect its shoreline from erosion, seawalls were built using boulders for a total length of about 7 km. But, in many places along the seawall, erosion occurred due to severe wave action and ground settling.

The Pondicherry port has been constructed by using breakwaters and this encourages progressive sediment deposition at the southern side and erosion at the northern side of the breakwater. After carrying out many feasibility studies, a groin field with artificial sand nourishment has been proposed to replenish the beach.

There is another example. During the 1950s, a wide sandy beach was present at the Tojo coast, Japan, but the coastal forest was artificially expanded very close to the shoreline and a recreational centre was built, resulting in narrowing of the natural sand dune area. On the Maebara coast, located southwest of the Tojo coast, a seawall was constructed very close to the shoreline, resulting in the expansion of the residential area. Detached breakwaters and fishing port breakwaters were built leading to significant shoreline recession. Thus, these coasts became vulnerable against coastal disaster due to man-made activities.

This is of concern in coping with expected sea level rise. The construction of detached breakwaters to protect the coast is seen to induce erosion in the surrounding area. Hence, their usage must be employed judiciously.

Dr Pravin Gawli is with the Indian Institute of Geomagnetism, Plot No 5, Sector 18, Kalamboli Highway, New Panvel, Navi Mumbai-410218