

Bio-Ecology of the Gulf of Kutch

(Keynote Address)

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The northern most part of the Indian coastline, which is characterized by the Rann of Kutch and the Gulf of Kutch is a typical arid area. The annual rainfall is less than 55 cm with maximum precipitation in July. As there are no major river openings, the land run-off is minimal. The relative humidity is over 80% in August and the minimum of 60% in December-January. Air temperature varies from 10° in January to 35° C in May-June. Wind pattern is predominantly seasonal with rare cyclonic disturbances.

Tides in the Gulf of Kutch are of mixed, predominantly semi-diurnal type with a mean spring tidal influx, between 2.1 and 6.2 m. The Gulf of Kutch is elongated in the east-west direction and has an average depth of 30 m. The coastal configuration is most irregular and is characterized with a number of islands, coral reefs, sand flats, mangrove vegetation, creeks, and bays.

With the prevalence of diverse ecosystems, the Gulf of Kutch, harbours a wide variety of marine biota, including corals, pearl oysters and a variegated type of molluscs, worms and anemones. Biogeographically the biota is akin to that of the Gulf of Oman and the Red Sea.

Over the years, the Gulf of Kutch, has undergone both long-term and short-term changes, due to subsidence or lowering of sea levels; erosion, siltation, dredging of coral stones and sands; deforestation of mangrove vegetation; industrialization and urbanization.

An attempt is made here to assess the impact of environmental and man-made changes on the bio-ecology of the Gulf of Kutch.

INTRODUCTION

A remarkable feature of the vast coastline of India, is the extreme diversity of ecosystems viz. estuaries, lagoons, bays, coves, sandy, muddy and rocky foreshores; coral reefs and the Gulf. While the 'gulf' is defined, as "portion of sea partially enclosed by sweep of coast and usually narrower at mouth than bay", in reality, a gulf can either be semienclosed or fully closed, especially towards end i.e. the head.

While there are three gulfs viz. Gulf of Kutch, Gulf of Kham-bath and the Gulf of Mannar, along the west and the east coast of India, a review of literature on the natural history, flora and fauna, reveals that the relevant information about the Gulf of Kutch is relatively more elaborate than the other two.

However, in the last four decades or so, the Gulf of Kutch, and the adjoining coastal zone is subjected to developmental activities of setting of a major port, industrialization, urbanization, and tourism and, consequently, the stage is all set, to review the present status of the bioecology of the Gulf of Kutch and evaluate the trend of changes over the years.

PHYSIOGRAPHY OF THE GULF OF KUTCH

The Gulf of Kutch (22°15'N - 23°40'N and 68°20'E - 70°40'E) measuring about 7300 km² in the surface area, is aligned in a east-west orientation, with a distinct constriction around 69°20'E. It is a shallow water body, with depth extending from 60 m at the mouth to less than 20 m at the head of the gulf. While the average depth is 30 m, the minimum depth is upto 5 m, around Lushington island.

The coastal configuration is very irregular with number of islands, creeks and bays. Despite the low level plain surface of the coastal interior, the southern shoreline has a submergent aspect indicated by marked indentations, deep inlets (one occupied by

the Kandla port), a number of off-shore islands and several creeks (Ahmed, 1984:484-486). It is known, that the Gulf of Kutch, till geologically recent times was an island or group of islands, separated from the Indian mainland by an arm or neck of the sea. It is believed that the Kathiawar peninsula alongwith the Gulf of Kutch and the Gulf of Khambat stood 150 feet lower than at present and was probably in Pleistocene time an island or group of islands (Fairbridge, 1966:113). It is one of the few regions along the Indian coastline, where the geological history is preserved to a greater extent in the rocks of the region (Pascoe, 1964:1896).

The coastal zone bordering the Gulf of Kutch, is about 20-30 km inland with an irregular inner limit. The deccan lava forms the inner part of the coastal zone. Towards, the north, it touches shoreline, where the coastal and the shore zones are formed of low plains, marshes as also the cliffs. The coastal region elsewhere, is formed, partly of alluvium and partly of tertiaries.

The Rann of Kutch is hardly a submarine area or the continental shelf, but is a sandy desert or dry swamp for most of the year and is submerged only during the southwest monsoon season, when the sea water is pushed into the Rann of Kutch, by the strong winds through the funnel shaped creeks and channels. The sea water causes the submergence of a large tract of the land, in the form of islands e.g. the Khadir island (~ 25 km across), the Panchcham island and the Bela island, respectively, on the west and the east of the Khadir island, are almost as large.

Besides the islands, there are a number of wavecuts, eroded, shallow banks like the Pirothan, Deda, Donna, Sankhodhar Beyt, Paga, Adatra and the Boria, which accounts for coral islands. The intertidal region is sandy and muddy or with sandstones of vast expanse and prolonged exposure. There is a clear indication of a relative change in the levels of land and the sea in the past as is evidenced by the raised coral reef at Okha.

still intact near the railway station (Pillay *et al.*, 1980:16-20), as well as the clays and foraminiferal limestone of oligocene-pliocene antiquity, near Dwarka (Ahmed, 1984:484-486).

About 100 km towards the north of the Gulf of Kutch, is located the opening of the Indus river, discharging an annual suspended load of 435 million tons. Some of the suspended sediments are transported in a southeasterly direction into the Gulf of Kutch, where the sediments are in transit under the action of the high velocity tidal currents (Nair *et al.*, 1982:77-86).

ENVIRONMENTAL PARAMETERS

The annual rainfall in the region of the Gulf of Kutch, is less than 550 mm, with maximum precipitation of about 340 mm in July and August. Being a semi-arid region and moreover, in the absence of any major river openings, the land run-off is minimal. The relative humidity is highest in August (82%) and lowest in December-January, (60%). Atmospheric temperature varies from 10°C in January to 35°C in May-June.

Tides in the Gulf of Kutch are predominantly semidiurnal with a large inequality. The average tidal range is 4 m and it varies from 3.06 m at Okha at the mouth to 5.89 m at Kandla at the head, with a spring tidal range of 6.2 m at its head. Exceptionally high tidal amplitude, generates high speed tidal current and accordingly the time taken by a tidal wave to proceed from the open sea to the closed end of the gulf, is estimated to be about two and half hours (Srivastava and John, 1977:39-48).

The wind pattern is predominantly seasonal with rare cyclonic disturbances. The predominant wind directions are west-southwesterly and north-northwesterly during June-September and December-March; respectively. Higher wind speeds, upto 74 kms/hr, blowing from west or west-southwest, do occur during the southwest monsoon season. July is the windiest month and the month of February is the calmest (Srivastava and John, 1977:39-48).

Surface currents vary from 1.5 to 2.5 knots at the mouth to 3 to 5 knots in the central portion of the gulf (Naval Hydrographic Chart No. L (D2) 203). The spring currents are 60 to 65% stronger than the neap currents. The currents are dominantly tidal with a semi-diurnal periodicity and with current speed exceeding from 0.05 m/sec to 1 m/sec. (Srivastava and John, 1977:39-48). The bottom currents are strongly periodic with biomodal current directions and with a velocity, normally 70% of the surface currents. The general direction is parallel to the bottom contour, suggesting thereby the dominance of the tidal currents.

With high tidal range, negligibly low land run-off and the irregular topography of the gulf, its waters as expected, are homogenous in terms of salinity and temperature. The behaviour of the gulf is in sharp contrast to the estuaries of the west coast of India, where seasonal stratification associated with the monsoonal precipitation is evident (Varkey *et al.*, 1977:67-74).

FLORA, FAUNA AND LIVING RESOURCES

Hornell (1916) was the first to report on the marine biology of the Gulf of Kutch in general and the Okhamandal in particular. Since then, a number of reports, on the natural history, flora,

fauna and the living resources potential of the Gulf of Kutch, are on record.

The marine floral components of the gulf are most varied and covers sand dune vegetation, mangroves, seagrasses and macrophytes. The dominant species of the sand dune flora are: *Euphorbia caudicifolia*, *E. nerifolia*, *Aloevera*, *Ephedra foliata*, *Urochloa setulosa*, *Sporobolan madraspatneus*, *Eragrostis unioloides*, *Calotropis procera*, *Fimbristylis* sp., *Indigera* sp. and *Ipomoea pescaprae*. The common seagrasses found growing on the mud flats are *Halophila ovalis*, *H. beccarii* and *Zostera marina*.

The dry climatic regime, scanty rainfall and the sheltered bays, creeks and mud flats form ideal sites for mangrove vegetation over an estimated area of about 52,000 hectares (Parulekar and Untawale, 1978:16). The formations are of open scrubby type, with isolated and discontinuous distribution from Kandla, Navalakhi in the north to Jodia, Jamnagar, Sikka, Salaya and Okha in the south, as also at Pirothan, Poshitra, Dohlani and Dwarka. The dominant species of mangroves are *Avicennia marina* var. *acutissima*, *A. officinalis*, *Brugiera parviflora*, *B. gymnorhiza*, *Rhizophora mucronata*, *R. apiculata*, *Ageiceros corniculata*, *Sonneratia apetala* alongwith the associated species of *Salicornia brachiata*, *Sueada fruticosa*, *Artiplex stocksii* and a lichen, *Rosella montana*.

The commonest marine algal species of the Gulf of Kutch, as reported by Parulekar and Untawale (1976) are *Ulva fasciata*, *U. reticulata*, *Enteromorpha intestinalis*, *Diclyota* sp., *Hypnea musciformis*, *Sargassum tennerimum*, *S. ilicifolium*, *Gracilaria corticata*, *Cystocera* sp., *Pandina tetrastomatica*, *Corallina* sp., *Laurencia* sp., *Caulerpa racemosa*, *C. peltata*, *Bryopsis* sp., *Turbinaria* sp., *Ectocarpus* sp., *Acanthophora* sp., *Chondria* sp., and *Codium* sp.

The marine fauna of the gulf is rich, both in variety and abundance. Sponges having a variety of colours are observed, both in the intertidal and subtidal biotopes. Most common species of sponge are *Adocia* sp., associated with coral reef fauna. In sandy and silty mud shores, *Tetilla dactyloides* (Carter) is common.

The commonest hydrozoans encountered are *Sertularia* sp. and *Plumularia* sp. The giant sea-anemone (*Stoichactis giganteum?*) is a common sight in the coral ecosystem. Sea anemones, belonging to *Anemonia*, *Bunodactis*, *Paracondylactis*, *Anthopleura* and *Metapeachia*, are of common occurrence. A zoantharian, *Gemmaria* sp., is found forming extensive hexagonal green mats in the coral pools. Another interesting actinarian, is the *Cerianthus* sp., found in tubes in the soft mud.

One of the most important biotic feature of the Gulf of Kutch, is the presence of living corals, thriving as patches, rather than reefs, either on intertidal sand stones or on the surface of wave-cut, eroded shallow banks, extending between longitudes 69 to 70°E and latitudes 22°20' to 22°35'N (Pillay *et al.* 1980:16-20). Recently, Wafar (1986:19-43) has reviewed the corals of the Gulf of Kutch. While Pillay *et al.* (1980) recorded only 26 species of hermatypic or reef building corals, Patel (1985 a) has reported 44 species of scleractinian corals and 12 species of soft corals in the Gulf of Kutch.

A number of polychaete worms, both sedentaria and errantia, with the commonest genera of *Eurythoe*, *Terebelle*, *Polynoe*,

Iphione and *Nereis* are rather common. Amongst the variety of sipunculid and echiuroid worms, the commonest species, are *Dendrostoma*, *Asphidosiphon* and *Ikadella misakiensis* (Ikeda). The intertidal crustacean fauna is very rich and equally diverse with spider crab (*Hyas* sp.) and the furry crab (*Pillunmus* sp), as specialities.

Amongst the invertebrate component of the marine fauna of the Gulf of Kutch, the molluscs have the maximum representatives. As many as 92 species of bivalves, 55 species of gastropods, 3 species of cephalopods and 2 species each of scaphopods and amphineurans have been reported. The most notable members of the molluscan fauna, are octopus, pearl oyster and a variety of chank, including the sacred chank.

The echinoderm fauna, represented by four classes and 14 genera, have the commonest species of *Palmopsis*, *Astropecten*, *Asteria*, *Temnopleura*, and *Holotura*. The subtidal benthic fauna of the Gulf of Kutch is dominated by polychaetes and bivalves, with an average biomass of 7gm⁻². The benthic environment is characterized by bottom salinity ranging from 35.1 to 37.1‰; dissolved oxygen varying between 0.67 and 5.26 ml/l and the suspended organic matter, fluctuating from 0.5 to 13 mg/lit. (Parulekar and Wagh, 1975:174-176).

The Gulf of Kutch area has a variety of potential and exploited species of finfishes and shellfishes and 83 exploited marine species have been reported (Pillay, 1948: 47-63) The sciaenids, polynemids, perches, eels, cat-fishes, the elasmobranchs and the prawns are commercially important groups with an average catch of 14000 tonnes (Rao, 1973:18-101). As per Jhingran (1975), the Gulf of Kutch area hold out promise for higher yields of prawns, Bombay Duck and the pomfrets.

ECOLOGICAL DISTURBANCES AND CONSERVATION

In the post-independence years, the trends of development, in India, are being set with accelerated rate and the area of Gulf of Kutch, is no exception. The setting of a major port at Kandla; cement manufacturing plants; the proposed tidal power plant; the setting of a major oil terminal etc. are some of the industrial activities, which may cause major changes in the ecology and productivity of a semi-enclosed water body, like, the Gulf of Kutch.

Accompanying the industrial growth, the demographic pressure also increases. To add to it are the frequent drought conditions which increases the dependence of terrestrial biota on the marine ecosystems. The cumulative effect of industrialization, population growth and major climate changes are clearly evidenced in the environs of the Gulf of Kutch, in the last two decades.

In a case study on Pirotan island Parulekar and Untawale (1978) observed :

- (i) irreparable damage due to indiscriminate cutting of mangrove vegetation in the Pirotan swamp between Pirotan and the Bedi Port, Jamnagar.
- (ii) non-stop dredging of coral stones led to severe erosion and considerable increase in the suspended sediments. The worst affected are the suspension feeders and photosynthesizers.

The continuous process of churning, resuspension and settlement of sediments affects the biological productivity potential to a great extent. Patel (1985 b) has reported the deleterious effects of calcareous sand mining on the marine life in the Gulf of Kutch.

The magnitude of destruction of coral ecosystems is reported to vary from 50% (Rashid, 1985) to as high as 70% (Bhatt, 1983: 38-44). Similarly, the indiscriminate use of mangrove vegetation as fodder for cattle and camel and also as firewood, has resulted in near depletion of this important coastal ecosystem, which under natural conditions, plays the role of coastal stabilization and curbing of erosion.

In a developing country like India, the industrialization has crucial part in boosting the national economy. However, the ecological consequences of unplanned industrial development are generally, deleterious. The perceptible damage to marine ecosystems as a result of industrial activities and accompanying demographic pressures is, at times, of a irreversible nature. The magnitude of environmental damage, with proper evaluation, can to a great extent be minimized, by implementing a long term strategy of marine conservation. While averting the potential threats to the environment, the marine conservation approach, integrating development without destruction principle, greatly helps in cleansing a deteriorated marine ecosystem with little side effects.

The first major conservation plan, to be practised in India, pertains to the marine environs of the Gulf of Kutch (Parulekar and Untawale, 1978: 16). The proposed marine sanctuary covers an area of about 456 km² from Okha to Jodiya, with a core area of about 162 km² as the marine national park. This approach, envisaging the conservation of renewable living resources and, thereby preserving the unique biotic heritage of the Gulf of Kutch, is a step in the right direction and needs not only to be augmented but also to be emulated for diverse marine ecosystems of India.

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