

Estuarine ecosystems

Estuaries are where rivers discharge into the sea. They are semi-enclosed bodies of water, connected to the open sea, but where the sea water is diluted by fresh water from the land.

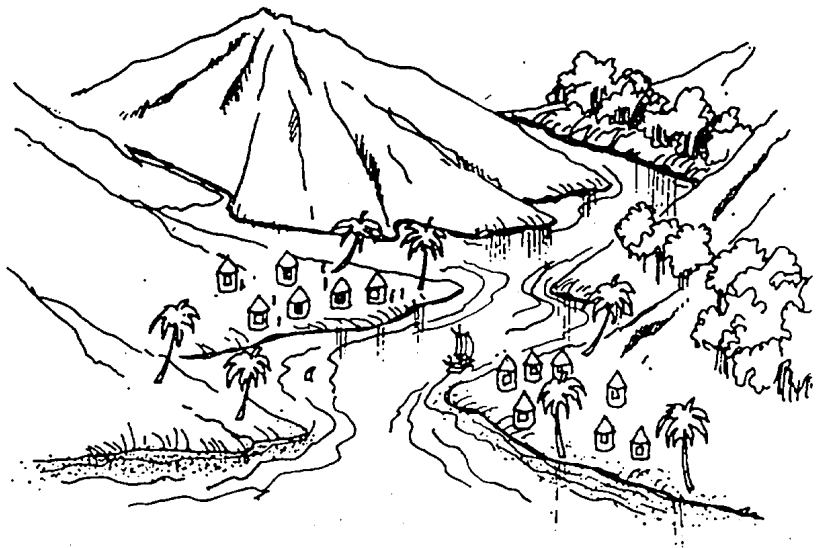
Both land and sea affect estuaries, and their influence varies throughout the day and from season to season. These factors pose serious challenges for living organisms, and estuaries have developed unique ecosystems in response.

Salinity

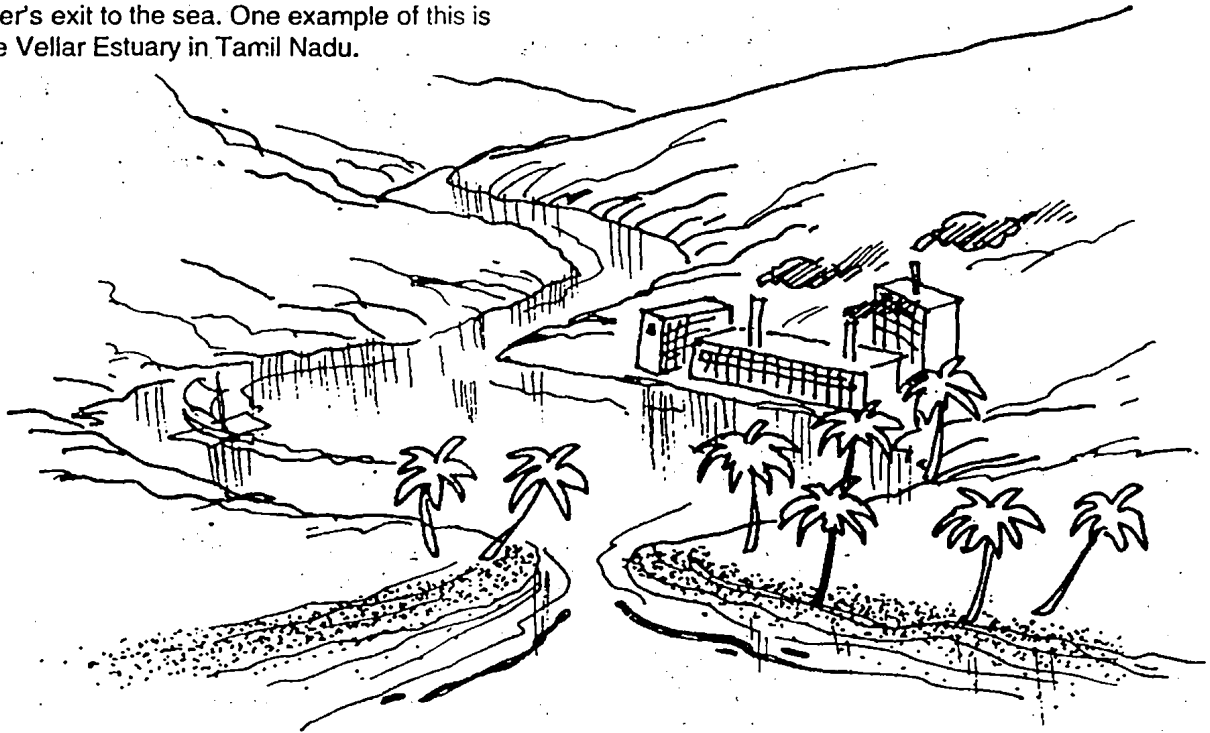
Inflow of fresh water from one side and the open sea at the other gives rise to a gradient of increasing salinity from the interior to the estuary mouth. The salinity also changes with the tides and the season. The Mandovi-Zuari estuary in Goa and Cochin backwaters in Kerala are typical estuaries in which surface salinity ranges from 0.65‰ at the peak of the monsoon in August to 33.64‰ in the hot pre-monsoon period in April.

Brackish waters are poorer in species diversity than either the sea or fresh water. Seasonal fluctuations in salinity influence the distribution of organisms in the estuary. Continuous rains during the monsoon harms marine fauna. When salinity returns to normal after few months, the marine animals re-establish themselves. Estuarine animals either adapt to avoid unfavourable salinities or tolerate a range in salinity by using physiological

Many estuaries in India were formed when the sea level rose, submerging parts of the coast and drowning river valleys. The Mandovi and Zuari estuaries in Goa were formed in this way.



Estuaries can also be formed when shingle and sand bars form parallel to the coast, enclosing a shallow area and partly blocking a river's exit to the sea. One example of this is the Vellar Estuary in Tamil Nadu.



mechanisms. For instance, to avoid unfavourable salinity, barnacles shut their valves, mussels close their shells, eupogebia burrow into the substrate, and other creatures migrate up and down the estuary.

Most estuarine animals have effective osmoregulatory adaptations (methods of controlling the amount of salt in their bodies). Some regulate their salt content higher than the surroundings when the surrounding water has low salinity (this is called *hyperosmotic regulation*). The shore crab *Carcinus*, amphipod *Gammarus*, the crab *Sarsama erythrodactyla* certain prawns and the bivalve *Mercenaria mercenaria* all show hypertonicity in blood in diluted sea water.

Mytilus edulis and *Arenicola marina* have no osmoregulatory mechanism. They adjust as their tissues are able to function under low salt content. However they are unable to survive in salinity below their threshold concentration.

Temperature

Temperatures vary widely in estuaries owing to the mixing of water of different temperatures and shallowness of the water. In shallow estuaries, the water is much cooler in winter and warmer in summer. These temperature fluctuations affect the species composition and eliminate most animals that cannot withstand wide changes.

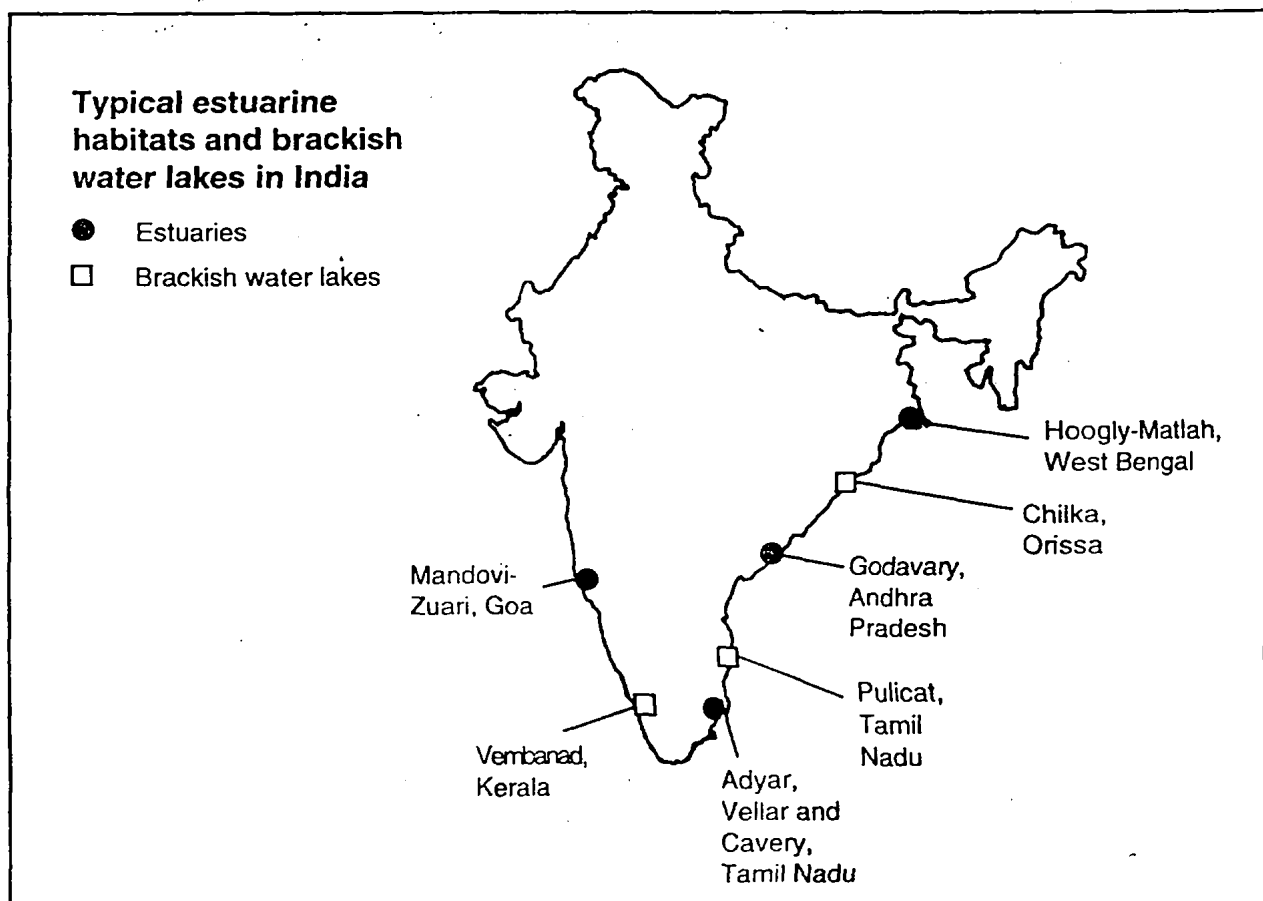


Sediments

The sediment type influences the organisms living in the estuary, especially plants and benthic animals. Mudflats are common. The substrate here is composed of soft, loose mud or a mixture of mud and sand. Characteristic vegetation such as eel grass in temperate areas and mangroves in the tropics develops on mudflats, making estuarine ecosystems very productive and at the same time providing special habitat for animals. Mangroves are found in most estuaries along the Indian coast.

Turbidity

Silt suspended in the water in estuaries causes the water to be turbid. The degree of turbidity varies widely throughout the year; it is at a maximum during the rainy season. It also varies from place to place within the estuary. Turbid water prevents light from penetrating even one metre below the water surface. This reduces the level of photosynthesis by phytoplankton in the deeper layers. Shore plants which are not covered by turbid waters are therefore the most important photosynthesisers of organic matter. Salt-marsh plants such as spartina and zoostera and mangrove forest assume great importance as primary producers.



Gross primary productivity: the rate at which energy from light is absorbed and used with carbon dioxide to produce organic matter through photosynthesis. It is measured in grammes of carbon per square metre per year ($\text{g C/m}^2/\text{yr}$).

Net productivity: The amount of organic matter formed in excess of that use in respiration.

Nutrient flows

The fertility of the estuary depends on the flow of nutrients from the river and on tidal currents. The Mandovi-Zuari rivers are rich in nutrients, especially nitrates and phosphates. Drainage from the land is the major source of nutrient inputs into the estuary. In addition, industrial effluents and city waters also find their way into the estuary. Some estuaries in Gujarat are subject to heavy industrial pollution, making it difficult for fish to survive.

The overall productivity of most Indian estuaries is low because of their high turbidity. In Cochin backwaters, the gross primary productivity measure of ranges from 270 to 298 $\text{g C/m}^2/\text{yr}$, while net production is 124 $\text{g C/m}^2/\text{yr}$. In Cochin backwaters, only 25% of the total phytoplankton production is estimated to be used by the herbivore population. The unconsumed food sinks to the bottom as detritus.

Even though the estuarine phytoplankton production is low, it is well compensated by the productivity of plants such as marsh grass, reeds and mangroves. More than 50% of production is available to estuaries in the form of detritus. Land drainage also supplies abundant detritus.

The abundant detritus means that it is the basis for most of the estuarine food chain. Several animals, or zooplankton, feed on the detritus and thus are primary consumers.

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