

MANGROVES

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What are Mangroves : By simple definition, mangroves (= mangal) is a group of plants inhabiting in coasts of tropical and subtropical seas and having following distinguishing characteristics

- i) ability to colonize and thrive in a wide range of tidal and salinity conditions;
- ii) production by terrestrial and aquatic autotrophs, flux of matter (energy nutrients) between these two components;
- iii) inhabitation by a wide range of heterotrophs that are adapted to subsist on energy derived from mangroves as well as aquatic algal production.

The total number of plants that are true mangroves and mangal related species, and are exclusive to mangrove environment is 60. This also includes two palms, Nypa and Phoenix. Mangrove forest cover in the tropical area is about 0.5 million km² and this sorts into two distinct geographical assemblages; (a) Indo-Pacific region, comprising of South Africa, the Red Sea, India, South East Asian, Southern Japan, Philippines, Australia, New Zealand and South East Pacific archipelago as far east as Samoa. (b) West Africa - Americas region, comprises of Atlantic coast of tropical America and the Galapagos Islands.

Extending the above definition, a mangrove ecosystem can be defined as an environment where the trophic organization and energy flux at the terrestrial and aquatic levels, are predominantly influenced by the occurrence and productivity of the mangrove trees.

Ecological and Economical value of mangroves :

The mangroves afford shelter to the juveniles of a wide variety of marine organisms, notable among them being shrimps, so much so that the magnitude of a shrimp fishery of a maritime state having mangroves is almost proportional to the aerial coverage of its mangrove forests. The second most important ecological value of mangrove vegetation is its ability to trap and accrete material so that shore erosion in areas bordering mangroves is greatly abated.

Economic values are still several more ranging from production of timber, through tannin, wax, fodder, pharmaceuticals to honey. Besides, mangroves are easily available to brackish water fish and shrimp culture, with the natural high productivity of this ecosystem, allowing an enhancement of harvestable yield at low investment, especially of supplementary feeds, which, otherwise is a major constraint to aquaculture elsewhere in the world.

Environmental factors that govern mangrove distribution :

The five most important environmental variables that influence mangroves are : temperature, salinity, tides, rainfall and winds, each having a distinct effect. Temperature affects the development and survival of the mangroves in the early stages. Salinity determines the distribution and zonation of the species within a mangrove forest, since each species has a particular salinity preference/tolerance. For example, Rhizophora species prefers high saline zones whereas Sonneratia caseolaris are found almost exclusively in the freshwater. Tides act conjointly with salinity in the dispersian and zonation, and the tidal amplitude determined the landward extension of the mangroves. Rainfall is important in the zonation of mangrove on flat coasts, and the productivity of a mangrove ecosystem is related to the frequency and volume of freshwater supply by rainfall. Wind is important in regulating the seasonality of litterfall, which is the major pathway of energy flux from terrestrial to aquatic system.

Physiological adaptations :

The unusual environment of the mangroves calls for a few physiological adaptations. Notable among them are : 1) salt regulation : Many species (ex. Avicennia spp) have salt glands that are capable of excluding salts that are absorbed by the root system. 2) viviparity : Members of Rhisophoraceae exhibit viviparity where the seeds germinates on the plant itself, before falling in the swamp, a condition that assures a better survival. 3) Pneumatophores : A universal feature of mangroves, where pneumatophores help in respiration and nutrient absorption under adverse conditions.

Productivity

Elements of mangrove productivity are phenology, litter production and litter transformation to aquatic detritus, and aquatic algal production.

a) Phenology : This study relates to growth and development of various components of a plant body, and is divisible into vegetative phenology (= of leaves, branches) and floral phenology (buds, flowers, fruits). The outcome of phenological studies will indicate the rate of growth of a mangrove tree, leaf formation, growth and fall, flowering and fruiting seasons, etc. Typical results from Indian mangrove show that growth in all mangroves is continuous, leaf formation can vary from unimodal to trimodal pattern according to species, leaf life is about between 6 and 12 mantus, and flowering and fruiting occur within an year.

b) The fate of bulk of vegetative and floral parts of mangroves is to fall in the mud and decompose there, since direct grazing by herbivores is of limited importance in mangroves. Thus, litterfall is a critical link in energy flux in these ecosystems. Typically, litterfall is seasonal in nature, with a major fraction of its variability accountable for by windrun, followed by salinity, rainfall and temperature. Nevertheless, not all of these can account for the total variability of litter production, indicating the involvement of certain physiological factors.

Bulk of litter is leaves with floral parts and fruits assuming importance only at flowering and fruiting peaks. Temporal variations in the quantity of these litter production can also indicate chronology of leaflife, flowering and fruiting, as well as the success rate of these. Examples from four mangrove species in Indian waters will be presented here to explain these.

Litter decomposition : The litter is not consumed directly by the herbivores, but is broken down to smaller fractions by microbial action, prior to consumption. This renders the litter more suitable for herbivorous feeding and also enhances its nutritive value. The average elemental ratios of litter are as follows : C:N = 48 ± 11 ; c:p = 523 ± 158 ; N:P = 11 ± 1 and the production in terms of these elements in Indian mangroves is about $5000 \text{ kgC ha}^{-1} \text{ yr}^{-1}$, $98 \text{ kg N ha}^{-1} \text{ yr}^{-1}$ and $7 \text{ kg P ha}^{-1} \text{ yr}^{-1}$. Decomposition of litter follows a first order kinetics, with decay constants varying from about 20 to 100 depending on the species. Aged (decomposed) litter has a better nutritive value and is easily consumed, well assimilated by herbivores, yielding good growth. Examples from our studies will be shown here to illustrate these.

Aquatic productivity : This is of little importance in mangroves, being around only 1-2% of the overall productivity. The most important reason for this is the high turbidity and rapid light extinction in these waters, which reduces considerably the depth of the euphotic zone. Lack of hard substratum presents the growth of other macroalgae. However, species like Enteromorpha can be found in abundance at a few places within the mangroves.

Interactions with adjacent ecosystems :

Mangrove ecosystem is a major exporter of nutrients and organic matter to adjacent ecosystems, which mostly are the neighbouring estuaries, and occasionally the neritic waters. This flux is along a concentration gradient and is a function of tidal currents. The net effect of this flux is to enhance the productivity of adjacent ecosystems as well.

Constraints in sustainability

Because of their proximity to human habitations, many mangroves have been adversely affected by human activities. The most important is reclamation of mangrove areas for urban development, which causes irreversible damages. The second is unplanned conversion of mangrove areas for farming (agricultural and aquacultural). Ranking in importance successively are : pollution, over-exploitation and unintentional effects that arise from human activities in other areas. Best example for the last case is the construction of dams across rivers in the highlands which reduces freshwater flow into mangroves in the lowlands, affecting productivity and survival of the mangroves.

Management of Mangroves :

The elements of management follow two paths. The first concerns the mangroves which are practically degraded but yet can be recovered. In this case, suitable steps would be a halt to reclamation/conversion, control of

discharge of pollutants, rationalization of resource uses, and development of latest potential of mangroves to maximize the yields.

The second case concerns the mangroves which are declared beyond redemption by simple management techniques. The only solution applicable here is afforestation, wherein seedling of mangroves are grown in nurseries and transplanted to areas where once mangroves, prevailed. This naturally is time consuming but its success rate is quite high, as our own results would show.