Ecological Succession of Mangroves mentioning the factors responsible in Sundarbans Forest

Introduction:

Mangroves are intertidal forested wetlands confined to the tropical and subtropical regions (Tomlinson, 1986).The total global area of the mangroves is estimated at only 18.1 million ha (Spalding et al., 1997), against over 570 million ha of freshwater wetlands including peat lands globally (but excluding paddy fields; Spiers, 1999). Although mangroves have been exploited for many centuries, our scientific understanding of these wetland forests remained poor until the 1970s (Lugo and Snedaker, 1974; Blasco, 1975; Chapman, 1976). During the past three decades or so, these wetland forests have received increasingly greater attention which is reflected in an exponential increase in the number of publications (Ellison, 2002). Several recent publications have examined issues concerning ecology, management and conservation of mangroves (Robertson and Alongi, 1992; Ricklefs and Latham, 1993; Ellison et al., 1999; Kathiresan and Bingham, 2001; Macintosh and Ashton, 2002; Ellison, 2002; Linneweber and de Lacerda, 2002; Vannucci, 2003; Saenger, 2003). The biodiversity of mangroves has also been of increasingly greater interest, firstly because of the Convention on Biological Diversity, and secondly, because the mangrove ecosystems are among the most threatened by the global climate changes, particularly the sea level rise (Macintosh and Ashton, 2002, 2004). The global patterns of biodiversity in mangroves also present an interesting picture .Interestingly; the mangrove-inhabiting molluscs follow a similar pattern (Ellison et al., 1999).

Definitions:

The term "mangrove" refers to an assemblage of tropical trees and shrubs that grows in the Inter tidal zone. Mangroves include approximately 16 families and 40 to 50 species (depending on classification). According to Tomlinson (1986), the following criteria are required for a species to be designated a "true or strict mangrove":

1. Complete fidelity to the mangrove environment.
2. Plays a major role in the structure of the community and has the ability to form pure stands.
3. Morphological specialization for adaptation to the habitat.
4. Physiological specialization for adaptation to their habitat.
5. Taxonomic isolation from terrestrial relatives.

Thus, mangrove is a non-taxonomic term used to describe a diverse group of plants that are all adapted to a wet, saline habitat. Mangrove may typically refer to an individual species. Terms such as mangrove community, mangrove ecosystem, mangrove forest, and mangrove swamp are Used interchangeably to describe the entire mangrove community.

Limits on Mangrove Distribution:

The following factors are considered to be the major determinants of mangrove distribution:

1. Climate: Mangroves are tropical species and are not tolerant of freezing temperatures. Their Latitudinal limits worldwide vary depending on air and water temperatures (Tomlinson 1986; Waisel 1972; Sherrod *et al*. 1986; Sherrod & McMillan 1985). The abundance of mangroves is also affected by aridity, and development is much greater along coasts that have high inputs of rainfall (Macnae 1968; Golley *et al.* 1975).

2. Salinity: Salt is generally not a requirement for growth, since most mangroves can grow in Fresh water (Tomlinson 1986; Ball 1988). However, they do not develop in strictly freshwater

habitats because of competition from freshwater species. Salinity is thus important in eliminating other vascular plant species that are not adapted for growth in a saline habitat.
3. Tidal fluctuation: Tidal influence is also not a requirement, but plays an important indirect role.

Geography of Sundarbans:

The Sundarbans forest lies in the vast delta on the Bay of Bengal formed by the super confluence of the Ganges, Hooghly, Padma, Brahmaputra and Meghna rivers across southern Bangladesh. The seasonally flooded Sundarbans freshwater swamp forests lie inland from the mangrove forests on the coastal fringe. The forest covers 10,000 square kilometres (3,900 sq mi) of which about 6,000 square kilometres (2,300 sq mi) are in Bangladesh. It became inscribed as a UNESCO world heritage site in 1997.Bangladeshi and Indian parts of the Sundarbans, while in fact adjacent parts of the uninterrupted landscape, have been listed separately in the UNESCO World Heritage List: as Sundarbans and Sundarbans National Park respectively. It is the world's largest delta. The Sundarbans is a network of marine streams, mud shores and mangrove forests. The region is known to contain numerous wildlife species, birds and reptiles, including Bengal tiger, chital, crocodile and snakes. Since 21 May 1992, the Sundarbans is recognized as a Ramsar Site of ecological importance. So far 69 vascular plant species of mangroves having several specific adaptations to thrive well in the rigorous and dynamic coastal marine estuarine environment have been documented (Blasco, 1975; Chapman, 1976; Kathiresen and Bingham, 2001) Another 80 species of plants, both herbaceous, and woody, being recognized as mangrove associates have been recorded (Cannolly and Lee, 2007) and they do not have special adaptations for living in the intertidal environment. More than 41% of the world's mangrove occurs in South and South east Asia of which Indonesia alone accounts for 23% (Gopal and Chauhan, 2006). A further 20% of the total mangrove area lies in Brazil, Australia and Nigeria (Spalding et al 1997). However, largest chunk of the world's mangrove occur in Ganga- Brahmaputra-Meghna Deltaic system of Sunderbans jointly shared by two countries - Bangladesh and India.

History of succession:

Precursors of the idea of ecological succession go back to the beginning of the 19th century. The French naturalist Adolphe Dureau de la Malle was the first to make use of the word *succession* concerning the vegetation development after forest clear-cutting. In 1859 Henry David Thoreau wrote an address called "The Succession of Forest Trees"[6] in which he described succession in an oak-pine forest. "It has long been known to observers that squirrels bury nuts in the ground, but I am not aware that any one has thus accounted for the regular succession of forests."[7] The Austrian botanist Anton Kerner published a study about the succession of plants in the Danube river basin in 1863.

Ecological succession

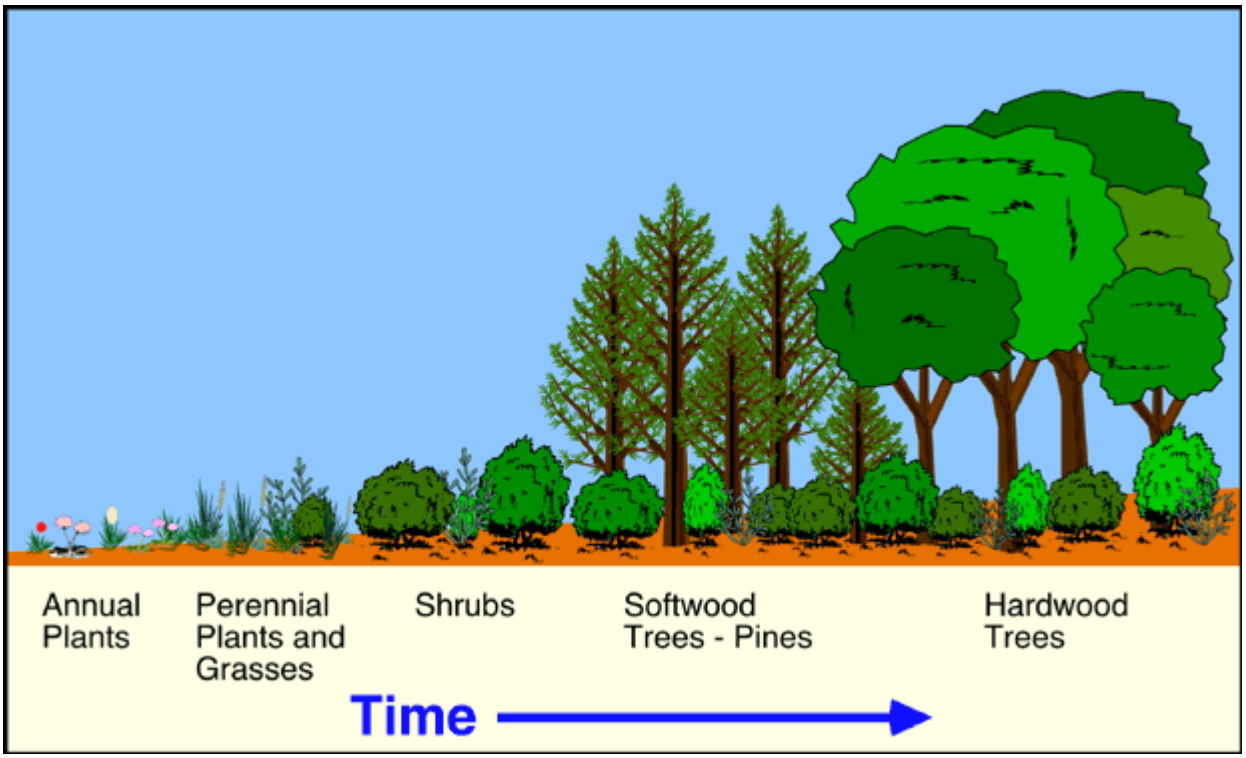
Ecological Succession is the series of changes in an ecosystem when one community is replaced by another community as a result of changes in biotic and abiotic factors.

•Can regenerate a damaged community
•Can create a community in a previously uninhabited area
•Occurs in all types of ecosystems (forests, ponds, coral reefs, etc.)

Ecological succession is the process of change in the species structure of an ecological community over time. The time scale can be decades (for example, after a wildfire), or even millions of years after a mass extinction. (Sahney, S.; Benton, M.J. (2008).In an accreting mudflats the outer community along the sequence represents the pioneer community which is gradually replaced by the next community representing the serial stages and finally by a climax community typical of the climatic zone. The pioneer vegetation on these newly accreted sites is Sonneratia, followed by Avicennia and Nypa. As the level of land rises through accretion and the land is only occasionally flooded by tides, Heritiera fomes begins to appear.

A consequence of living is the sometimes subtle and sometimes overt alteration of one's own environment (Smith, S. & Mark, S. (2009).

Ecological succession process:



Types of succession

1. Primary Succession

2. Secondary succession.

Primary Succession

•Primary Succession: the process of creating and developing an ecosystem in an area that was previously uninhabited
•Occurs in areas with no soil

•Is a very slow process

•The process of primary succession starts with the arrival of living things such as lichens and mosses that do not need soil to survive

•Pioneer species: the first organisms to live in a previously uninhabited area

•The pioneer species help create soil by breaking down the rock particles into smaller and smaller pieces
•As lichen and mosses die, they decompose and add small amounts of nutrients to the rock particles, creating soil
•During this early stage of succession there are not many habitats so not many organisms are found in the environment
•Over time, as animals die and decompose, their bodies add nutrients to the soil allowing larger plant species to populate the area
•Larger animals follow the larger plants
•Eventually, a mature community is formed, this mature community is called a climax community

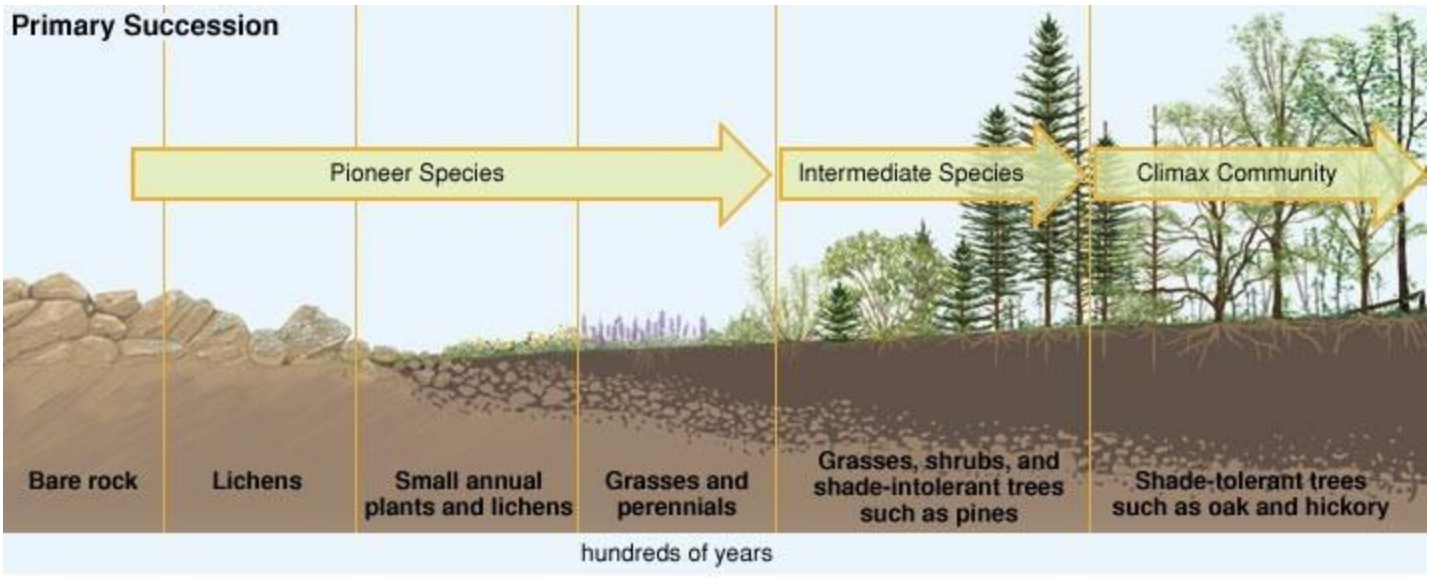
•A climax community is a community that is able to maintain itself for long periods of time with few changes in the species that populate it

Examples of uninhabited areas:

•Sides of volcanoes

•Sites of glacier recession

Primary Succession



Secondary Succession

This occurs in areas that have been disturbed. The causes of these disturbances may be natural or human-made. Secondary succession may occur in abandoned crop fields, cutover forests, areas damaged by wind storms or floods, and other previously occupied regions. The conditions that result in secondary succession are usually harsh. For example, if land has been used for agriculture for many years, the soil may be depleted of many important nutrients. When secondary succession occurs, communities are usually reintroduced to the ecosystem more quickly than happens during primary succession. Plant and animal communities already existed before the disturbance that leads to secondary succession. Therefore, the soil is often richer than in areas where primary succession occurs.

•It is typically a much faster process than primary succession because there is already soil

•Secondary succession is a never ending process

•Any disturbance in an ecosystem results in secondary succession starting over

•If an ecosystem is frequently disturbed it will not be able to support large trees and animals so it will consist of the animals typical of the early stages of succession

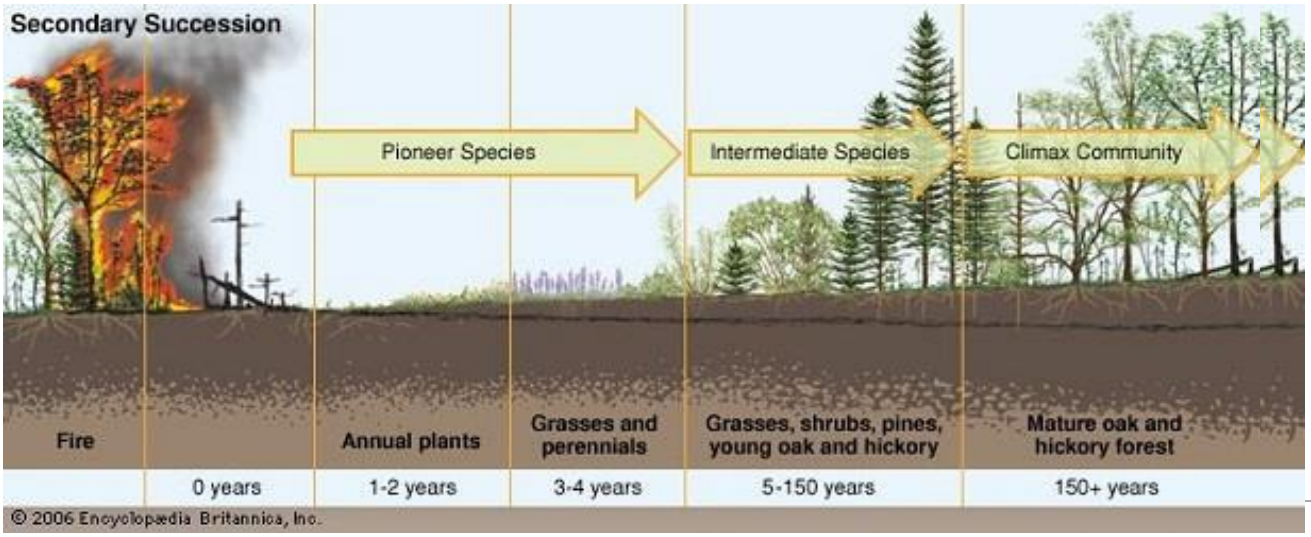
Examples of events that damage ecosystems:

•Natural disasters

•Human activities

•Death of organisms

Secondary Succession



Ecological Significance

Although early workers regarded mangrove forests as unimportant, transitional communities with a low productivity, most ecologists today view them as highly productive, ecologically Important systems. Four major roles of mangrove swamps are recognized:

1. Mangroves contribute to soil formation and help stabilize coastlines.
2. Mangroves act as filters for upland runoff.
3. Mangrove systems serve as habitat for many marine organisms such as fish, crabs, Oysters, and other invertebrates and wildlife such as birds and reptiles.
4. Mangroves produce large amounts of detritus that may contribute to productivity in offshore waters.

Factors of Ecological Succession

The trajectory of successional change can be influenced by site conditions, by the character of the events initiating succession (perturbations), by the interactions of the species present, and by more stochastic factors such as availability of colonists or seeds or weather conditions at the time of disturbance. Some of these factors contribute to predictability of succession dynamics; others add more probabilistic elements. Two important perturbation factors today are human actions and climatic change (*Bazzaz, F. A. (1996).*

Trends in ecosystem and community properties in succession have been suggested, but few appear to be general. For example, species diversity almost necessarily increases during early succession as new species arrive, but may decline in later succession as competition eliminates opportunistic species and leads to dominance by locally superior competitors. Net Primary Productivity, biomass, and trophic properties all show variable patterns over succession, depending on the particular system and site.

Ecological succession is the process by which an environment changes structure, in terms of resident species, over a period of time. Ecological succession falls under two categories, primary and secondary, which determine the types of factors that are involved. The factors involved in ecological succession are either biotic or abiotic. Biotic factors are those that involve life and its

aspects. Abiotic factors are those that involve aspects external to life but are still indirectly involved. An example of an abiotic factor would be climate.

Topographical

Extreme conditions cause abiotic topographical factors, which are mainly involved with secondary succession. Landslides and mudslides are examples of this type of factor because they cause a massive reformation of the landscape. The disturbance caused by landslides and mudslides allows for disturbance-tolerant species to repopulate the habitat.

Soil

The soil, an abiotic factor, of an environment affects ecological primary succession greatly. Different species of plants require different soil conditions. Trees tend to be the largest driving organism in this portion of ecological succession. The pH levels of the soil is often affected most by the inhabiting trees and determines what type of plants can thrive there. The type of soil (loamy sand, sandy, top soil with humus, etc.) also plays a large role in what species can inhabit an area. In sandy areas, only a select few species are able to take root and survive. The moisture level of the soil determines what sort of trees inhabits an area. Swampy areas tend to house trees with higher pH level requirements where drier soils tend to house trees with lower pH level requirements.

Climate

Climate, an abiotic factor highly involved in both primary and secondary succession, plays a significant role in determining the direction of succession in an environment. If an environment receives a period of low precipitation, it becomes more susceptible to fires caused by lightning. This leads to secondary succession in which fire-resistant and tolerable species thrive and the others die out. Wind has the ability to reform the landscape over time by way of erosion. Winds can also drive wildfires to further cause disturbance. However, when an environment receives high levels of precipitation, it becomes more suitable for certain species that are tolerable of high moisture levels, which is an example of climatic effect on primary succession.

Species Interaction and Competition

The interaction and competition between species in a particular habitat is a biotic factor of ecological primary succession. When succession begins and the very first species, known as pioneer species, change the environmental structure, new species now tolerable to the new conditions move in. The diversity among the species present is high at this point. However, in

time, competition and interaction causes a significant drop in species diversity where the dominant species thrive and the rest die off.

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