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Popular Article

Green Shields of the Shore: The Untold Power of Mangroves

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Introduction:

Mangroves are dense, tangled woods where land meets the sea, found around the world's tropical and subtropical coastlines. These distinct ecosystems, sometimes unappreciated and undervalued, are among the world's most productive and biologically diverse places. In addition to serving as the vital link between marine and terrestrial ecosystems, mangroves have enormous beneficial impacts on the environment, the economy, and the climate. Their root systems serve as the green shields of nature, absorbing vast amounts of carbon, promoting marine biodiversity, and protecting coastlines from storm surge.

Despite their significance, mangroves are becoming more and more endangered due to climate change and human activities. This article delves into the unfathomable power of mangroves, including their ecological importance, species richness, economic value, and the critical need for conservation.

The Ecological Role of Mangroves:

Mangroves are extremely significant ecosystems that are frequently referred to as "guardians of the coast" and play a critical ecological role in coastal zones across the globe, particularly in tropical and subtropical regions. Below is a detailed breakdown of their ecological functions

1. Coastal Protection:

Mangrove roots stabilize and bond soil, thereby mitigating erosion caused by tides, currents, and waves. Natural breakwaters are created by their extensive root systems. Mangroves act as protective barriers against tsunamis, storm surges, and coastal erosion. Their extensive network of above-ground roots catches sediments and distributes wave energy, preventing coastal deterioration.

According to a study by Narayan et al. (2016), mangrove trees can drastically lessen the impact of coastal flooding by lowering wave heights by up to 66% over a 100-meter belt. In comparison to deforested areas, areas with intact mangrove forests, such as regions of Tamil Nadu, India, reported fewer fatalities and less damage during the 2004 Indian Ocean tsunami (Kathiresan & Rajendran, 2005). These results provide credence to the use of mangroves in nature-based climate resilience options.

Ecological Benefit:

- It reduces coastal erosion.
- It protects the coastal regions from storm surges and tsunamis.

- lessens the effects of hurricanes and cyclones.
- Protecting human settlements and infrastructure from natural calamities.
- Reduction of coastline retreat and land loss.

2. Carbon Sequestration: The Blue Carbon Sink

Mangroves are extremely effective in absorbing atmospheric carbon dioxide (CO2). They store carbon in their biomass, especially in their anaerobic and slow-decomposing soils. Mangroves are extremely effective at storing "blue carbon"—carbon stored in coastal environments. They sequester carbon in the soil and in their biomass. When compared to terrestrial forests, they capture carbon dioxide more efficiently.

Donato et al. (2011) found that mangroves are among the most carbon-rich ecosystems in the world, sequestering up to 1,023 Mg C/ha. The idea of "blue carbon" highlights the importance of coastal vegetation ecosystems including mangroves, seagrasses, and salt marshes in buffering climate change (Mcleod et al., 2011). Mangrove conservation can help nations accomplish climate targets and reduce emissions.

Ecological Benefit:

- Reduces climate change by absorbing CO_2 from the atmosphere.
- holds carbon for centuries if left untouched.
- Mangrove soils are capable of storing carbon for millennia.
- It is crucial for the global carbon budgets

3. Biodiversity Hotspots:

Mangrove environments are vibrant with life. They provide essential habitat for thousands of species, both endemic and migratory. A distinct combination of marine, estuarine, and terrestrial species are supported by mangroves.

Flora:

Globally, there are approximately 70 real mangrove species divided into genera such as Rhizophora, Avicennia, Sonneratia, and Laguncularia.

• Red Mangrove (Rhizophora mangle) is known for its stilt roots and serves as a frontline against waves.
• Black Mangrove (Avicennia germinans) can be identified by pneumatophores utilized for gas exchange.
• White mangrove (Laguncularia racemosa) thrives in higher elevations with lower salinity.

Fauna:

Fish and Crustaceans:

Many commercially significant fish and shellfish use mangrove roots as nurseries, and research conducted in the Caribbean and Indo-Pacific indicates that up to 80% of commercial fish species require mangroves as part of their life cycles (Nagelkerken et al., 2002). These conditions are ideal for crabs (Ucides spp.), shrimp (Penaeus spp.), and mollusks like the mangrove cockle (Anadara tuberculosa).

Birds:

More than 200 bird species live in mangrove ecosystems. Major instances are:

- Roseate spoonbill (Platalea ajaja).
- The Mangrove Warbler (Setophaga petechia castaneiceps)
- Mangrove Finch (Camarhynchus heliobates) are critically endangered and indigenous to the Galápagos Islands.

Mammals and Reptiles:

Mangroves support several essential species, yet are less diversified than avian and marine fauna.

- The Proboscis monkey (Nasalis larvatus) is unique to Borneo.
- Fishing cats (Prionailurus viverrinus)
- Saltwater crocodiles (Crocodylus porosus) are found in the Sundarbans.

Ecological Benefit:

- Many marine animals use these areas as their nursery grounds.
- Help protect endangered species such as the Bengal tiger (in the Sundarbans), manatees, and saltwater crocodiles.
- High productivity and species diversity strengthen food webs.
- Maintain genetic diversity.
- Promotes ecological resilience and adaptation.

4. Economic and Social Benefits:

Mangroves serve as both natural assets and economic engines for coastal towns.

Fisheries:

- An annual revenue from mangrove-associated fisheries exceeds $7.6 billion (Rönnbäck, 1999).
- Depending on the area and species richness, a hectare of mangrove can provide up to 1.08 tons of fish per year.

Timber and Non-Timber Products

Mangrove timber is used by communities as fuel, construction material, and charcoal. However, unsustainable exploitation is still a problem. Additional goods include: tannins for leather manufacture; honey from mangrove flowers; and traditional medicine made from bark and leaves.

Ecotourism:

Mangroves are popular destinations for kayaking, bird watching, and ecological tours. Mangrove ecotourism has grown as a sustainable source of income in nations like India, the Philippines, and Costa Rica.

5. Mangroves and Climate Adaptation:

Mangroves provide two functions in a changing climate: mitigation and adaptation.

Mitigation: By acting as carbon sinks and sequestering carbon.

- Adaptation: By stabilizing coastlines and acting as a buffer against harsh weather occurrences.

6. Water Filtration and Nutrient Cycling:

Mangroves operate as natural water purifiers by filtering pollutants and trapping sediments from upstream. They also recycle nutrients, such as phosphate and nitrogen. By capturing contaminants and sediments, including nutrients and heavy metals, roots help to purify water. Bacterial colonies in mangrove sediments Help to decompose organic waste.

It prevents sedimentation in coral reefs and seagrass habitats.

Threats to Mangrove Forests

Despite their significance to the environment and the economy, mangroves are increasingly threatened by both natural and human-caused factors. Worldwide, these stresses are causing mangrove habitats to deteriorate and disappear, which has major ramifications for coastal people, biodiversity, and climate resilience. Understanding these challenges is key for developing effective conservation measures and preserving the future of these important coastal ecosystems.

1. Aquaculture Expansion

According to studies, aquaculture has been responsible for more than 35% of the destruction of mangroves around the world. The growth of aquaculture, especially shrimp farming, is one of the main causes of mangrove loss; enormous areas of mangrove forests have been removed to make way for shrimp ponds, which changes hydrological systems and damages ecosystems (Ocean Portal Team, 2021).

2. Pollution

Mangroves are particularly vulnerable to pollution: Pesticides and fertilisers that cause eutrophication are carried by agricultural runoff (Next IAS, 2023). Chemicals and heavy metals from industrial waste have a negative effect on mangrove plants and animals (ELAW, 2023). The survival of mangrove trees is impacted by oil spills because they suffocate their roots, preventing oxygen from reaching them (Next IAS, 2023). In addition to physically endangering species, plastic pollution disrupts tidal flows (AP News, 2023).

3. Overexploitation of Resources

In several areas, mangroves are used for charcoal, building materials, and firewood. The removal of important species due to overfishing in mangrove areas also upsets the ecological balance (ResearchGate Contributors, 2023).

4. Coastal Development and Urbanization

Mangrove zones are frequently invaded by the fast expansion of the coast, including ports, highways, and urban housing. Habitat fragmentation and long-term loss result from this (Environmental Law Alliance Worldwide (ELAW), 2023). Additionally, the natural processes required for mangrove regeneration are disrupted by urbanization.

5. Invasive Species

Certain grasses and non-native trees are examples of invasive species that can overtake mangrove environments, decreasing biodiversity and changing natural processes (Unsustainable Magazine, 2024).

6. Climate Change and Sea-Level Rise

Mangroves are at risk from the negative consequences of climate change, such as increasing storm

severity, altered rainfall patterns, and rising sea levels. Due to their inability to travel swiftly enough to adapt to these changes, many mangrove species are extremely vulnerable to erosion or drowning (World Wildlife Fund (WWF), 2024).

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