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Mangrove Plants in India

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ABSTRACT: On the International Day for the Conservation of the Mangrove Ecosystem, West Bengal, which is home to approximately 40% of India's mangrove forests, unveiled plans to establish a dedicated 'Mangrove Cell' to streamline mangrove management efforts.

International Day for the Conservation of the Mangrove Ecosystem
The International Day for the Conservation of the Mangrove Ecosystem is celebrated every year on 26 July and aims to raise awareness of the importance of mangrove ecosystems as “a unique, special and vulnerable ecosystem” and to promote solutions for their sustainable management, conservation and uses.

This International Day was adopted by the General Conference of the UN Educational, Scientific and Cultural Organization (UNESCO) in 2015.

KEYWORDS: mangrove, conservation, ecosystem, sustainable, cultural, management, plants, India

I. INTRODUCTION

- Mangroves are a unique type of coastal ecosystem found in tropical and subtropical regions. They are dense forests of salt-tolerant trees and shrubs that thrive in intertidal zones, where land meets the sea.[1,2,3]
- These ecosystems are characterized by their ability to withstand harsh conditions, such as saline water, tidal fluctuations, and muddy, oxygen-poor soils.
- Characteristics:
- Mangroves exhibit Viviparity mode of reproduction, where seeds germinate within the tree before falling to the ground. This is an adaptive mechanism to overcome the challenge of germination in saline water.
- Some mangrove species secrete excess salt through their leaves, while others block the absorption of salt at their roots.
- Mangrove plants have special roots like prop roots and pneumatophores, which help impede water flow and provide support in the challenging tidal environment.
- Mangrove Cover in India:
- According to the Indian State Forest Report 2020, Mangrove cover in India is 4992 sq. Km which is 0.15% of the country's total geographical area.
- Sundarbans in West Bengal are the largest mangrove forest regions in the world. It is listed as a UNESCO World Heritage Site.
- Besides the Sundarbans, the Andamans region, the Kachchh and Jamnagar areas in Gujarat too have substantial mangrove cover.
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  Significance:
- Biodiversity Conservation: Mangroves provide a unique habitat for a wide variety of plant and animal species, serving as breeding, nursery, and feeding grounds for numerous marine and terrestrial organisms.
  - For example, sundarban hosts the Royal Bengal tiger, Irrawady Dolphin, Rhesus macaque, Leopard cats, Small Indian civet.
- Coastal Protection: Mangroves act as natural buffers against coastal erosion, storm surges, and tsunamis.
  - Their dense root systems and tangled network of prop roots stabilize shorelines and reduce the impact of waves and currents[4,5,6].
  - During hurricanes and cyclones, mangroves can absorb and dissipate a significant amount of energy, protecting inland areas and human settlements from devastating damage.
- Carbon Sequestration: Mangroves are highly efficient carbon sinks, sequestering large amounts of carbon dioxide from the atmosphere and storing it in their biomass and sediments.
- Fisheries and Livelihoods: Mangroves support fisheries by providing nursery areas for fish and shellfish, enhancing fishery productivity and contributing to livelihood and local food security.

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- Water Quality Improvement: Mangroves act as natural filters, trapping and removing pollutants and excess nutrients from coastal waters before they reach the open ocean.
    - Their role in purifying water contributes to the health of marine ecosystems and helps maintain the balance of fragile coastal ecosystems.
- Tourism and Recreation: Mangroves offer recreational opportunities such as eco-tourism, birdwatching, kayaking, and nature-based activities, which can promote sustainable economic growth for local communities.
- Challenges:
- Habitat Destruction and Fragmentation: Mangroves are often cleared for various purposes, including agriculture, urbanization, aquaculture, and infrastructure development.
    - Such activities lead to the fragmentation and loss of mangrove habitats, disrupting their ecosystem functioning and biodiversity.
    - The conversion of mangroves into shrimp farms and other commercial uses is a significant concern.
- Climate Change and Sea Level Rise: Rising sea levels due to climate change pose a significant threat to mangroves.
    - Climate change also brings about extreme weather events, such as cyclones and storms, which can cause severe damage to mangrove forests.
- Pollution and Contamination: Pollution from agricultural runoff, industrial discharges, and improper waste disposal contaminate mangrove habitats.
    - Heavy metals, plastics, and other pollutants adversely affect the flora and fauna of these ecosystems.
- Lack of Integrated Management: Often, mangroves are managed in isolation, without considering their interconnectedness with adjacent ecosystems like coral reefs and seagrass beds.
    - Integrated management approaches that consider the broader coastal ecosystem are necessary for effective conservation.
- Government Initiatives Related to Mangrove Conservation:
- MISHTI (Mangrove Initiative for Shoreline Habitats & Tangible Incomes)
- Sustainable Aquaculture In Mangrove Ecosystem (SAIME) initiative
- Drone Monitoring and AI: Employ drone technology equipped with high-resolution cameras and AI algorithms to monitor mangrove health and detect illegal activities such as encroachment or illegal logging.
- This approach can help in efficient and timely surveillance over vast areas.
- Mangrove Adoption Program: Launch a public-driven initiative where individuals, corporates, and institutions can "adopt" a patch of mangroves.[7,8,9]
- Participants would be responsible for the maintenance, protection, and restoration of their adopted area, fostering a sense of ownership and collective responsibility.
- Mangrove Research and Development: Invest in research to explore novel applications of mangroves, such as phytoremediation to clean polluted water or developing new medicines from mangrove plant extracts.
- This could lead to innovative ways to leverage mangroves' unique properties for sustainable development.

II. DISCUSSION

In tropical and subtropical regions of the world, the mangrove forest dominates the coastlines and is an essential component of the forest ecosystem.

Mangrove is the crossroad, where oceans, freshwater, and land meet.
There are 54–75 species of true mangroves, which are taxonomically distinct from their terrestrial counterparts and exclusively occur in the intertidal zones of coastlines.

Mangrove forests are among the planet’s most complex ecosystems, flourishing in environmental conditions that would swiftly kill most other types of vegetation.

Mangroves can survive in extremely salty waters and soils because they are highly adaptable to their surroundings and capable of excluding or expelling salt.

Features of Mangrove Forest

- Some mangrove plants exclude salt by having very impermeable roots that function as an ultra-filtration system to keep sodium salts out of the rest of the plant, effectively lowering the salt content by 90%–97%.
- The plant then sheds its old leaves, which are concentrated with salt that does collect in the shoot.

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- Some mangroves have cell vacuoles that can store salt.
- Other species' leaves contain unique glands that actively release salt, leaving visible salt crystals on the leaf's upper surface.
- Many kinds of mangrove trees have airborne roots, known as pneumatophores, that draw up oxygen from the air for the roots because the soil in shallow regions of mangrove forests is often flooded during high tides.
- A lot of mangrove plants also have a distinctive way of reproduction. Mangrove seeds begin growing while still attached to the parent plant, known as propagules, these seedlings develop roots as well.

Global Distribution
Mangroves are found worldwide, but the greatest species diversity is in Southeast Asia.
Mangrove forests are found in tropical and subtropical regions in tidal areas, that are frequently inundated with salt water.

Worldwide, mangrove forests occupy about 15.2 million hectares (1,52,000 sq km) of tropical coasts, found across Africa, Australia, Asia, and America.

While the mangrove forests are spread across more than 100 countries and territories, three-quarters of the mangroves are found only in 15 countries and less than seven percent of them are protected.

Asia has a share of 42 percent of the world's mangroves, which is followed by Africa (21 percent), North/Central America (15 percent), Oceania (12 percent), and South America (11 percent).

It is important to note that the mangrove area decreases with increasing latitude excluding the Sundarbans which account for the world's largest tract of mangroves situated along the Ganges delta.[10,11,12]

Largest Area Under Mangrove Forest
The countries with the largest area of mangroves are:
1. Indonesia
2. Brazil
3. Australia
4. Mexico
5. Nigeria

Source: Landsat data & World Atlas of Mangroves
Mangroves in India
"About 40% of the world's mangrove is found in South East Asia which is 6.8% of the world's mangrove cover and India has about 3% of the share of the total Mangrove cover that is found in South Asia"

India's Mangrove cover has increased by 54 sq km (1.10%) as compared to the last assessment."
As per the current data, mangrove cover in the country stands at 4,975 sq km [(1.2 million acres)], which is 0.15% of the country's total geographical area.
Sundarbans in west Bengal alone accounts for almost half of the total area that is found under mangrove in India.

West Bengal has a total of 42.45% of India's mangrove cover, followed by Gujarat at 23.66%, and A&N Islands at 12.39%. All around the country, Gujarat showed a maximum increase in mangrove forest cover of 37 sq.
1. West Bengal (2114 sq km),
2. Gujrat (1140 sq km),
3. A&N Islands (617 sq km),
4. Andhra Pradesh (404 sq km)
5. Maharashtra (304 sq km)

Among the states, Kerala (9 sq km) and among the UTs, Puducherry (2 sq km) have the least Mangroves cover.
For Research and Development, National Mangrove Genetic Resource Centre was established in Bhitarkanika (Odisha) by the Environment Ministry.
India State of Forest Report 2020
As per the India State of Forest report 2020, the area under Mangrove forest has increased by 17 sq km making India's total mangrove cover as 4,992 sq km.

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Top 3 states showing mangrove cover increase: Odisha (8 sq km), Maharashtra (4 sq km), and Karnataka (3 sq km).
Important Mangroves Region in India
Gujrat: Gulf of Kutchh, Gulf of Khambhat, Dumas-Ubhrat
Andhra Pradesh: Coringa East Godavari Delta, Krishna Delta
Odisha: Bhaitarkanika, Mahanadi, Subarnarekha, Devi-Kauda, Dhamra, Chilka
West Bengal: Sunderbans
Andaman & Nicobar: North Andaman, Nicobar
Maharashtra: Achra-Ratnagiri, Devgarh-Vijay Durg, Veldur, Kundalika-Revdnada, Mumbra-Diva, Vikroli.
Goa: Goa
Karnataka: Coondapur, Dakshin Kannada/ Hannavar, Karwar, Mangalore Forest Division.[13,14,15]
Kerala: Vembanad, Kannur (North Kerala)
Tamil Nadu: Pichavaram, Muthupet, Ramnad, Pulicat, Kaznuveli
Importance of Mangroves
Species: Plankton, algae, fish, and shellfish are all fed by the nutrients found in mangrove leaves and roots. Many different species of birds and mammals live in mangroves, including mangrove monkeys in South Asia and Bengal tigers in Sunderbans.

Fishery: Mangroves are essential for fish and shellfish, migratory birds, and sea turtles to nest and breed, which highlights their significance for coastal fishing communities. An article published in the Journal of Sea in 2008 estimates that mangrove forests are directly or indirectly responsible for 80% of the world's fish catch.

Nutrient Filters: Because of the destruction of mangrove habitats, which typically filter the amount of silt and nutrients that reach the ocean, the amount of sediment and nutrients that reach oceanic waters has increased. That can result in an Algal boom because of excess nutrients discharge.

Climate change: Mangroves are effective carbon sinks. They store three to five times more carbon per unit area than tropical forests and isolate carbon at a pace that is two to four times faster than tropical forests like the Amazon. More greenhouse gases are released when they are cut down compared to other areas of forests.

Stabilization of shorelines: Mangroves create a natural barrier that shields coastal communities from increased storm surges, flooding, and storms also stabilizing shorelines by reducing erosion.

Tsunami Shield: Mangroves can absorb wave energy, and because of that they are very important for protecting coastal areas from coastal calamities namely, tsunamis, storm surges, etc. Mangroves can effectively absorb about 70-90 percent of normal wave energy. It is evident that even under extreme circumstances, mangroves' dense root and branch networks could help diffuse tsunamis, and reduce their devastating effects.

In December 2004 a massive tsunami hit Asia and causes mass-scale destruction and loss of life. Degradation of the coastal mangrove system makes the coastal areas more prone to tsunamis, and flood-related destructions.
It is evident that damage to the property and loss of lives was minimal in coastal regions where there were healthy mangroves.
Threats to Mangrove Forest
There are approximately 70 species of mangroves around the world but the reduction in it and extinctions is evident.
These areas are rich in nutrients and are part of larger wetland systems that make them desirable for agriculture and lead to deforestation.

A threat to the mangrove ecosystem is associated with global warming and climate change.
As these areas are near the sea, it is also exploited for salt production.
Rapid and mostly unregulated coastal development is one of the main obstacles to mangrove growth. According to the coastal regulation zone notification 2011, these important habitats have been included in CRZ-1 (Coastal Regulation Zone 1) for the protection of these vital ecosystems.

Strategies to Mitigate Climate Change Effects
Management of Man-Made Pressure, mangroves are needed to be protected from anthropogenic pressure by sustainable practices.
Establishment of green belt along the open coast, river banks, lagoons, etc for coastal protection from erosion.
Restoration of the degraded areas through hydrological manipulation, community participation, and integrated farming practices.

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Establishment of baseline data on forestry structures, diversity, an abundance of flora and fauna, species richness, nutrient, and hydrological aspects, etc.

Endemic Mangroves Species in India

- Rhizophora annamalaya- Pichavaram, Tamil Nadu
- Heritiera kanikensis- Bhitarkanika, Odisha
- Mangroves diversity in India
- Genera of Plants found in Indian Mangroves: Avicennia, Acgiceras, Aegialitis, Acanthus, Kandelia, Bruguirea, Sonneratia, Carapa, etc.
- Sundari tree: Heritiera littoralis

III. RESULTS

- A Mangrove is a small tree or shrub that grows along coastlines, taking root in salty sediments, often underwater.
- The word 'mangrove' may refer to the habitat as a whole or to the trees and shrubs in the mangrove swamp.
- Mangroves are flowering trees, belonging to the families Rhizophoraceae, Acanthaceae, Lythraceae, Combretaceae, and Arecaceae.
- Features of Mangroves:
- Saline environment: They can survive under extreme hostile environments such as high salt and low oxygen conditions.
- Low oxygen: Underground tissue of any plant needs oxygen for respiration. But in a mangrove environment, the oxygen in soil is limited or nil.
    - Hence the mangrove root system absorbs oxygen from the atmosphere.
    - Mangroves have special roots for this purpose called breathing roots or pneumatophores.
    - These roots have numerous pores through which oxygen enters the underground tissues.
- Survival in Extreme Conditions: With their roots submerged in water, mangrove trees thrive in hot, muddy, salty conditions that would quickly kill most plants.
    - Succulent leaves: Mangroves, like desert plants, store fresh water in thick succulent leaves.[16,17,18] A waxy coating on the leaves seals in water and minimises evaporation.
- Viviparous: Their seeds germinate while still attached to the parent tree. Once germinated, the seedling grows into a propagule.
    - The mature propagule then drops into the water and gets transported to a different spot, eventually taking root in a solid ground.
- Geographical Location:
- Mangroves are found only along sheltered coastlines within the tropical or subtropical latitudes because they cannot withstand freezing temperatures.
- They share the unique capability of growing within reach of the tides in salty soil.
- Area Covered
- Global Mangrove Cover:
- The total mangrove cover in the world is one 1,50,000 sq kms.
- Asia has the largest number of mangroves worldwide.
    - South Asia comprises 6.8% of the world's mangrove cover.
        - India's contribution is 45.8% total mangrove cover in South Asia.
- Mangroves in India:
- Coverage: According to the India State of Forest Report, 2019, the mangrove cover in India is 4,975 sq km, which is 0.15% of the country's total geographical area.
    - West Bengal has the highest percentage of area under total Mangrove cover followed by Gujarat and Andaman Nicobar Islands.
- Largest Mangrove Forest: Sundarbans in West Bengal are the largest mangrove forest regions in the world. It is listed as a UNESCO World Heritage Site.
    - The forest is home to the Royal Bengal tiger, Gangetic dolphins and Estuarine crocodiles.
- Bhitarkanika Mangroves: The second largest mangrove forest in India is Bhitarkanika in Odisha created by the two river deltas of River Brahmani and Baitarani.
    - It is one of the most significant Ramsar wetlands in India.
- Godavari-Krishna Mangroves, Andhra Pradesh: The Godavari-Krishna mangroves extend from Odisha to Tamil Nadu.
- The deltas of the Ganges, Mahanadi, Krishna, Godavari, and the Cauvery rivers contain mangrove forests.

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- The backwaters in Kerala have a high density of mangrove forest.
- Pichavaram in Tamil Nadu has a vast expanse of water covered with mangrove forests. It is home to many aquatic bird species.
- West Bengal has 42.45% of India's mangrove cover, followed by Gujarat 23.66% and A&N Islands 12.39%.[18,19,20]

IV. CONCLUSION

Significance of Mangroves

- Ecological Stabilisation: Ecologically mangroves are important in maintaining and building the soil, as a reservoir in the tertiary assimilation of waste.
    - They provide protection against cyclones.
    - They play a significant role in promoting land accretion, fixation of mud banks, dissipation of winds, tidal and wave energy.
- Mangroves and Tides: The dense tangle of roots allows the trees to handle the daily rise and fall of tides.
    - Most mangroves get flooded at least twice per day.
- Coastal Stabilisation: Mangrove forests stabilize the coastline, reducing erosion from storm surges, currents, waves, and tides.
- Water Purification: Mangroves improve the water quality by absorbing nutrients from runoff that might otherwise cause harmful algal blooms offshore.
    - Both coral reefs and seagrass beds rely on the water purifying ability of mangrove forests to keep the water clear and healthy.
- Storing Blue Carbon: Mangroves make up less than 2% of marine environments but account for 10-15% of carbon burial.
    - Once the leaves and older trees die they fall to the seafloor and take the stored carbon with them to be buried in the soil.
    - This buried carbon is known as "blue carbon" because it is stored underwater in coastal ecosystems like mangrove forests, seagrass beds and salt marshes.
- Supporting Biodiversity: The mangrove ecosystem also supports an incredible diversity of creatures including some species unique to mangrove forests.
    - They provide habitat and refuge to a wide array of wildlife such as birds, fish, invertebrates, mammals and plants.
- Threats Faced by Mangroves
- Commercialisation of Coastal Areas: Aquaculture, coastal development, rice and palm oil farming and industrial activities are rapidly replacing these salt-tolerant trees and the ecosystems they support.
    - According to UNESCO, mangroves are disappearing at three to five times faster rate than overall losses of global forest cover in the face of infrastructure development, urbanisation and agricultural land conversion.
        - Mangrove coverage has shrunk by half in the last 40 years. Less than 1% of tropical forests are mangroves.[19]
- Shrimp Farms: The emergence of shrimp farms have caused at least 35% of the overall loss of mangrove forests.
    - The rise of shrimp farming is a response to the increasing appetite for shrimp in the United States, Europe, Japan and China in recent decades.
- Temperature Related Issues: A fluctuation of ten degrees in a short period of time is enough stress to damage the plant and freezing temperatures for even a few hours can kill some mangrove species.
- Soil Related Issues: The soil where mangroves are rooted poses a challenge for plants as it is severely lacking in oxygen.
    - Most plants can easily take oxygen from gases trapped within the surrounding soil, but for mangrove roots this is not an option as not only their roots underground, they are also flooded with water up to two times a day.
- Excessive Human Intervention: During past changes in sea level, mangroves were able to move further inland, but in many places human development is now a barrier that limits how far a mangrove forest can migrate.
    - Mangroves also frequently suffer from oil spills.

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- Conservation of Mangroves
- UNESCO Designated Sites: The inclusion of mangroves in Biosphere Reserves, World Heritage sites and UNESCO Global Geoparks contributes to improving the knowledge, management and conservation of mangrove ecosystems throughout the world.
- International Society for Mangrove Ecosystem (ISME): The ISME is a non-governmental organization established in 1990 to promote the study of mangroves with the purpose of enhancing their conservation, rational management and sustainable utilization.
- Blue Carbon Initiative: The International Blue Carbon Initiative is focused on mitigating climate change through the conservation and restoration of coastal and marine ecosystems.
    - It is coordinated by Conservation International (CI), IUCN, and the Intergovernmental Oceanographic Commission-UNESCO (IOC-UNESCO).
- International Day for the Conservation of the Mangrove Ecosystem: UNESCO celebrates this day on July 26 with the aim of raising awareness about mangrove ecosystems and to promote their sustainable management and conservation.
- Mangroves for the Future Initiative: IUCN and UNDP developed a unique initiative to promote investment in coastal ecosystem conservation called the "Mangroves for the Future (MFF)".
    - The member nations include Bangladesh, Cambodia, India, Indonesia, Maldives, Myanmar, Pakistan, Seychelles, Sri Lanka, Thailand, and Vietnam.
- National Mangrove Committee: The Government of India set up a National Mangrove Committee in 1976 which advises the government about conservation and development of mangroves.[20]

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