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An Over View of Conservation, Restoration and Development of Mangrove Forests in Goa

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ABSTRACT

Mangroves are coastal plants spread over sea cost of tidal zones or backwaters particularly in tropical and sub-tropical climate regions. Mangroves Are Champions at Sucking Out Carbon Dioxide from Air, and each tonne removed is worth a few dollars. Hence it is important that conservation, plantation, and restoration of mangroves need to be given top priority. In fast developing world there are various issues affecting the forest, wildlife, flora and fauna environment ecology and what not, so there is urgent need of not only protecting the mangrove biodiversity but also restoring and developing mangrove forests. This paper presents an over view on mangroves and Conservation, Restoration and Development of Mangrove Forest in Goa.

Key words: *Conservation, Development, Environment, Goa, Mangroves, Restoration, Goa*

Introduction

In fast developing world there are various issues affecting the forest, wildlife, flora and fauna and environment ecology Due to this some of the wild life and plants have become already became extinct and threatening the existence of some more wildlife and plants. Such indiscriminate activities are also responsible for environment degradation and ecological imbalance and greenhouse effect and is a threat to next generations to come. One such plant is "Mangrove". They are also referred as tidal forests or coastal wood forest.

Mangroves are a special type of vegetation and they are found in the intertidal regions where freshwater and saltwater intermixes, in the bays, estuaries, creeks, and lagoons. They are the salt-tolerant variety of plants, which can survive in harsh conditions. And they are economically and ecologically significant.

Mangroves are coastal plants spread over sea cost of tidal zones or backwaters particularly in tropical and sub-tropical climate regions. The term mangrove is believed to be derived from two words namely Mangue (a Portuguese word) + grove (an English word). Basically, mangrove can be divided in to broad category based on their formation namely

(i) Swampy Mangrove: These are located below the high tide level and get submerged twice a day due to high tide and low tide.
(ii) Tidal Mangroves: Such mangroves get submerged in water only in high tide or during unusual tide situation.

This paper discusses various aspects of Systematic and Scientific Conservation, Plantation and Restoration of Mangroves and also multiple benefits of such efforts for the earth and mankind as a whole with specific details on Mangroves of State of Goa.

Worldwide Mangroves Forests

Mangroves can be found in over one hundred coun-

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tries and territories in tropical and sub-tropical regions of the world. According to an estimate Mangroves were 114 million years ago in Indo-Malaysian area and latter spread to the other regions of tropic (Dhargalkar *et al.*, 2014). The largest percentage of mangroves is found between the 5° N and 5° S latitudes. Approximately 75% of world's mangroves are found in just 15 countries. The most extensive mangrove area is found in south and southeast Asia, followed by south America, western and central Africa, north and central America and Oceania. The first attempt at estimating the total mangrove area in the world was undertaken as part of the Food and Agriculture Organization (FAO) of United Nation Environment Programe (UNEP). According to the FAO/UNEP Tropical Forest Resources Assessment in 1980, the world total was estimated as 15.6 million hectares. More recent estimates range from 12 to 20 million ha. For many of these studies, countries with small areas of mangroves were excluded due to lack of information and because their combined area of mangroves would not significantly affect the world total. According to Tropical Forest Resources Assessment Project, Forest Resources of Tropical Asia (FAO, UNEP, 1981) mangroves in India were about 278 thousand ha.

The Global mangrove distributions have fluctuated throughout human and geological history. The area covered by mangroves is influenced by a complex interaction between land position, rainfall hydrology, sea level, sedimentation, subsidence, storms and pest-predator relationships. In the last 50 years, human activities have strongly affected mangrove distributions, resulting in declines or expansions of worldwide mangrove area. Mangroves provide several important ecological services including coastal stabilization, juvenile fish habitats, and the filtration of sediment and nutrients. Mangrove loss has important implications for coastal ecological systems and human communities are dependent on healthy mangrove ecosystems. As of 2010, mangroves are found in 117 countries and territories. Although distributed across 117 countries and territories, the top 15 mangrove holding nations contain approximately 75% of the global mangrove stock with Indonesia alone containing between 26% and 29% of the entire global mangrove stock. Figure 1 shows global distribution of Mangrove forest (FAO, UNEP, 2000).

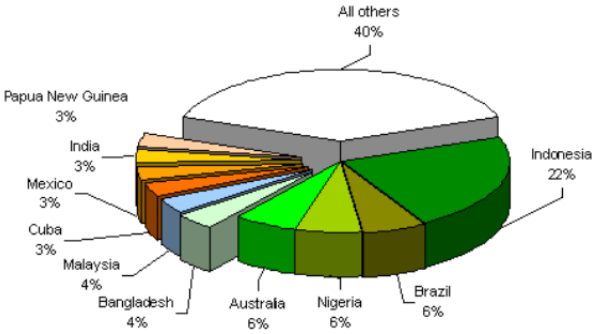

Fig. 1. Global distribution of Mangrove Forest

Mangroves Forests in India

As per the current data, mangrove cover in the country stands at 4975 sq km, which is 0.15% of the country's total geographical area namely Sundarbans Groves, Mahanadi Mangroves, Krishna Godavari Mangroves, Mangroves of Gujarat, Ratnagiri Mangroves, Cauvery Deltaic Mangroves, Goa Mangroves.

The largest continuous area of mangrove forest is likely in-and-around the Sundarbans National Park in India and the Sundarbans Mangrove Forests in Bangladesh, which are both recognized by UNESCO as World Heritage Sites. Sundarbans in West Bengal alone accounts for almost half of the total area that is found under mangrove in India. The second largest mangrove forest in India is Bhitarkanika in Odisha. This forest is created by the two river deltas of River Brahmani and Baitarani. It is one of the most significant Ramsar wetlands in India. Based on denseness of Mangrove cover it divided in three classes as given in Table 1.

Table 1. Denseness and Area of Mangrove Forest in India

Sl. No.	Density of Mangrove	Area Covered, sq. km.	Area Covered, %
1	Very Dense	1476	29.66
2	Moderately Dense	1479	29.73
3	Open Mangrove	2020	40.61

According to Ministry of Environment, Forests, and Climate Change annual report (ISFR, 2021) there are 38 mangrove sites in India as of 2021. Maharashtra has the greatest number of mangrove sites in a state (10), followed by Orissa (7 sites). The Figure 2 shows mangrove sites in India.

Fig. 2. Mangroves Sites in India

The area covered by mangrove in 12 states and UT of India is presented in Table 2. It can be seen from Table 2 that over 40% of Indian mangrove occurs in West Bengal. Further only 4 states and UT namely Tal Nadu, Odisha, West Bengal and Andaman & Nicobar Islands have very dense mangrove.

Types of Mangroves in India

Indian mangrove vegetation represents fourth largest in the world, distributed along the coast-line and occupies 8 % of the total world mangrove covering 6749 ksq km areas (Naskar and Mandal, 1999). The entire mangrove habitats in India are situated in three zones: east coast (4700 sq km), west coast (850 sq km) and Andaman & Nicobar Islands (1190 sq km). East coast zone ranges from Sundarban forest of West Bengal to Cauvery estuary of Tamil Nadu and comprises 70 % mangrove (Untawale and Jagtap, 1992). West coast region stretches from Bhavnagar estuary of Gujarat to Cochin estuary of Kerala and constitute15 % mangrove (Mandal and Naskar, 2008). Mangrove flora of India constitutes about 60 species belonging to 41 genera and 29 families (Untawale, 1985). Along the west coast of India, 34 species of mangroves belonging to 25 genera and 21 families have been reported. There are about 11, 20, 14 and 10 species of mangroves reported along the coast of Gujarat, Maharashtra, Goa and Karnataka respectively in western India.

On the basis of colour mangroves in India are divided into Red, Black and White Mangroves. Every kind of mangrove that has adapted to the distinct climatic conditions found in India's wide coastline is found growing there.

(a) **Red mangroves**: The hardest of the three main varieties of mangrove plants, they are seen growing along coasts.

(b) **Black mangroves**: Mangroves known as "black" ones get their name from their dark bark. Usually, they grow higher than red mangroves. Because their roots are more exposed, they can get more oxygen.

(c) **White mangroves:** Compared to red and black mangroves, they grow at greater elevations. They typically lack aerial roots. However, when oxygen levels are low due to flooding, peg roots can occasionally grow in an unusual way.

Types of Roots

The mangrove roots have the ability to survive in waterlogged and anoxic soil, and to tolerate brackish water with the adaptations.

(a) Prop Roots: Extend from the trunk or branches

Table 2. Distribution of Mangrove Forest in India

Sl. No	State/UT	Very Dense Mangrove	Dense Mangrove	Open Mangrove	Total Mangrove Area
1	Andhra Pradesh	0.00	213.00	191.00	404.00
2	Goa	000	20.00	6.00	26.00
3	Gujarat	0.00	169.00	1008.00	1177.00
4	Karnataka	0.00	2.00	8.00	10.00
5	Kerala	0.00	5.00	4.00	9.00
6	Maharashtra	0.00	88.00	232.00	320.00
7	Odisha	81.00	94.00	76.00	251.00
8	Tamil Nadu	1.00	27.00	17.00	45.00
9	West Bengal	996.00	692.00	424.00	2112.00
10	Andaman and Nicobar Islands	398.00	169.00	49.00	616.00
11	Daman and Diu	0.00	0.00	3.00	3.00
12	Puducherry	0.00	0.00	2.00	2.00
Total	* the area given are in sq km	1476.00	1479.00	2020.00	4975.00

vertically downwards into the soil, supplying stability and anchorage inside the muddy substrate.

(b) **Stilt Roots**: Arise from decreased parts of the trunk or branches and increase diagonally downwards and outwards, supplying extra guidance in risky soils and for the duration of tidal movements.

(c) **Pneumatophores:** Vertical extensions of the foundation device that emerge above the soil floor and facilitate gasoline alternate, permitting the mangroves to continue to exist in waterlogged, anaerobic sediments.

(d) **Cable Roots**: Horizontal roots that run along the soil surface, aiding in erosion manipulation and **sediment stabilization, preventing** the lack of coastal land.

(e) **Feeder Roots**: Fine, hair-like roots that take in vitamins and water from the soil, crucial for the increase and sustenance of the mangrove timber.

Conditions for Mangrove Thriving in Indian Coastal-Survival Essentials

There are certain environmental conditions for mangrove to grow and prosper. They are listed below:

(a) **Salinity Tolerance:** Mangroves are uniquely adapted to thrive in saline environments, with some species tolerating salt stages of as much as 90-1000 (ppt), which is drastically higher than seawater (around 35 ppt). For instance, the crimson mangrove (Rhizophora mangle) can alter its internal salt degrees by way of actively accepting salt at the foundation degree, permitting it to live on in extraordinarily saline situations.

(b) **Brackish Water:** This brackish water, with a salinity variety of approximately 5 to 25 ppt, presents the proper balance for mangrove boom. In regions with High salinity levels, mangroves can shape giant forests along coastlines, which include the Sundarbans in Bangladesh and India.

(c) **Silt Deposition:** Mangroves rely on sediment deposition for their growth and balance. Sediments carried via rivers and tidal currents acquire round mangrove roots, supplying important vitamins and supporting root anchorage. Studies have proven that mangrove forests can acquire sediment at quotes exceeding 1 cm in keeping within 12 months, contributing to soil formation and atmosphere resilience.

(d) **Adequate Oxygen:** Mangroves have evolved particular diversifications to cope with waterlogged soils and low oxygen degrees. Specialized systems like pneumatophores, which are aerial roots that extend above the waterline, facilitate oxygen trade, allowing mangrove roots to get entry to oxygen.

(e) **Warm Temperatures:** Mangroves are predominantly found in tropical and subtropical areas, in which temperatures continue to be warm all through the year. The most desirable temperature range for mangrove increase is between 20°C and 35°C. Frost species, consisting of Avicennia and Rhizophora, are confined to frost-frost-lose coastal regions, limiting their distribution in colder areas.

(f) **Sufficient Sunlight:** Mangroves require adequate daylight for photosynthesis, which is essential for his or her increase and productivity. While mangrove canopies offer color, gaps inside the cover permit sunlight to attain the wooded area floor, assisting the growth of understory flowers and presenting a habitat for diverse species.

(g) **Adaptations to Flooding:** Mangroves have advanced various adaptations to cope with tidal flooding and waterlogging. Species like Rhizophora and Avicennia have pneumatophores that facilitate air exchange, even as others, like Sonneratia and Bruguiera, develop knee-like structures or aerial roots to aid the tree and keep stability in saturated soils.

Benefits of Protection and Growing Mangroves Forest

Mangrove ecosystems are dense forests along the tidal estuaries and comprise incredible biological diversity. Mangrove trees are salt tolerant and survive in muddy anaerobic soils by the presence of pneumatophores (breathing roots). Mangroves have crucial ecological and economic importance. They carry out the source and sink in the carbon cycle, and protect the coasts from floods, tsunamis and other disasters. Some of the uses of Mangroves are listed below.

1. Prevention from soil erosion and stabilization of coasts and beaches
2. Protection of land from tidal surges and cyclonic storms.
3. Aqua culture.

4. Provides fuel wood, green manure, charcoal, timber, etc
5. Used for boat / canoe making
6. Provides tannin.
7. Used for thatching material, cordage and rope material
8. Used for art and craft, bow making
9. Used as food and beverage
10. Widely used for medicinal purposes.
11. Useful for bee hives and provides wax and honey.
12. Useful for recreational purpose as eco-tourism
13. Provides an excellent home to birds and animals.

Mangrove leaves and bark are potential sources of pharmaceutical compounds to treat AIDS, jaundice and cancer. (Mishra, 2023). Mangroves are good for the environment, and they could bring in dollars too. That's because each tonne of carbo dioxide they suck out of the air earns one 'carbon credit', and. These credits sell in the international voluntary market for $5-12 each. In fact, mangroves generate about 50 carbon credits per hectare, far more than the 5-15 credits per hectare from agricultural activity, and 20-30 from terrestrial afforestation. So, increasing India's mangrove cover makes sense (Das P, 2023).

Mangroves in Goa

Goa houses 16 mangrove species (Sawant, 2021) and it has one of the best mangrove forests in the country. There are seven estuaries fringed with mangroves along the Goa coast. There exist an intricate network of creeks and backwaters Chorao Island in Mandovi river is one of the best mangrove forests and houses most of the species found in Goa. The Species wise description of mangroves found in Goa

(a) ***Rhizophora mucronata:*** It is a moderate sized tree, much branched, very rough bark, leaves elliptic, broad, opposite, pale beneath with black dots, flowers yellowish white, four petals, radicle slender, elongated, 15 to 40 cms. long, flowering and fruiting takes place in between December to Mid-June Locally known as Kandal, it is available in plenty in the high salinity areas in all the estuaries.

(b) ***Rhizophora apiculata:*** It is a moderate sized much branched tree with rough bark, leaves elliptic, lanceolate, dark green above, base tapering, pink petioled, clustered towards end of branches, infloroscence 3-4 times forked, 4-8 flowered, flowers white, radicle thick, short and cylindrical, upto 30 cms. in length. Flowering and fruiting take place in between December to May. It is seen mainly in between R. mucronata trees, which is dominant species. The species is found occasionally here and there and its total occurrence is quite less in Goa.

(c) ***Bruguiera gymnorrhiza:*** It is a straight stemmed, buttressed tall tree, upto 30m. in height, dark coloured, fissured bark, leaves elliptic, pointed, pale beneath, crowded at branchlet end, flowers solitary, petals bifid with hairs at the base, calyx red to bright red, radicle 15-20 cms. long, faintly ribbed, alike ladyfinger. Flowering and fruiting take place in between November to April. It is found in low salinity areas and can be seen in the interior areas of the State. The tree has a conical shape and is seen mainly in Zuari and Chapora rivers.

(d) ***Bruguiera cylindrica:*** It is a medium to tall buttressed tree with smooth grey bark, leaves oblanceolate, thin, elliptic, flowers white to greenish, radicle 10-15 cms., short. Flowering and fruiting takes place in between the months of November to April. The species is observed in most of the river estuaries of the State and smaller size trees only are seen. It does not form a colony and is seen scattered here and there.

(e) ***Ceriops tagal:*** It is a small, 1to 2 m. tall straight stemmed tree or shrub forming buttress. Stem has lot of lenticels, leaves simple, opposite narrowed downwards, collected at branchlet end, flowers white, small and in cyma inflorescences. The species is localized to Terekhol river only and also planted in Chapora river. Flowering and fruiting takes place in between January to April.

(f) ***Kandelia candel (K. rheedi):*** It is a small, 5-6 tall tree with smooth reddish bark, leaves dark green, polished above, shortly petioled, elliptic, flowers white, radicle 30-40 cm. long and slender. Distributed in all estuaries of Goa. Flowering and fruiting take place two times in a year, prominently from December to April and also from September to December.

(g) ***Avicennia officinalis:*** A tree with smooth yellowish grey bark, low branching, leaves very fine, silvery white, tomentose beneath. Flowers yellow, collected in small clusters, capsule velvety, compressed, obviate and pointed. It is found in all estuaries and make colonies. Pro-

fuse seedings and regeneration is observed. Flowering and fruiting takes place in between March to August.

(h) ***Avicennia marina:*** It is known as "White mangrove" due to its white bark, leaves opposite, shortly petioled, glossy green on upper side & dull grey or silvery white tomentose hair on lower side, flowers yellow or white, fruit a compressed capsule. Found in all estuaries and make colonies. Flowering and fruiting takes place in between March to August. Profuse seedings & regeneration is observed.

(i) ***Sonneratia alba:*** It is much branched moderate size tree, bark orange brown / grey, branches silvery grey, swollen, leaves leathery, opposite, elliptic, thickened, flowers solitary or in threes, white, pale green, fruit about 3 cms. dome shaped. It is available in plenty in higher salinity areas. Profuse regeneration forming pure patches is observed. Flowering and fruiting take place twice in a year, from January to April and September to December.

(j) ***Acrostichum aureum:*** It is erect fern, attaining height upto 1.5m having small bushy appearance, fibrous typical fern like roots but without any aerial roots. Pinnate leaves with a terminal leaflet.

(k) ***Sonneratia caseolaris:*** It is a moderate sized tree, brown rough bark, leaves 5-10 cms. long, broadly obvate, flowers tinged with rose colour, fruit fleshy, cushion shaped. It is found in low salinity areas, on the higher reaches of the rivers. Flowering and fruiting take place twice in a year, from January to April and September to December. Fine patches showing excellent growth are seen at many places, particularly along Zuari river, in Khazan land in Borim and Shiroda.

(l) ***Aegiceras corniculatum:*** It is a small shrubby tree, bark brown with reddish tinge, leaves alternate, elliptic, flowers white, in umbels, fruit cylindrical, curved, very small. Available in plenty in low salinity areas. Flowering and fruiting take place in between February to April.

(m) ***Excoecaria agallocha:*** It is a much-branched tree, up to 5 m high. Bark greyish, leaves pale green, alternate, elliptic, produce latex which is poisonous and dangerous to eyes. Flowers dioecious, arranged in sessile axillary catkins. Male and female plants found separately with distinct characters. Found in all the estuaries and is a common species in Goa.

(n) ***Acanthus illici folius:*** It is a shrub, up to 2 m high, aerial root formation is seen. Leaves glabrous, decussate with pair of spines. Flowers light blue to violet. Fruit 2-3 cms. long. It is found in abundance in all the estuaries. Flowering and fruiting take place in between February to April.

(o) ***Lumnitzera racemosa:*** A small tree up to 10 m. high. Bark grey and fissured. Pneumatophores are thin, knee shaped. Leaves small, fleshy, oval, clustered towards end of branches Flowers white. Fruit hard, ovoid. Flowering and fruiting in between March to September. Localised to Siolim area, along the bunds.

(p) ***Derris heterophylla:*** A climber, much branched shrub, evergreen, perennial, tap roots deep sunken and without any aerial growth, compound leaves, 3 to 5 leaflets. Flowering in June to December.

Composition and Configuration of Mangroves of Goa

The composition and configuration of mangrove species in estuaries varies as per the salinity gradient, which varies from the mouth of the river to the rise of river. This gradient decrease as we proceed from the mouth to the upstream of the river. The gradient also varies from day to day due to the high tide-low tide phenomena. The longitudinal and vertical strata is very distinct and it forms a compact mass of canopy from high tide level to the low tide level with varying colour of canopy from pale green, pale yellowish green to dark green and blackish green from high tide level to low tide level. From distance, the varying conglomerate colour gives the clear appearance of species. The size of the propugules of different species plays an important role in establishment of the species in different zones which are formed from high tide level to the low tide level in varying depth of the silt in the substratum. The composition of species as per the salinity gradient in Goa (Department of Forest, Goa, 2024) is presented in Table 3.

Estuary wise composition and configuration of mangrove species

The map of Goa showing various Estuary is presented in Figure 3 (Khotori and Rao, 2022). The eight 8 esturies where mangrove forest occur are

Table 3. The composition of species as per the salinity gradient in Goa

Sr. No.	Species	Salinity gradient	Likely substratum
1.	*Rhizophora mucronata*	6% to 37%	Silt, sand & soil.
2.	*Rhizophora apiculata*	6% to 37%	Silt, Sand & soil
3.	*Bruguiera gymnorrhiza*	6% to 33%	Silt & sand
4.	*Bruguiera cylindrica*	11% to 35%	Silt & more sand
5.	*Ceriops tagal*	10% to 37%	Silty soil
6.	*Kandelia candel*	6% to 26%	Silty soil
7.	*Lumnizera racemosa*	6% to 30%	Silt, sand & silty soil
8.	*Avicennia marina*	6% to 40%	Silt, sand & silty soil
9.	*Avicennia alba*	7% to 35%	Silt.
10.	*Sonneratia alba*	10% to 37%	Silt & sand
11.	*Sonneratia caseolaris*	5% to 22%	Silt
12.	*Aegiceras corniculatum*	11% to 35%	Silt & soil
13.	*Acanthus illicifolius*	11% to 39%	Silt & soil
14.	*Excoecaria agallocha*	9% to 35%	Silt & more soil
15.	*Derris heterophylla*	5% to 30%	Silt & soil
16.	*Acrosticum aurum*	0% to 20%	Silt & soil

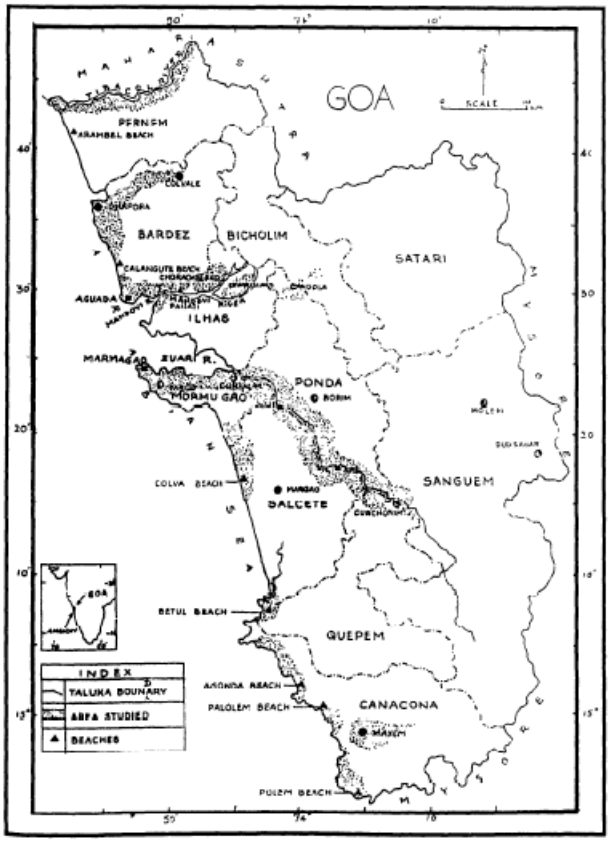

Fig. 3. The map of Goa showing various Estuary

Mandovi, Zuari, Chapora, Terakhol, Sal, Talpona, Galgibag, Kumbharjua Canal

The Mandovi, Zuari and Kumbhargua Cnal being the three hotspots for Mangroves forest. The estuary wise composition of mangrove species in these three main river estuaries in Goa are given in Table 4.

The mangrove forest of Goa also has associated plants such as *Derris heterophylla Clerodendron inermi, Acrostichum aureum, Cyperus spp., Porteresia coaretata, Ceasalpinia crista, Salvadora persica, Halophila beccarii, Lannea grandis, Abrus precatorius, Thespesia populnea*

Protection, Conservation and Development of Mangroves in Goa

The unregulated urban development, increased pollution, altered distribution and national highway expansion, bridges and increased tourism has resulted in the most destructive impact on mangrove forest. In the present study, a field survey of mangrove sites in Goa like the areas of Cortalim, Ribandar, Old Goa, etc. has conducted to observe the mangrove morphology, and growing pattern and analyse the impact of urbanization on declining mangrove health. Further, a survey was conducted to track public awareness about the declining mangrove ecosystem. The individuals were divided into four different categories and five questions were asked including whether they are aware of mangroves, their occurrence, their decline, and measures to protect them. Results suggest that most people are aware of declining mangroves but haven't experienced mangrove declines in their locality. Most people suggest that creating awareness, building mangrove farms and implementing strict rules can help in conserving mangroves. To preserve India's mangrove forests, both the national and interna-

Table 4. Estuary wise composition and configuration of mangrove species in Goa

Estuary/Broad area	Specific Location	Type and percentage of Mangroves
Mondovi (Mapusa side)	Betim Fisheries Jetty & near Mandovi Bridge	*Sonneratia alba* - 90%; *Rhizophora mucronata & Avicennia alba* - 10%.
	Penha De Franca (Britona):	*Avecenia alba & Avicennia officinalis* - 90%; *Acanthus illicifolius & Deris heterophylla* - 10%.
	Salvador do Mundo & Pomburpha	*Avicennia officinalis & Avicennia alba* - 80%; *Rhizophora mucronata & Kandelia candel* - 20%.
	Moira & Aldona	*Avicennia alba* - 60%; *Kandelia candel* - 10% *Acrosticum aurum & Acanthus illicifolius* - 10%.
	Mapusa & Peddem	*Avicennia alba* - 60%; *Kandelia rheedii* - 10%; *Acrosticum aurum & Acanthus illicifolius* - 30%.
Mondovi Estuary (Diwar Naroa side)	Vanshi	*Avicennia officinalis* - 40%; *Bruguiera cylindrica* - 30%; *Porterasia coaretata* - 20%; & *Acanthus illicifolius* - 10%.
	Naroa & around	*Avicennia officinalius* - 80%; *Porterasia coaretata* - 10%; and *Acanthus illicifolius* - 10%.
Mondovi Estuary (Old Goa Side):	Piedade & Old Goa	*Avicennia officinalis* - 30%; *Sonneratia alba* - 30%; and *Porterasia coaretata* -
	Panaji, Patto & Ribandar	
	Old Goa & Dhauji	*Avicennia officinalis and Avicennia a alba* - 80%; *Sonneratia alba* - 15%; and *Acanthus illicifolius* - 5%.
	Khandola, Amona, Tonca	*Sonneratia caseolaris* - 80%; and *Acanthus illicifolius & Aegiceras corniculatum* - 20%.
Mondovi Estuary (Chorao area)	Wildlife Sanctuar	*Avicennia officinalis & Avicennia alba* - 40%; *Sonneratia alba* - 10%; *Rhizophora mucronata & Rhizophora apiculata* - 15%; *Acanthus illicifolius* - 3%; *Aegiceras corniculatum* - 2%; *Kandelia candel* - 5%; *Bruguiera cylindrica* - 1%; *Excoecaria agallocha* - 20%; and *Derris heterophylla* - 4%.
Zuari Estuary (Cortalim side)	Cortalim:	*Avicennia officinalis & Avicennia alba* - 40%; *Acanthus illicifolius & Aegiceras corniculatum* - 40%; and *Excoecaria agallocha* - 20%.
	Lotolim & Rai	*Avicennia officinalis & Avicennia alba* - 50%; *Sonneratia alba* - 20%; and *Excoecaria agallocha & Acanthus illicifolius* - 30%.
	Borim, Sanvordem	*Avicennia officinalis & Avicennia alba* - 40%; *Sonneratia caseolaris* - 40%; and *Acanthus illicifolius & Acrosticum aurum* - 20%.
Zuari Estuary (Agaciam side)	Agacaim & Madkai	*Avicennia officinalis & Avicennia alba* - 60%; *Rhizophora mucronata & Rhizophora apiculata* - 20%; and *Bruguiera gymnorrhiza* - 20%.
	Durbhat & Borim	*Avicennia officinalis & Avicennia alba* - 60%; *Rhizophora mucronata & Bruguiera gymnorrhiza* - 20%; and *Acanthus illicifolius* - 40%.
	Panchwadi, Shrioda	*Avicennia alba* - 40%; *Sonneratia caseolaris* - 20%; *Kandelia candel, Acanthus illicifolius & Acrosticum aurum* - 40%.
Kumbharjua Canal:	The prominent species are: *Avicennia officinalis & Avicennia alba* - 60%; *Rhizophora mucronata & Rhizophora apiculata* - 30%; and *Acanthus illicifolius & Derris heterophylla* - 10%.	
Note:	The canal joins two major estuaries i.e., Mandovi and Zuari and bears good mangrove areas, which hosts number of estuarine crocodiles and encourages Eco - Tourism. These mangroves there protects the bunds, which prevents the entry of blackish water into the khazan lands.	
Note:	In the west coast, *Kandelia candel* is rare, but it is very prominent and abundant in Mapusa river in Goa in between Pomburpa to Mapusa, Peddem - Goa. Note: - *Sonneratia caseolaris* is very prominent and dense in Panchawadi, Shrioda areas which is due to the low salinity.	

tional governments have launched a number of programs.

(a) The Indian Constitution was amended in 1976 to include a new section called "Fundamental Duties," which said that it was the responsibility of all Indian citizens to preserve and enhance the country's natural resources, such as its forests, lakes, rivers, and animals.
(b) The National Mangrove Committee was established by the Indian government to provide guidance on the preservation and advancement of mangroves.
(c) Mangrove forests in India are included in the National Forest Policy of 1988 as a priority area for forestry research, with the goal of effectively conserving and managing these natural forest ecosystems.
(d) Plants and animals are protected by the Wildlife Protection Act of 1972 and the Indian Forest Act of 1927. They do not, however, particularly address mangroves; instead, they can be applied to the preservation of India's mangrove forests' ecology and biodiversity.
(e) The Ramsar Convention protects several mangrove sites worldwide, including those in India.

Government, Citizens, media, Social and Environmental groups and educationalist and education institutes of Goa are active not only protecting and preserving mangroves forest in Goa but are also attempting to develop them. However the development activity in coastal zone are making mangrove forest vulnerable (Deshpande and Kerkar, 2023). Ministry of Environment and Forest, Government of India enacted the Costal Regulation Zone (CRZ) notification issued under Environment Protection Act of 1986, which was notified through Gazette in 1991. Through this act, the coastal stretches of seas, bays, estuaries, creeks, rivers and back waters which are influenced by tidal action (in the landward side) upto 500 meters from the High Tide Line (HTL) and the land between Low Tide Line (LTL) and the HTL are declared as coastal regulation zone and imposed restrictions on setting up and expansion of Industries, operations or processes etc in the said Coastal Regulation Zone (CRZ). For the purposes of the notification the High Tide Line. Although Goa Coastal Zone Management authority (Goa-CZMA) is regulating developments in coastal areas, however it still needs to do a lot as frequent changes in regional and development plans are making it more vulnerable. As can be observed from data (Deshpande and Kerkar, 2023) that mangrove cover in two major estuaries that is Mandovi and Zuari within 100 m of CRZ zoe reduced fom 6.66 sq k to 3.90 sq k and 6.70 sq km to 4.50 sq km during period of 1991 to 2018. According to a survey study (Mishra, 2023) citizens of Goa are aware and they feel that creating more awareness and building the concept of mangrove farming will be helpful. Sawant, 2021 carried out elaborate study of mangroves identifying threats and recommended various measures for conservation and management of mangrove forests.

Although recent data is encouraging as from total mangrove cover in 2021 is observed to be 4992 sq km (ISFR, 2021) which was 4975 sq km in 2019 (ISFR, 2019). This is about 0.34% increase. During the same period mangrove forest in Goa increased by just 1 sq km that is from 53 sq km to 54 sq km making it an increase of just 1.89%. Although nationwide and or Goa the increase in mangrove cover is very noinal, it indicates a trend that at least destruction of mangrove forest has been arrested and conservation efforts are in right direction. However ow there is a need to further positive steps of development such as increasing the mangrove cover.

Conclusion

Mangroves are coastal plants spread over sea cost of tidal zones or backwaters particularly in tropical and sub-tropical climate regions. This paper presents an over view on mangroves and Conservation, Restoration and Development of Mangrove Forest in Goa. The major conclusions of the study are

(i) Mangroves forest are very important biodiversity and not only needs protection and restoration but also development.
(ii) United Nations Environment Programme has created great awareness at international and national level in Conservation, Restoration and Development of Mangrove Forests.
(iii) Government of India and various state Governments including Government of Goa are also taking various initiatives for Conservation, Restoration and Development of Mangrove Forests.
(iv) The Indian State Forest Report 2019 and 2021 clearly indicate a nominal increasing in mangrove cover and national level as well in State of Goa, although increase is nominal it clearly proves that the initiatives are paying positively and at least destruction of mangrove forest has

been arrested.

(v) Mangroves are champions at sucking out Carbon Dioxide from Air and with treading of carbon credit internationally each tonne Carbon Dioxide removed is worth a few dollars. With this aspect also added there is bright future for further development of mangrove forests.

Conflict of interest: None

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