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Biodiversity and Importance of Mangrove Ecosystem

M. S. Swaminathan Research Foundation

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“Mangroves provide coastal communities with a wide range of benefits, and we should be grateful to nature for providing us with this wonderful gift”.

Prof. M S Swaminathan, Founder Chairman,
M S Swaminathan Research Foundation, Chennai

“Nature provides for everybody's need, but not for everyone's greed”

Mahatma Gandhi

Mangrove wetlands

The mangrove forest refers to the group of plants present in the sheltered coastlines of tropical and subtropical intertidal coastal zones.

Types of Mangroves



Mangroves are classified into : 1. True mangroves and 2. Associate mangroves

1.True mangroves

- True mangroves have morphological and physiological adaptations to thrive in the saline environment.
- Few mangroves have salt exclusion mechanism.

2. Mangrove associates

- Mangrove associates are the flora representing in adjoining the tidal periphery of mangrove habitats.
- Mangrove associates do not have the special adaptation characteristics that the true mangroves have.

Worldwide distribution of mangroves

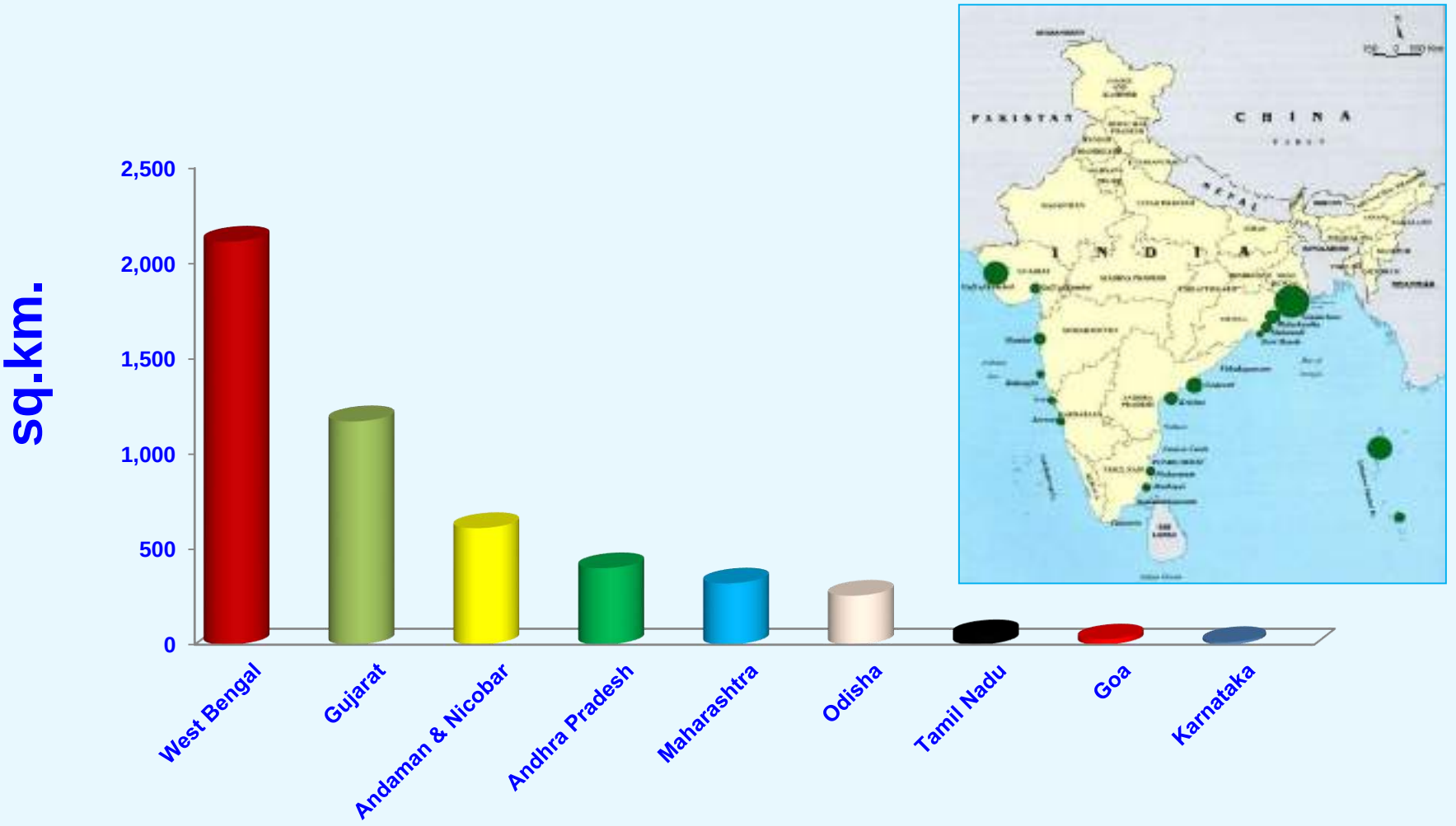
Map Source: https://scienceworld.scholastic.com/issues/2018-19/100818/mapping-mangroves.html#1120L
Source: The state of the world mangroves 2021. Pp.41.

Mangroves are found in the tropical and sub-tropical areas i.e., between 25°N and 25°S latitude. The greatest mangrove species diversity exists in South East Asia. India has about 3% of the total mangrove cover in the world. Mangrove diversity indicates that there are 24-29 families and 54-75 species worldwide.

Extent of the mangroves in Asia

Country	Area (ha)
Bangladesh	6,00,386
Cuba	4,21,538
India	4,97,500
Indonesia	45,42,100
Malaysia	6,42,400
Myanmar	4,94,584
Pakistan	4,11,487
Sri Lanka	21,437
Thailand	2,64,100
The Philippines	2,63,137
Total	81,58,669

Distribution of mangroves in India



The Sundarban Mangroves in West Bengal and Bhitarkanika Mangroves in Odisha are rich in diversity. The Sundarban mangroves (India and Bangladesh combined) is the largest mangrove wetland in the world.

Mangrove Cover in India (sq km)

S.No	Name of the State	Assessment Year																	
		1987	1989	1991	1993	1995	1997	1999	2001	2003	2005	2007	2009	2011	2013	2015	2017	2019	2021
1	Andhra Pradesh	495	405	399	378	383	383	397	333	329	354	353	353	352	352	367	404	404	405
2	Goa	0	3	3	3	3	5	5	5	19	16	17	17	22	22	26	26	26	27
3	Gujarat	427	412	397	419	689	901	911	911	916	991	1046	1046	1058	1103	1107	1140	1177	1175
4	Karnataka	0	0	0	0	2	3	2	2	3	3	3	3	3	3	3	10	10	13
5	Kerala	0	0	0	0	0	0	0	0	8	5	5	5	6	6	9	9	9	9
6	Maharashtra	140	114	113	155	155	124	118	118	158	186	186	186	186	186	222	304	320	324
7	Odisha	199	192	195	195	195	211	219	219	203	217	221	221	222	213	231	243	251	259
8	Tamil Nadu	23	47	47	21	21	21	23	23	35	36	39	39	39	39	47	49	45	45
9	West Bengal	2076	2109	2119	2119	2119	2123	2125	2081	2120	2136	2152	2152	2155	2097	2106	2114	2112	2114
10	Andaman and Nicobar Islands	686	973	971	966	966	966	966	789	658	635	615	615	617	604	617	617	616	616
11	Daman and Diu	0	0	0	0	0	0	0	0	1	1	1	1	2	1	3	3	3	3
12	Puducherry	0	0	0	0	0	0	0	1	1	1	1	1	1	1.63	2	2	2	2
Total		4046	4255	4244	4256	4583	4737	4871	4482	4448	4581	4639	4639	4663	4628	4740	4921	4975	4992

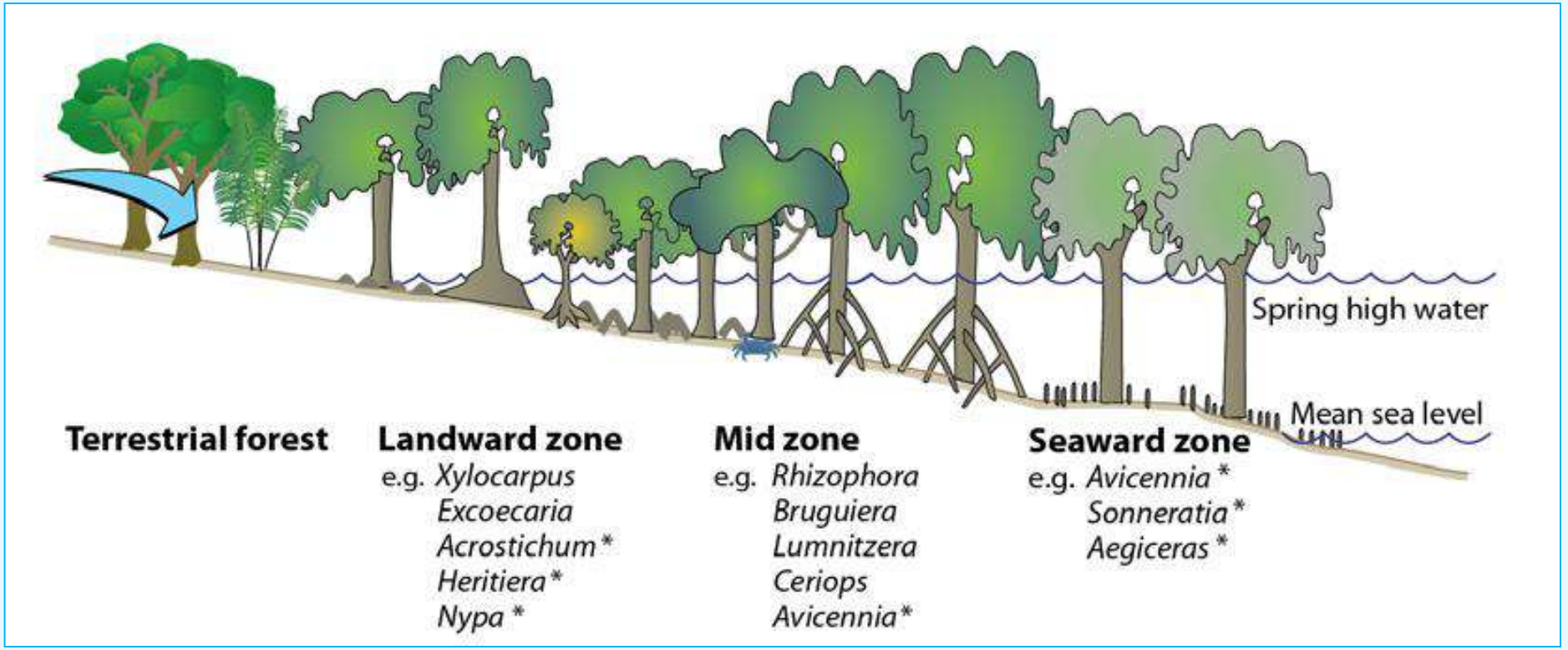
Source: Forest Survey India, 2021 https://fsi.nic.in/forest-report-2021-details

Factors for the increase in mangroves cover – Restoration and natural regeneration; Reduction in dependency for domestic needs including fodder and Grazing; Awareness among the community

Mangrove species diversity in India

The Indian mangroves are comprised of 59 species belonging to 41 genera and 29 families. Of these, 34 species are belonging to 25 genera occur along the west coast. As many as 48 species are belonging to 32 genera occur along the east coast.

Species zonation in mangrove wetland



Source: Waycott et al., 2011. Vulnerability of mangroves, seagrasses and intertidal flats in the tropical Pacific to climate change. Book Chapter 6.pp79.

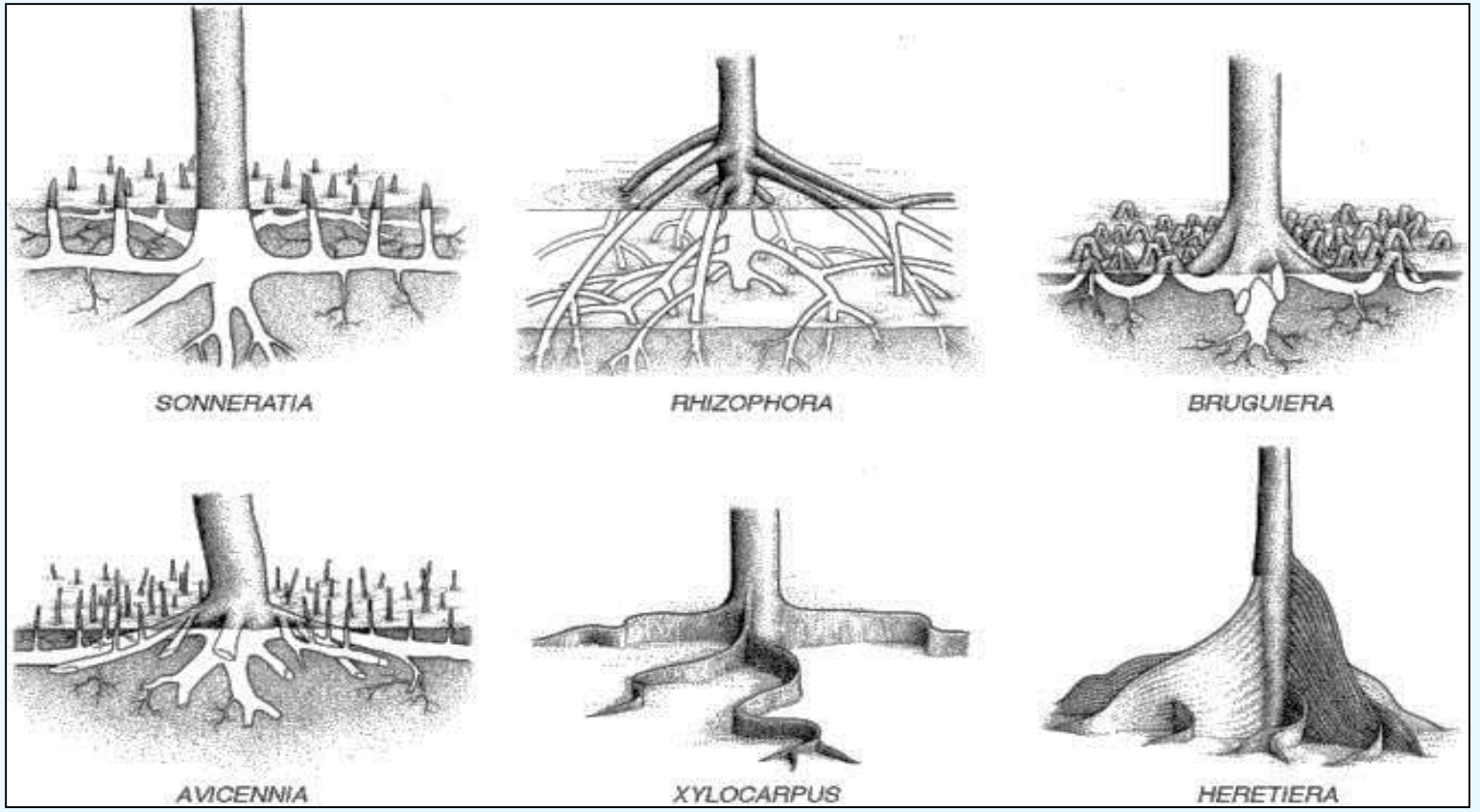
Adaptations in Mangrove plants

Mangroves have specialized adaptation to survive in the extreme conditions of the coastal environment.

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

- Stilt Roots
- Pneumatophores
- Salt Excretory Glands
- Salt Excluding Roots
- Viviparous seeds

Adaptations in Roots



Source: Göltenboth and Schoppe, 2006, Mangroves. https://www.sciencedirect.com/topics/earth-and-planetary-sciences/mangrove

The root system is modified as prop roots, stilt roots, pneumatophores, knee roots, spreading root and buttress roots. These root systems give not only mechanical support but provide oxygen to the root system as well as excluding salt.

Mangroves in land building process

- Mangroves have diverse types of roots which are specially adapted to soil binding.
- Well developed root systems penetrate the soil system and bind compactly with soil particles.
- Plants like *Avicennia* and *Heritiera* growing in marshy places and saline lands, develop pneumatophores from underground roots which rise vertically upwards above the ground to prevent soil erosion.

Adaptation in leaves

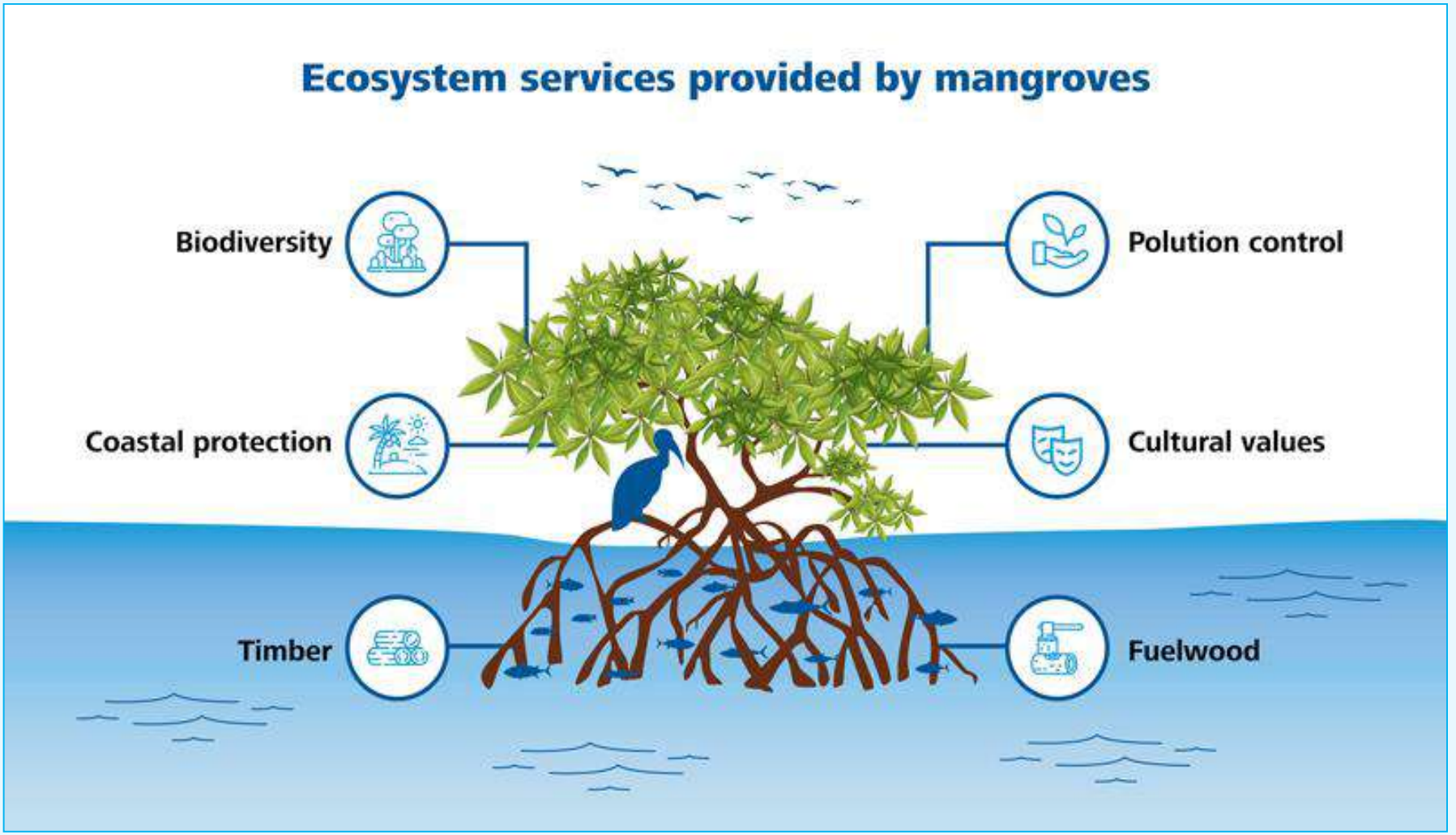


Few mangroves have salt glands in the leaves to excrete salts and few others have xerophytic characteristics such as leathery leaves, hairy surfaces, wax coating to reduce water loss through evapotranspiration.

Reproductive adaptation

Few mangroves species have viviparous seeds. The seeds germinate into propagules in the trees before falling down. The propagules dispersed with the tides and water currents to the surrounding shorelines.

Importance of Mangroves

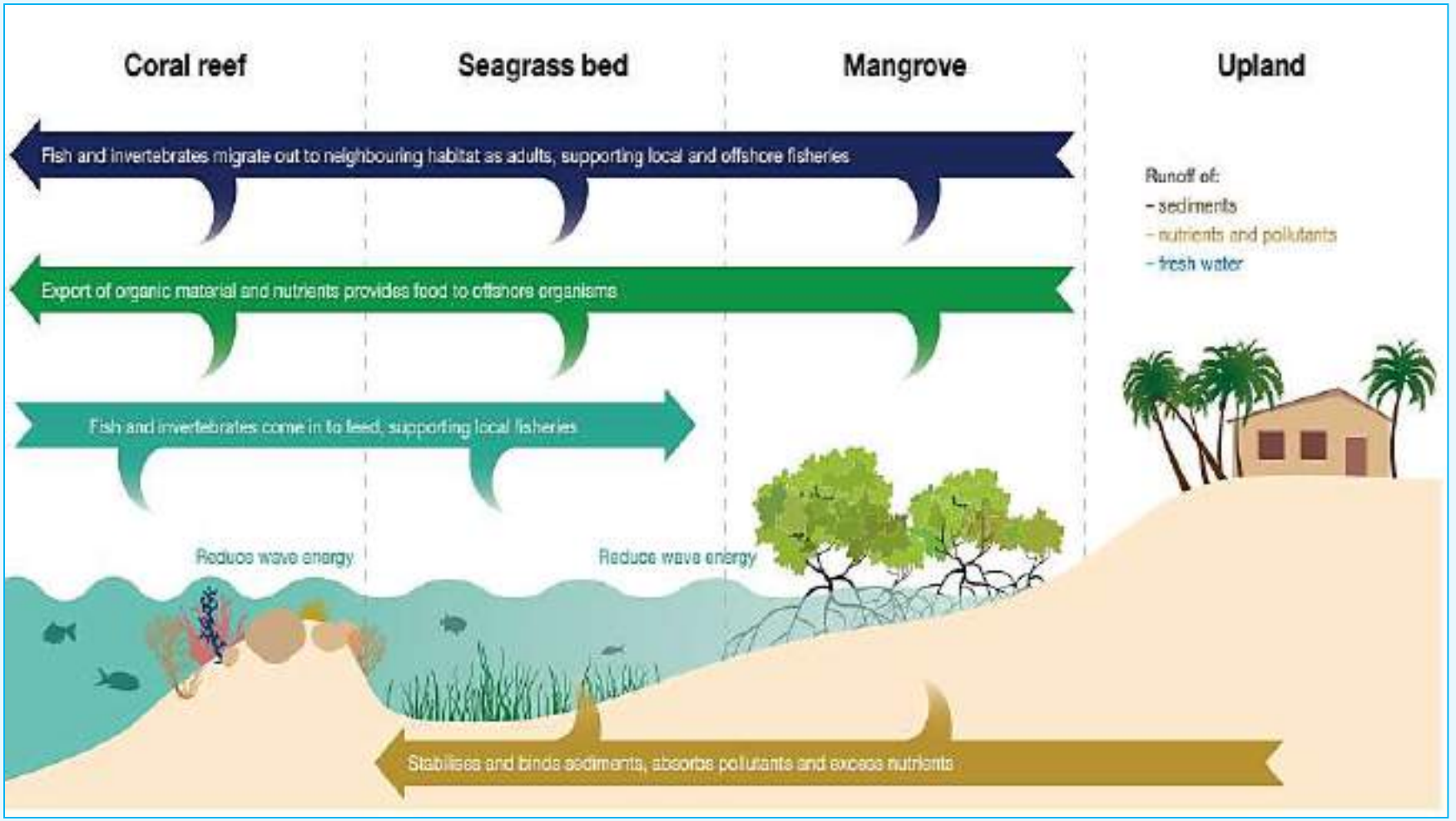


Source: https://www.southpole.com/

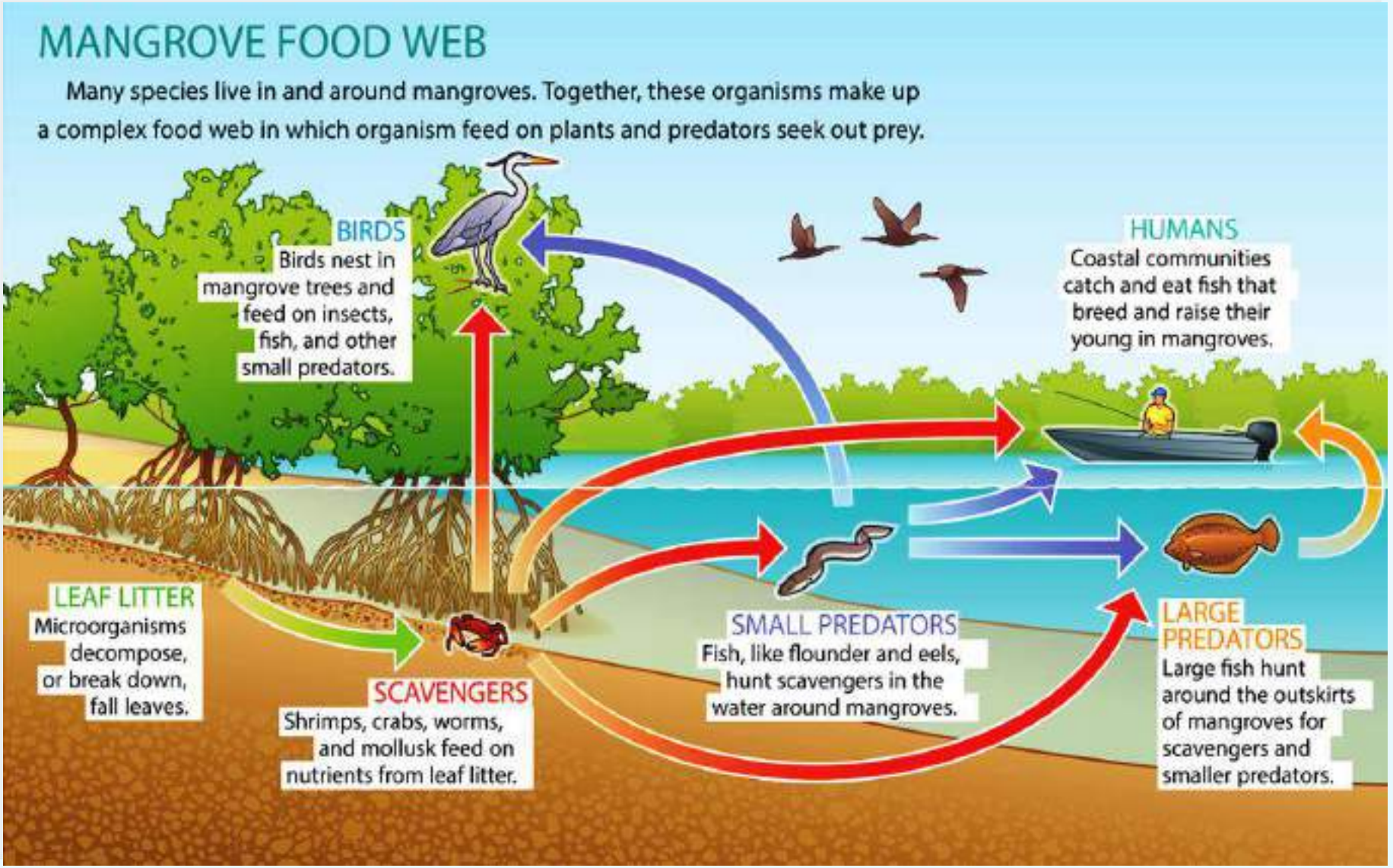
Ecosystem services of mangrove

Source: https://programs.wcs.org/india/Newsroom/News/ID/14509/Cyclone-Amphan-Reminds-Us-Why-

Mangrove is an interconnectivity between coastal ecosystems



Source: UNEP (2014). The Importance of Mangroves to People: A Call to Action. van Bochove, J., Sullivan, E., Nakamura, T. (Eds). United Nations Environment Programme World Conservation Monitoring Centre, Cambridge. 128 pp.

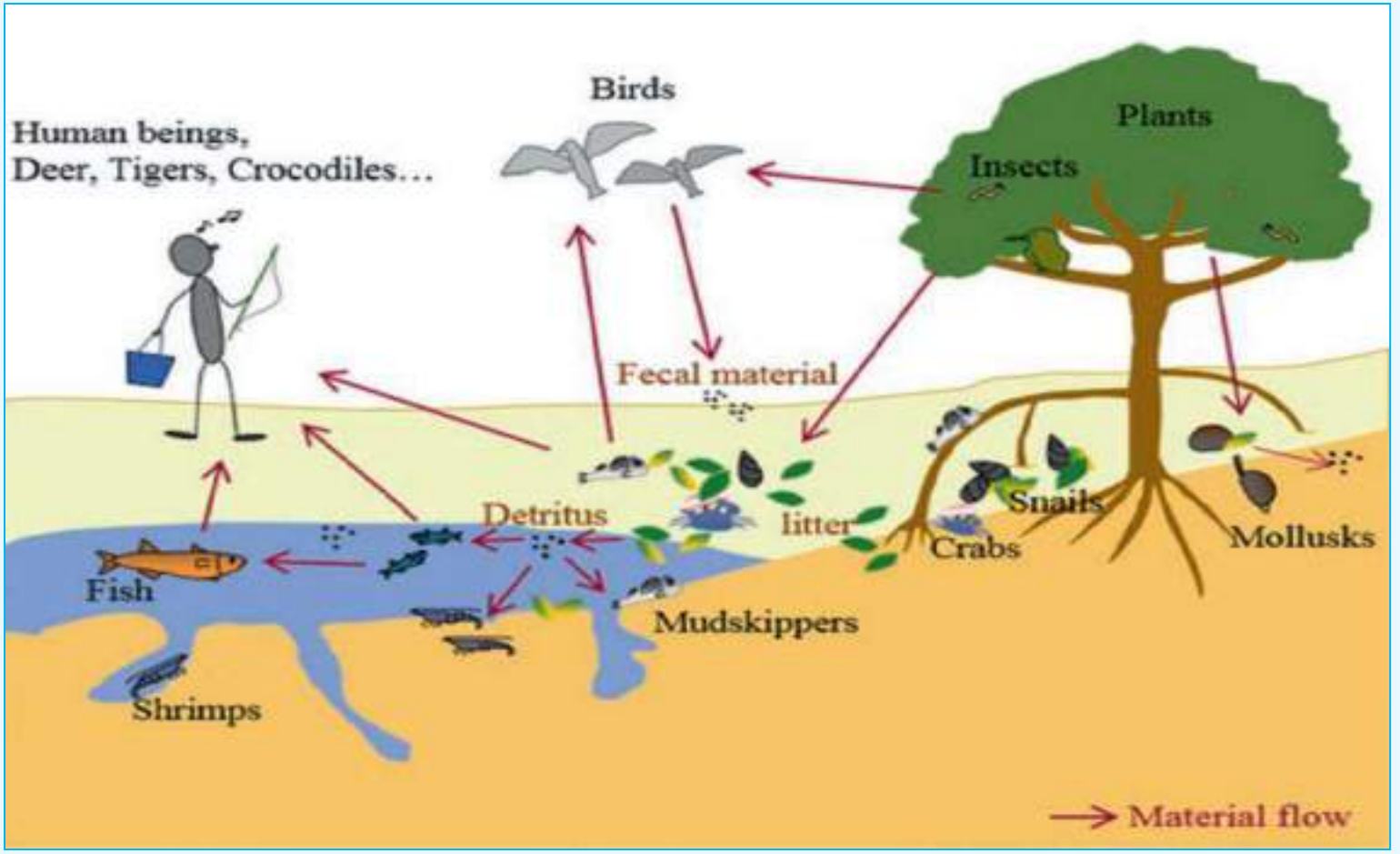


Source: https://www.behance.net/gallery/77657263/Mangrove-Food-Web

Biodiversity in Mangrove Ecosystem

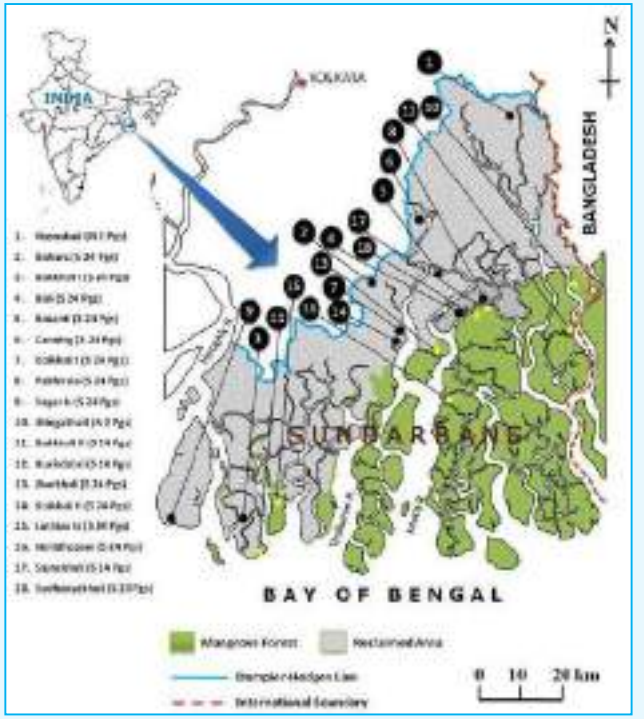
Source: https://www.freepik.com/free-photos-vectors/mangroves

Mangrove Food Chain



Source: Inoue, T. (2019). Carbon Sequestration in Mangroves. In: Kuwae, T., Hori, M. (eds) Blue Carbon in Shallow Coastal Ecosystems. Springer, Singapore. https://doi.org/10.1007/978-981-13-1295-3_3

Mangroves in Sundarbans

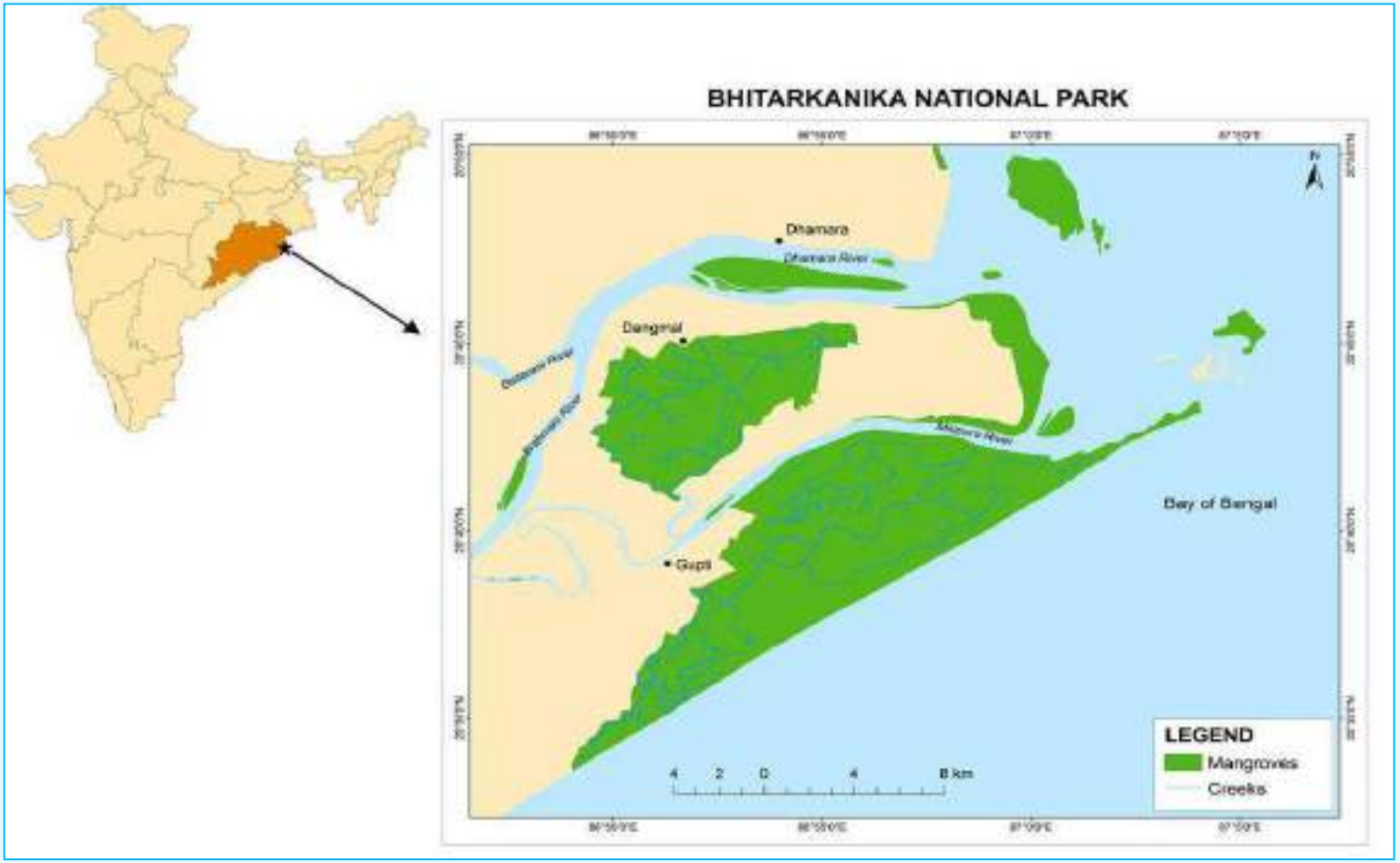


The Sundarbans mangrove covers an area of about 10,000 km^2, of which 4,260 km^2 is in West Bengal (India) and the rest in Bangladesh. The most abundant tree species are *Heritiera fomes* and *Excoecaria agallocha*. Habitat to 453 fauna including 290 bird sps., 120 fish sps., 42 species of mammals, 35 reptiles and 8 amphibian species. 24 true mangrove species have been recorded in Sundarbans.

Mangroves in Sundarbans

Acanthus ilicifolius	*Kandelia candel*
Acrostichum aureum	*Lumnitzera racemosa*
Aegialitis rotundifolia	*Nypa fruticans*
Aegiceras corniculatum	*Phoenix paludosa*
Avicennia alba	*Rhizophora apiculata*
Avicennia marina	*Rhizophora mucronata*
Avicennia officinalis	*Scyphiphora hydrophylacea*
Bruguiera gymnorrhiza	*Sonneratia alba*
Bruguiera cylindrica	*Sonneratia apetala*
Bruguiera sexangula	*Sonneratia caseolaris*
Ceriops decandra	*Sonneratia griffithii*
Ceriops tagal	*Xylocarpus granatum*
Excoecaria agallocha	*Xylocarpus mekongensis*
Heritiera fomes	

Bhitarkanika Mangroves

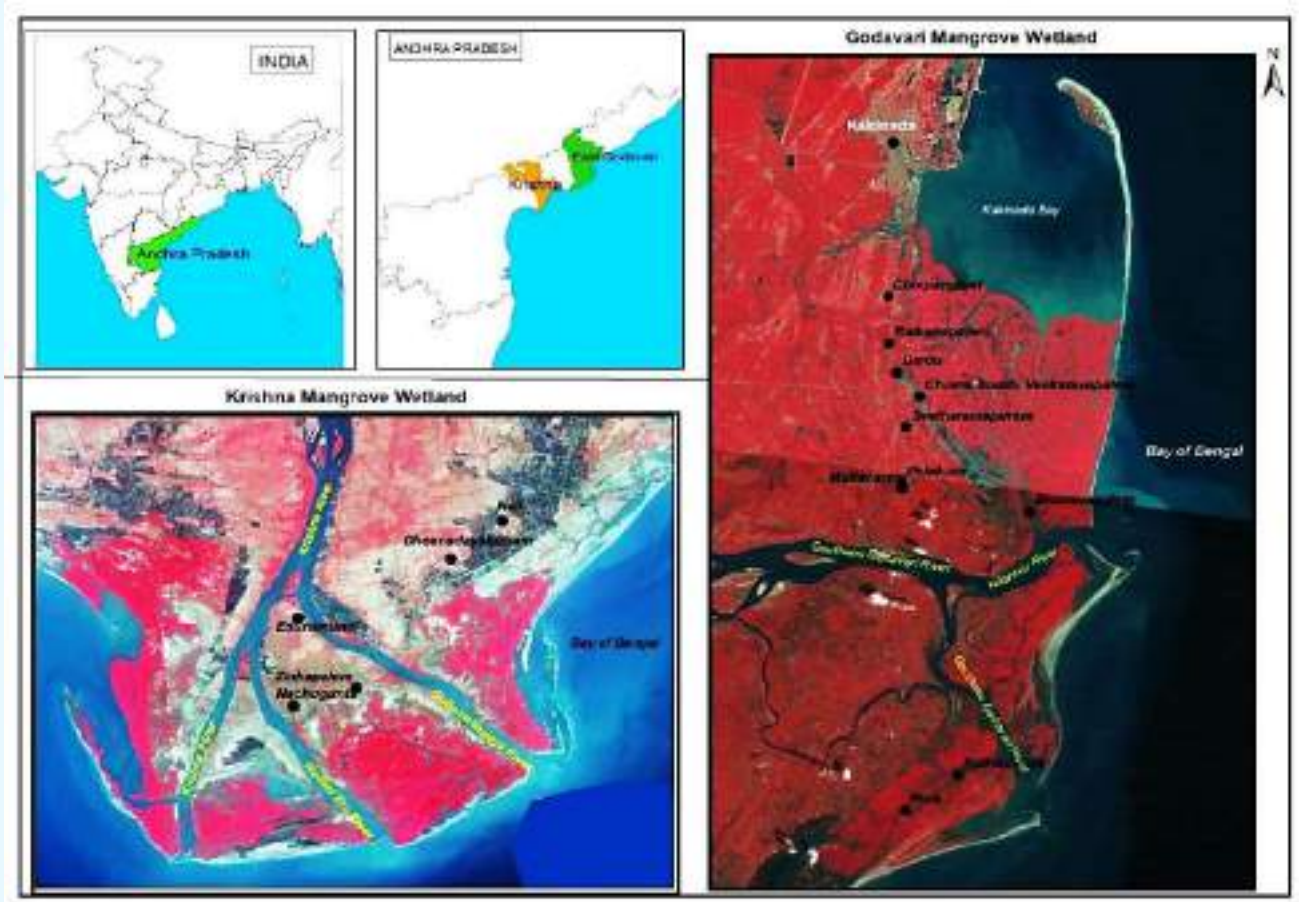


Bhitarkanika wildlife sanctuary in Odisha, has an extent of about 672 sq km in the Brahmani River and Baitarani River deltas. A core area of Bhitarkanika Wildlife Sanctuary comprising of 145 Sq. Kms was declared as a National Park. About 62 mangrove species occur in the Bhitarkanika and the major species are *Avicennia, Bruguiera, Heritiera and Rhizophora.* It is also designated as a Ramsar site.

Mangroves in Bhitarkanika

Acanthus ilicifolius	*Heritiera fomes*
Acanthus volubilis	*Heritiera kanikensis*
Acanthus ebracteatus	*Lumnitzera littorea*
Aegialitis majus	*Lumnitzera racemosa*
Aegialitis rotundifolia	*Nypa fruticans*
Aegiceras corniculatum	*Phoenix paludosa*
Avicennia alba	*Rhizophora apiculata*
Avicennia marina	*Rhizophora mucronata*
Avicennia officinalis	*Rhizophora stylosa*
Bruguiera cylindrica	*Sonneratia apetala*
Bruguiera gymnorhiza	*Sonneratia caseolaris*
Bruguiera parviflora	*Sonneratia griffithii*
Bruguiera sexangula	*Xylocarpus granatum*
Ceriops decandra	*Xylocarpus mekongensis*
Ceriops tagal	*Xylocarpus moluccensis*
Excoecaria agallocha	

Mangroves in Krishna and Godavari wetlands in Andhra Pradesh



The Godavari wetlands is located in the Godavari river delta between 16° 30’ - 17° N and 82° 23’ E in the East Godavari district, Andhra Pradesh. The extent of this wetland is about 33,263 ha The Krishna mangroves are between 15° 42' - 15° 55' N and 80° 42' - 81° 01’E spread across Krishna and Guntur Districts. The extent of mangrove wetland is 24,999.47 ha .

Mangroves in Krishna and Godavari

Acanthus ilicifolius	*Lumnitzera racemosa*
Aegiceras corniculatum	*Rhizophora apiculata*
Avicennia alba	*Rhizophora mucronata*
Avicennia marina	*Scyphiphora hydrophylacea*
Avicennia officinalis	*Sonneratia alba*
Bruguiera cylindrica	*Sonneratia apetala*
Bruguiera gymnorrhiza	*Xylocarpus granatum*
Ceriops decandra	*Xylocarpus moluccensis*
Excoecaria agallocha	

Mangroves in Pichavaram

Pichavaram mangrove is located between Vellar and Coleroon estuaries of the Cauvery delta in Tamil Nadu. The wetland has an extent of about 1400 ha in which the mangrove cover is about 700 ha. There are 12 true mangrove species present in the wetland.

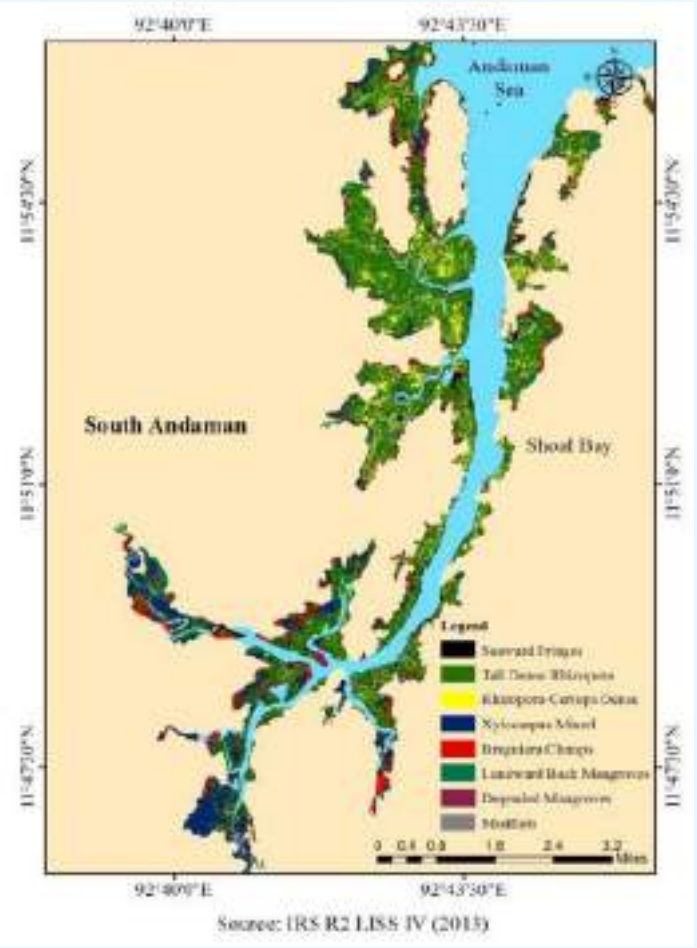
Mangroves in Pichavaram

Acanthus ilicifolius
Aegiceras corniculatum
Avicennia marina
Avicennia officinalis
Bruguiera cylindrica
Ceriops decandra
Excoecaria agallocha
Lumnitzera racemosa
Rhizophora apiculata
Rhizophora mucronata
Rhizophora annamalayana
Xylocarpus mekongensis

Mangroves in Andaman and Nicobar Islands

Andaman and Nicobar islands cover 615 sq.km, mangrove area. The Andaman group of islands has mangroves in 612 sq.km, while the Nicobar group of islands have only 3 sq. km. About 34 true mangrove species are documented. Some important species are

- *Cynometra iripa*
- *Avicennia marina*
- *Avicennia officinalis*
- *Bruguiera gymnorrhiza*
- *Bruguiera sexangula*



Map Source: Yuvaraj et., 2017. Distribution and zonation pattern of mangrove forest in Shoal Bay Creek, Andaman Islands, India. IJMS, (6)597-604.

Common mangrove species in India

1. ***Aegiceras corniculatum*** **(L.) Blanco**
2. ***Avicennia marina*** **(Forssk.) Vierh.**
3. ***Avicennia officinalis*** **L.**
4. ***Bruguiera cylindrica*** **(L.) Bl.**
5. ***Ceriops decandra*** **(Griff.) Ding. Hou.**
6. ***Excoecaria agallocha*** **L.**
7. ***Heritiera fomes*** **Banks**
8. ***Lumnitzera racemosa*** **L.**
9. ***Rhizophora apiculata*** **Blume**
10. ***Rhizophora mucronata*** **Lam.**
11. ***Sonneratia apetala*** **Buch.Ham.**
12. ***Xylocarpus granatum*** **K.D. Koenig**

Aegiceras corniculatum (L.) Blanco

Aegiceras corniculatum belongs to the family Myrsinaceae. It is a tree growing up to 7 m in height. The leaves are often encrusted with salt crystals that are secreted through the glands on the leaf blade. The fruits are slightly curved with cryptovivipary. The flowers have good quality nectar and honey from the mangroves have high demand and value.

Avicennia marina (Forssk.) Vierh.

Avicennia marina is also known as gray mangrove or white mangrove. It is a medium size tree belonging to the Avicenniaceae family. They have a large number of breathing roots emerging from cable roots called pneumatophores. The pneumatophores supply oxygen to the entire plant. The cable roots and pneumatophores minimize the soil erosion. This species can tolerate up to 90 PPT (parts per thousand) salinity. It is the most abundant species in the arid tropical zones.

Avicennia officinalis L.

*Avicennia officinalis (*Black mangrove*)* is an evergreen tree, growing up to 15 m height. Numerous upright breathing roots (pneumatophores) rise above the soil from long shallow, horizontal roots.

Bruguiera cylindrica (L.) Bl.

Bruguiera cylindrica is a mangrove tree coming under the family Rhizophoraceae. Long-stalked leaves are thin, fleshy, and leathery leaf blades. Flower is short and light green in colour. The propagule is cylindrical, short, turning from green to purple when mature.

It has various medicinal uses including usage to lower blood pressure, bleeding, haemorrhage and ulcers.

Ceriops decandra (Griff.) Ding. Hou.

Ceriops decandra is a straight, shrub or small tree that comes under the family Rhizophoraceae. Leaves are simple, entire, opposite, obovate. Flowers are small with 5 mm in size. Fruit is brown in colour and the hypocotyl is 15 cm long with prominent ridges. The tannin from the bark is used to colour cotton fish nets by the fishers earlier.

Excoecaria agallocha L.

Excoecaria agallocha belongs to the family of Euphorbiaceae. It is called as blinding tree. The latex causes injury to the skin and eye. Generally found in fringe areas and are about 5 to 8 meter in height. It has been found to have various medicinal values including the treatment for epilepsy, ulcers, leprosy, rheumatism, and paralysis**.**

Heritiera fomes Banks

Heritiera fomes is a medium-sized evergreen tree in Malvaceae family. It is growing to a height of 10 to 15 metres. The roots are shallow and spreading and send up pneumatophores. The trunk develops buttresses and is grey with vertically fissured bark. The leathery leaves are elliptical and tend to be clustered at the ends of the twigs. The pink or orange bell-shaped flowers are each about 5 mm. They are in panicles, each flower being either male or female. The International Union for Conservation of Nature has declared the species as endangered

Lumnitzera racemosa L.

Lumnitzera racemosa is commonly known as the white-flowered black mangrove in the family Combretaceae. It grows up to 3 to 4 meters in height. Leaves are arranged spirally at the tips of the shoots. The flowers are small and white, fruits containing a single seed.

The extracts from *L. racemosa* have antibacterial, antifungal, antihypertensive, antioxidant, cytotoxic, and hepatoprotective activities.

Rhizophora mucronata Lam.

Rhizophora mucronata belongs to the family Rhizophoraceae. The tree grows up to 8 to 10 meter height. The tree has a large number of aerial stilt roots. The stilt root and dense canopy protect the coastal area from the extreme waves and storm surges caused by cyclones and tsunami.

Rhizophora apiculata Blume

Rhizophora apiculata belongs to the Rhizophoraceae family. It reaches between 5 – 8 metres in height. Leaves are simple and elliptic oblong. They have stilt root system which provides mechanical stability to the *Rhizophora* plant. The stilt roots help to withstand the plants against natural disasters. Viviparous fruit- 2.5 to 3 cm in diameter and about 30 in length.

Scyphiphora hydrophylacea C.F. Gaertn

It is a rare plant in Godavari wetlands belonging to the family Rubiaceae. The number of plants are very less and are available in small pocket near Sacramento lighthouse in Godavari wetland. The seeds are not viable and MSSRF has successfully regenerated the plants through air layering and has planted in the Mangrove Genetic Resources Center, established in the Coringa Wildlife Sanctuary, Andhra Pradesh.

Sonneratia apetala Buch.Ham

Sonneratia apetala is a tree, which can grow up to 15 m in height. It belongs to the family Sonneratiaceae. It is a major pioneer tree species in the Sundarbans and Coringa mangroves. The leaves are simple opposite, entire and leathery. Flowers are apetalous and cream in colour.

Xylocarpus granatum K.D. Koenig

*Xylocarpus granatum (*family Meliaceae) grows up to 15 meters in height. It has well-developed buttresses root found above the ground. The plant is usually evergreen, though in some areas it becomes briefly deciduous due to seasonal variation in climatic conditions. The tree is utilized locally for timber, tannin and medicine.

Endangered mangroves

More than one in six mangrove species worldwide are in danger of extinction due to coastal development and other factors, including climate change and anthropological activities.

According to the IUCN red list, 11 of the 70 mangrove species in the world (16%) are under the threat of extinction.

Among them, two species namely *Sonneratia griffithii* (critically endangered) and *Heritiera fomes* (endangered) are in India

Heritiera fomes

Sonneratia griffithii

Medicinal uses of mangrove plants

S.No	Species	Uses
1	*Acanthus ilicifolius*	Skin diseases, snake bites, stomach pains
2	*Avicennia alba*	Skin diseases, tumors and ulcers
3	*Avicennia officinalis and Bruguiera cylindrica*	Hepatitis
4	*Avicennia marina and Ceriops decandra*	Ulcers
5	*Bruguiera gymnorhiza*	Eye diseases
6	*Nypa fruiticans*	Asthma and diabetes
7	*Rhizophora apiculata*	Diarrhoea, stops bleeding and typhoid
8	*Rhizophora mucronata*	Elephantiasis
9	*Sonneratia sp.*	Swellings and sprains
10	*Xylocarpus granatum*	Cholera, fever and malaria

Ravikumar et al., 2011.Ethnobotanical Survey of Coastal Medicinal Plants Along the Palk Strait Coast of South India https://doi.org/10.1080/10496475.2011.584823

Mangrove Faunal Diversity

Mangrove trees and canopies provide shelter for a wide range of species such as birds, insects and reptiles. The wetlands are important habitat for tigers, otters, fishing cats, monkeys, saltwater crocodiles, king cobra, jackals, spotted deer, fishes and crustaceans.

Endangered Tiger in the Sundarban mangroves

Bengal tiger- *Panthera tigris tigris* L.

Status: Endangered

Range: India, Bangladesh

This iconic species is found in tropical forests including mangrove forests such as the Sundarbans. 96 Bengal tigers were found in the Indian part of Sundarbans (2020-21 census).

Fishing cats in mangrove forests

Prionailurus viverrinus Bennett. is commonly known as fishing cat. *P. viverrinus* and *Felis viverrina* are occurring in Sundarbans mangrove forests. Fishing cats are globally threatened cats that occur in wetlands such as marshlands, mangroves and river banks of South and Southeast Asian countries. About 176 fishing cats were recorded in Chilika Lake during the census conducted in 2021-22; 20 fishing cats were recorded in Bhitarkanika National Park. In Coringa wildlife sanctuary as per the 2019 census, there were about 115 fishing cats.

Nasalis larvatus Wurmb

- *Nasalis larvatus* Wurmb (Proboscis Monkey)
- Status: Endangered
- Range: Endemic to Borneo, found in Brunei, Indonesia, India and Malaysia.
- This unique primate is declining due to habitat destruction. It is found in coastal and riverine forest such as mangroves and is limited to these specific habitats.

Lutrogale perspicillata Geoffroy Saint Hilaire

- *Lutrogale perspicillata* Geoffroy Saint Hilaire (Smooth-coated Otter in mangroves)
- Status: Vulnerable
- India is home to 3 of the 13 species of otters found worldwide. It can grow up to 65cm and is found in large rivers, lakes and mangrove estuaries.
- In Sundarbans- Eurasian Otter (*Lutra lutra*) and in Coringa-Smooth-coated Otter *(Lutra perspicillata*) are reported.
- This aquatic mammal faces many threats from humans.

Crocodylus porosus Schneider

- *Crocodylus porosus* Schneider (Saltwater Crocodile)
- Status: Least Concern
- Bhitarkanika is one of the largest populations of endangered saltwater crocodiles in India and is globally unique.
- There are about 1,784 salt-water crocodiles in the Bhitarkanika mangroves (Census, 2022)
- Major threats are illegal hunting, habitat loss and pollution

Mangrove Snakes

Mangrove snakes are potentially aggressive and nervous creatures. They are carnivores and feed on reptiles, birds, and small mammals. They help to control the populations of small mammals, birds and reptiles.


Mangrove Pit Viper Snakes


Blind Snake


Rattle snake

Critically endangered mangrove (Hawks-bill) Turtle

Eretmochelys imbricata Fit.

It is one of the critically endangered species found in mangroves. The turtles have been declining over the past century, with some estimates put at 80% losses in the last 3 decades.

This reduction has been attributed to hunting, accidental catches by fishermen and loss of nesting grounds. Conservation of the turtle is the need of hour.

Boleophthalmus boddarti Pallas

Mudskippers (Oxudercidae), a highly evolved group of fishes, are distributed exclusively in the mudflats of estuaries and mangroves of the Indo-West Pacific region.

The Mudskippers are the most conspicuous fish in Indian mangroves. They have uniquely adapted to survive in the terrestrial activity. They breathe by holding water in their mouth and gill chamber.

Carcinoscorpius rotundicauda Latreille

- *Carcinoscorpius rotundicauda* Latreille (Mangrove horseshoe crab)
- Status: Data Deficient
- It is also known as the round-tailed horseshoe crab. Found in tropical marine and brackish waters in India (Bhitarkanika).
- Mangrove horseshoe crabs play an important role in the marine food chain, besides providing nutrient-rich eggs to migratory birds.
- Threats - overfishing for use as food and medicine.

Austruca mjoebergi Rathbun

•*Uca* sp. is also known as fiddler crab

•The fiddler crabs contribute significantly to ecosystem functioning by their repeated burrowing and re-burrowing activities, which enhance the aeration of soil, and promote nutrient recycling.

•It Increases oxygen dispersion in anoxic mangrove sediment. Thus it accelerates the decomposition rate under oxic and suboxic conditions.

Mollusks in mangroves

Bivalves	Gastropoda
Anapella cycladea	*Cerithidea alata*
Anadara granosa	*Cerithidea cingulata*
Bactronophorus thoracites	*Fusinus colus*
Bankia bipennata	*Littoraria undulata*
Bankia nordi	*Nerita polita*
Bankia carinata	*Nerita undulata*
Bankia campanellata	*Nassarius olivaceus*
Gafrarium pectinatum	*Nassarius stolatus*
Mactra violaceae	*Rhinoclavis aspera*
Meretrix meretrix	*Telescopium telescopium*
Solen brevis	

R. Rajendar Kumar (2016). Distribution of Molluscan fauna in Coringa Estuarine Mangroves, South East Coast of India.Biolife,4(2):261-264.

Shelter and feeding place for the migratory birds

- Bird migration is the regular seasonal movement.
- Species follow set routes that include suitable habitats where they can stop to rest and refuel along the way.
- Many of these routes include stopovers in mangroves which are excellent sites offering protection and abundant food sources for migratory birds.

Anastomus oscitans Boddaert

- *Anastomus oscitans* Boddaert (Open billed storks)
- Status: Least Concern
- It is a large wading bird, greyish or white with glossy black wings found mainly in India and Southeast Asia. It is largely found in the mangrove areas and other wetlands along the East and West coasts.

Pelargopsis amauroptera Pearson JT

- *Pelargopsis amauroptera* Pearson JT (Brown-winged kingfisher)
- Status: Near Threatened
- Its natural habitats are tropical and subtropical mangrove forests
- In India, it has been mainly reported from the Sundarbans region. It is found along the north and eastern coasts of the Bay of Bengal, occurring in the countries of Bangladesh, India, Malaysia, Myanmar and Thailand
- Degradation of mangroves is the main threat that may endanger the survival of this species.

Leptoptilos javanicus Horsfield

- *Leptoptilos javanicus* Horsfield (Lesser adjutant)
- Status: Vulnerable
- It is a large wading bird mostly associated with wetland habitats including mudflats and mangroves.
- It is a widespread species found from India through Southeast Asia to Java
- Threats - Hunting and habitat loss.

Pelecanus philippensis Gmelin

- *Pelecanus philippensis* Gmelin (Spot-billed pelican)
- Status: Near Threatened
- The species is found to breed only in peninsular India, Sri Lanka and in Cambodia
- The main habitat is shallow lowland freshwaters, lakes and coastal waters.
- Mature spot-billed pelicans have no predators, however crows, Brahminy kites, and jackals eat nestlings and fledglings and steal eggs

Threskiornis melanocephalus Latham

- *Threskiornis melanocephalus* Latham (Black-headed ibis)
- Status: Near Threatened
- This species is a widespread breeding bird in India, Sri Lanka, Nepal and Myanmar
- Its found in freshwater and salt-water marshes, mangroves, lakes, ponds and rice fields
- Threats: Habitat disturbance due to agriculture and other land uses, and other human encroachments

Ardea goliath Cretzschmar

- *Ardea goliath* Cretzschmar (Goliath heron)
- Status: Least Concern
- It is also known as the giant heron, a large wading bird of the heron family. Important habitats are lakes, swamps, mangrove wetlands and reefs.
- They tend to prefer pristine wetlands and generally avoid areas where human disturbances are a regular occurrence.

Greater Flamingos in Thane Mangroves

Two flamingo species are found in Thane Creek – the Greater Flamingos and the Lesser Flamingos. During the period of December 2021 and March 2022, the Thane Creek Flamingo Sanctuary (TCFS) witnessed 54,000 numbers of greater flamingos.

Insect biodiversity in the fragile mangrove forest

- Insects are one of the biotic components that make up the mangrove ecosystem. They are bio-indicators of the condition of the mangrove ecosystem
- Most abundant insects in the salt marsh are the Diptera, Homoptera, Coleoptera, Orthoptera, Lepidoptera, Hemiptera, Hymenoptera, and Odonata.

Honey collection in mangroves

- Beeswax and honey produced by wild bees are commercially important. The nectar of *Aegiceras corniculatum* produces one of the best qualities of honey from Sundarban. This unifloral honey is more costly than other types of honey found in Sundarban because of its taste, whitish colour and odour.

- About 47,412 kg/year wild honey is being harvested from Sundarbans which values around Rs. 35.56 lakhs (Bhattacharya et al., 2018).

Fishery resources in mangroves




- Some of the most common fish species in Indian mangrove waters are *Liza*, *Mugil, Lates, Polynemus, Sciaena, Setipinna, Pangasium, Hilsa, Ilisha* and *Etroplus*.
- Prawns are represented by the species of *Penaeus* and *Metapenaeus*
- Crabs are represented mainly by *Scylla serrata*.

Fishing in Mangroves

The mangrove ecosystem rich in detritus is highly suitable for feeding ground for fishes. The major fishery resources found in these waters are detritivorous species of fishes, crabs, crustaceans and molluscs. Roughly about 60% of India's coastal marine fish species are dependent on the mangrove ecosystem. Mangrove wetlands provide livelihood to a large number of small artisanal fishermen.

Ecotourism in Mangrove Environment

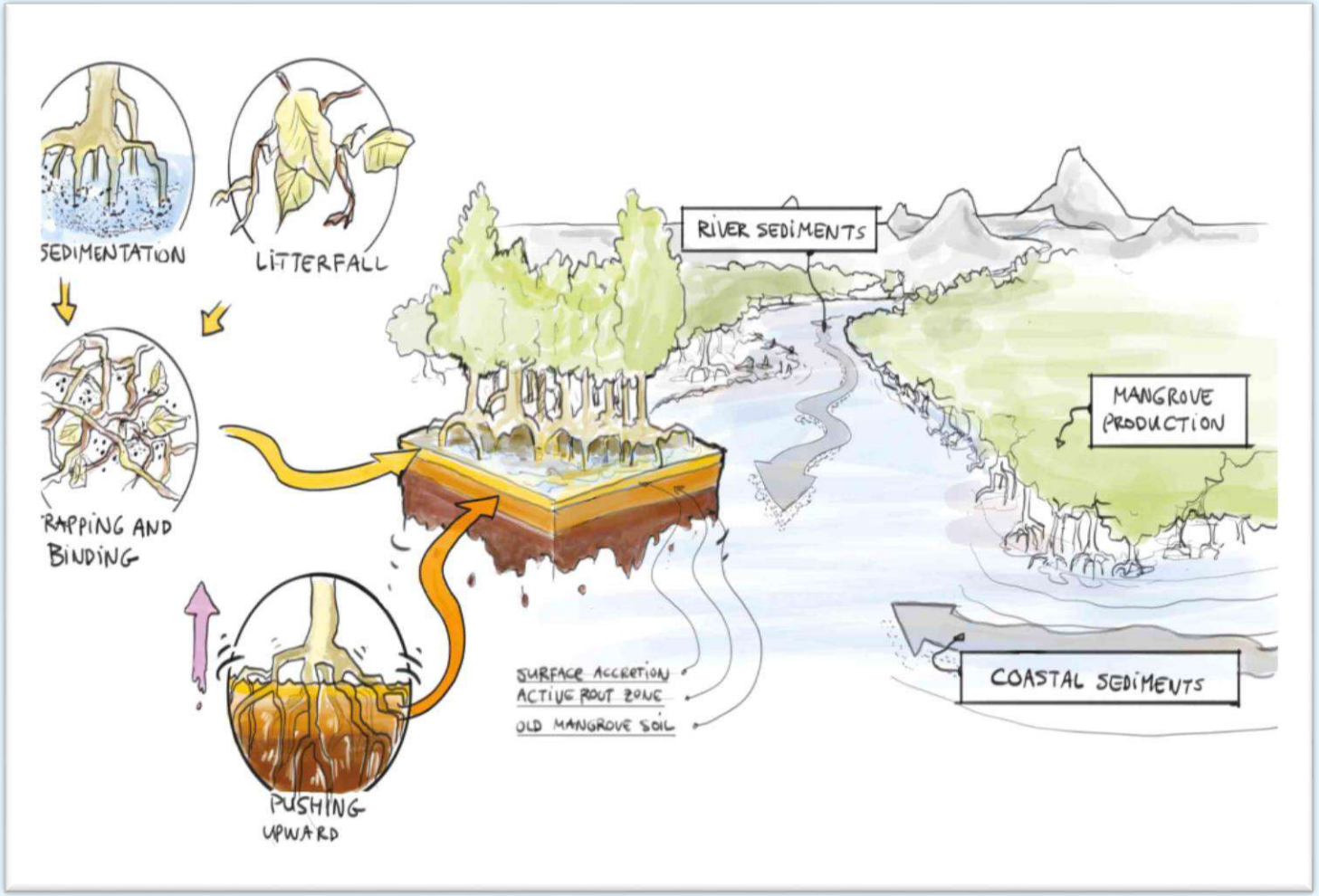
Pichavaram

Mangrove wetland is an excellent destination for the tourists. In India, Pichavaram, Muthupet, Coringa, Sundarbans, Bhitarkanika attract a large number of national and international tourists. It provides substantial livelihood for the local fishermen community.

Coringa

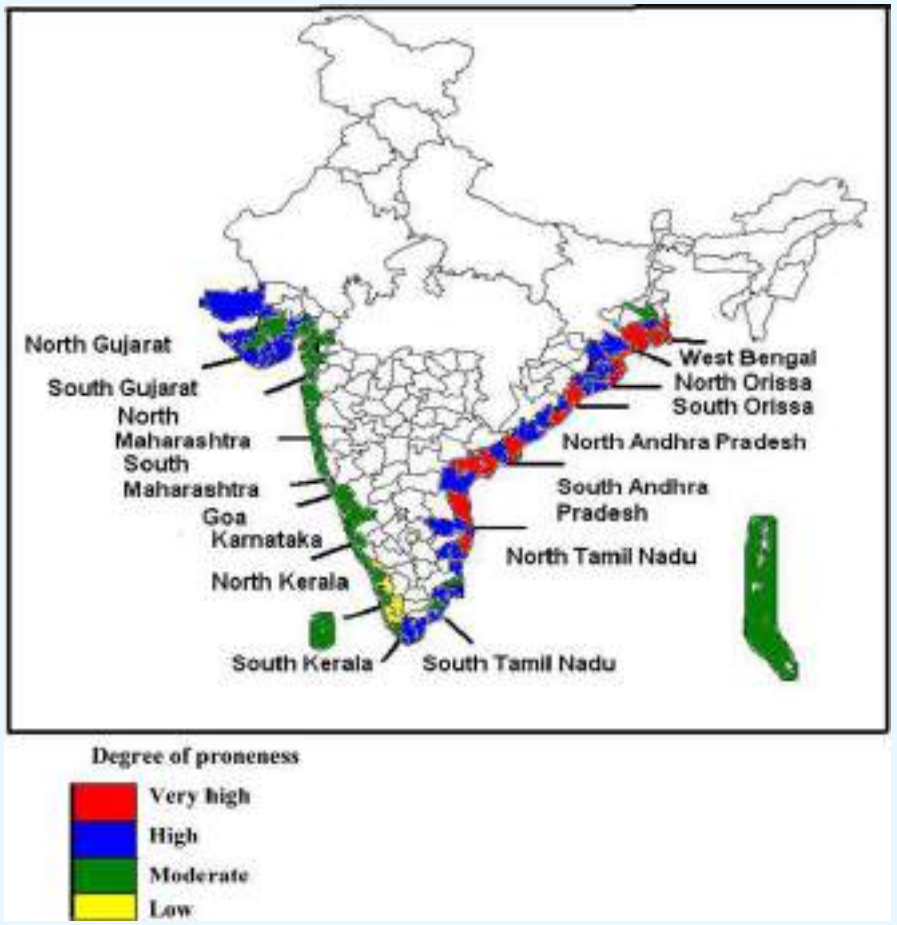
Bhitarkanika

Mangroves reduce the impact of sea level rise



Mangroves have the ability to trap and retain sediments (Root structure) that will lead to increase in surface elevation (vertical accretion rate may be between 0.7 and 20.8 mm/yr -site-specific)

Cyclone Prone Districts in India



A cyclone is a vast, violent whirl in the atmosphere which moves from the high seas towards the coastal areas.

Cyclones often bring heavy rains that can cause flooding. Some of the most powerful cyclones in this decade are Cyclone Thane, Cyclone Megh, Cyclone Jal, Cyclone Roanu, Cyclone Lehar.

Source: M Mohapatra, 2015. Cyclone hazard proneness of districts of India. J. Earth Syst. Sci. 124, pp. 515–526.

Deadliest Tropical Cyclones

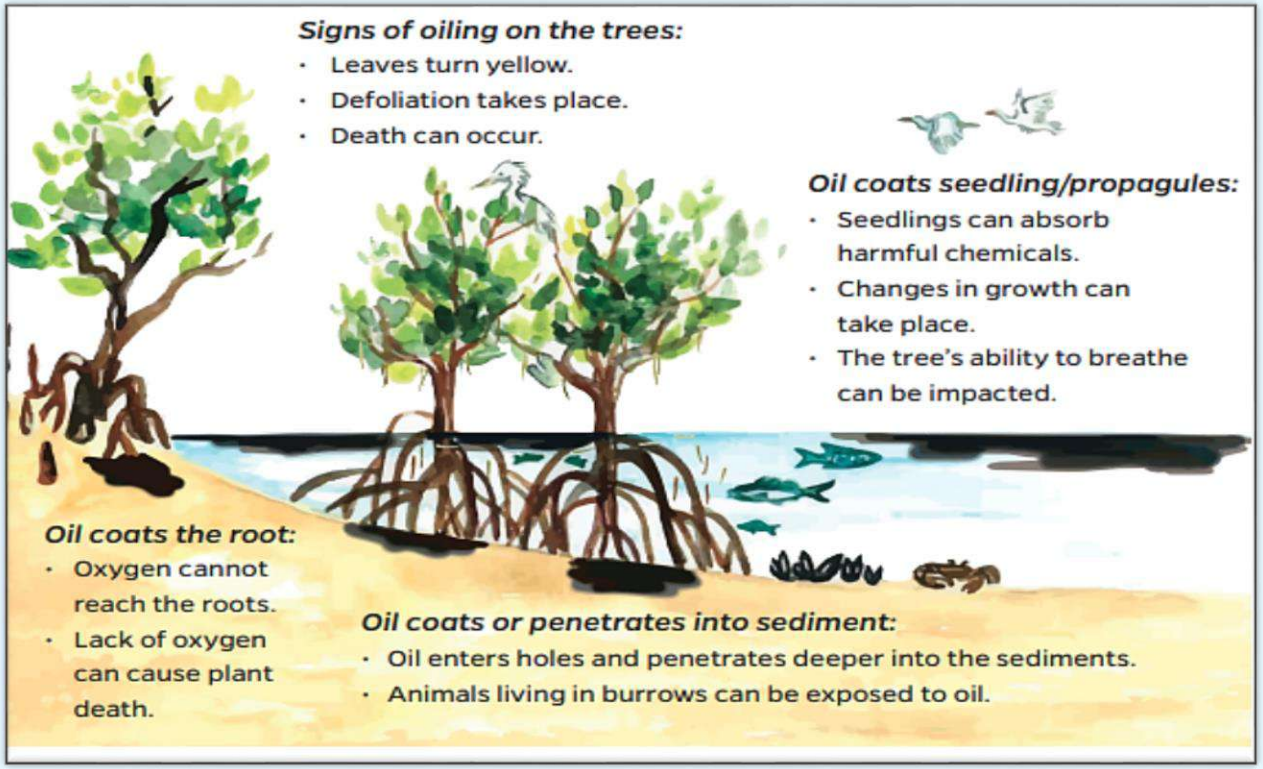
Rank	Name/ Areas of Largest Loss	Year	Ocean	Deaths
1	Great Bhola Cyclone, Bangladesh	1970	Bay of Bengal	550,000
2	Hooghly River Cyclone, India	1737	Bay of Bengal	350,000
3	Haiphong Typhoon, Vietnam	1881	West Pacific	300,000
4	Backerganj Cyclone, Bangladesh	1584	Bay of Bengal	200,000
5	Great Backerganj Cyclone, Bangladesh	1876	Bay of Bengal	200,000
6	Bangladesh	1897	Bay of Bengal	175,000
7	Super Typhoon Nina, China	1975	West Pacific	171,000
8	Cyclone 02B, Bangladesh	1991	Bay of Bengal	140,000
9	Great Bombay Cyclone, India	1882	Arabian Sea	140,000
10	Hakata Bay, Typhoon, Japan	1281	West Pacific	65,000
11	Calcutta, India	1864	Bay of Bengal	60,000
12	Bangladesh	1882	Bay of Bengal	50,000
13	Bengal Cyclone, Calcutta, India	1942	Bay of Bengal	40,000

Mangroves play an important role in minimizing and mitigating the impact of cyclones in the coastal areas. During the super cyclone in1999 along the Odisha coast, dense mangroves protected many lives and livelihoods. The Indian coast experiences severe weather events, such as cyclones and super-cyclones at an average of nine cyclones per year (ICZMP 2010). Ranked in the risk class level 9 (range between 0 and 10) (South Asia Disaster Report (SADR))

Causes for mangrove degradation

- Felling for Domestic Needs: Fuel wood, fodder, timber, fencing and fishing poles
- Grazing and fodder collection for the cattle
- Conversion of mangrove wetlands for Aquaculture/ Agriculture/ Industries
- Changes in Topography; Bar Mouth closure; Reduction in fresh water flow
- Climate change – Cyclones; Higher evapotranspiration; increase in salinity

Oil Pollution on Mangroves



Source: Spadling et al., 2010.World Atlas of Mangroves. Earthscan, London, xv+ 319pp.

Oil Pollution

Oil spill causes physical suffocation and toxicological impacts to mangroves.

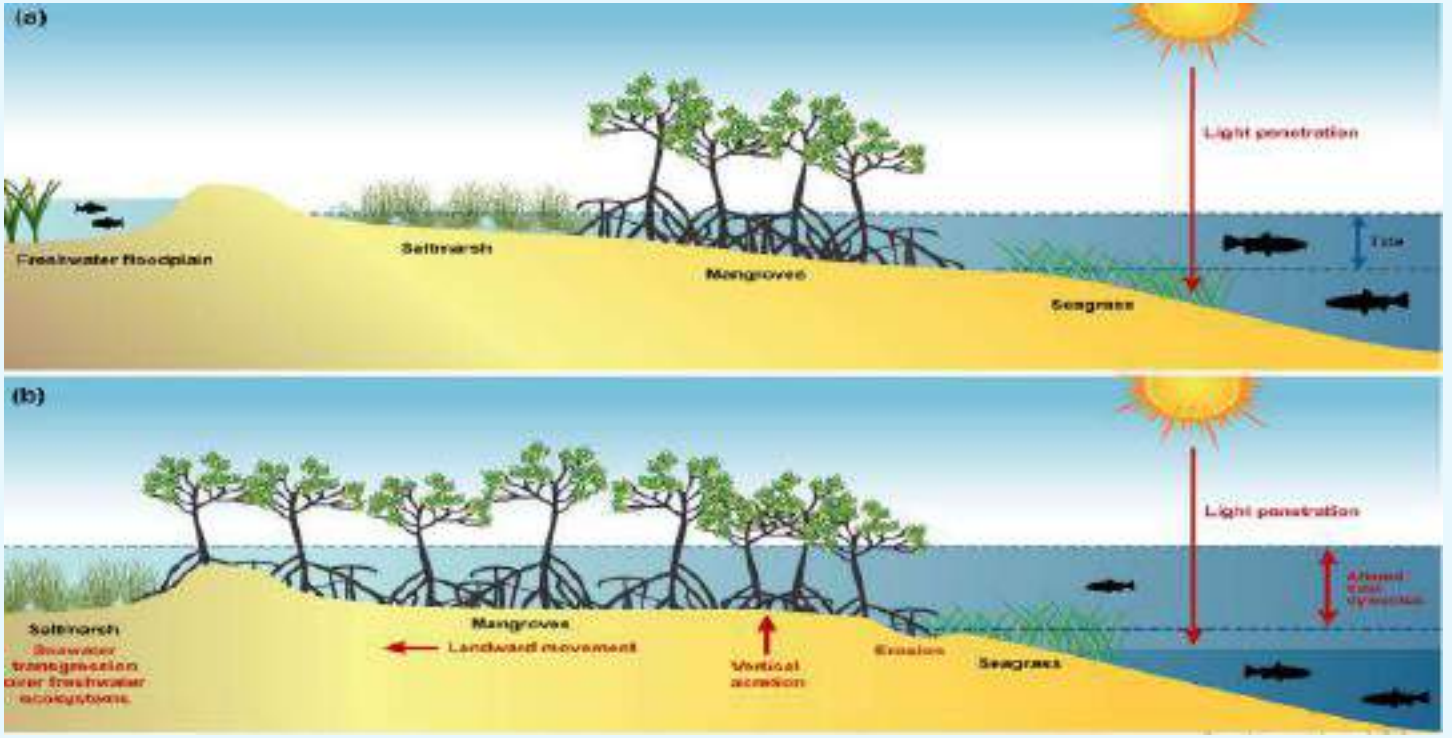
Spilled oil covers the aerial breathing mangrove roots inhabiting gaseous exchange and disrupting oxygen transport to underground roots leading to death of trees.

Oil spill can be spread over a wide area and damage can be more scattered.

Plastic Pollution

Mangrove ecosystems are at particular risk of being polluted by plastic carried from rivers to the sea. Fifty-four per cent of mangrove habitat is within 20 km of a river that discharges more than a tonne of plastic waste a year into the ocean. Southeast Asia is more affected by river-borne plastic pollution than any other region in the world.

Impact of Sea level rise on Mangroves



Source: Khojasteh et al.2021. Sea level impacts on estuarine dynamics. Science of the total environment. Pp.146470

Sea level rise poses a major threat to mangrove ecosystems and the impacts are

- Sediment erosion and loss of salt marsh habitats
- Inundation stress and shift of mangroves towards landward side
- Increased salinity at landward zone

Sea levels are rising globally at a rate of more than 3 mm/ year.

THREATS

Drivers of mangrove loss

Mangrove loss

35% between 1980 and 2000[1] - the equivalent of losing almost 150,000 annually[2], and **4 times higher** than overall global forest loss[3]

Climate change

Air temperature and rainfall regimes influence global mangrove distribution[4]; abrupt changes in sea level are a primary cause of **local and regional extinctions**[4-6]

Logging

can cause altered species composition, **fragmentation and total clearance** of mangrove forests

Agriculture

Conversion to rice paddies responsible for **88% of mangrove loss** in Myanmar[10]

Aquaculture

causes more than **half of mangrove losses globally**, mostly due to shrimp culture[9]

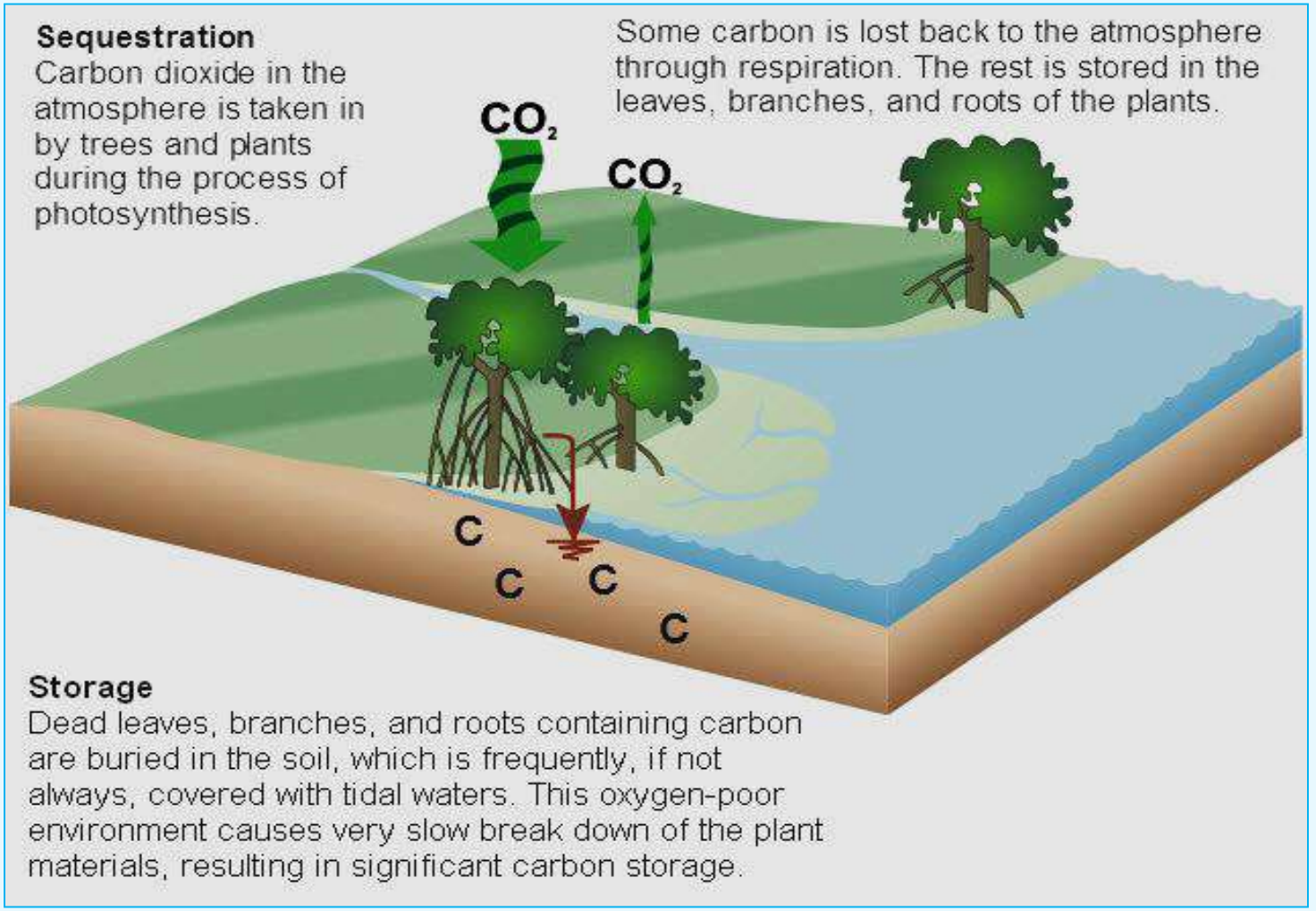
Pollution

Mangrove's aerial roots, through which they obtain oxygen, can easily be smothered and clogged by **sediment, solid waste and oil**[8]

Coastal development

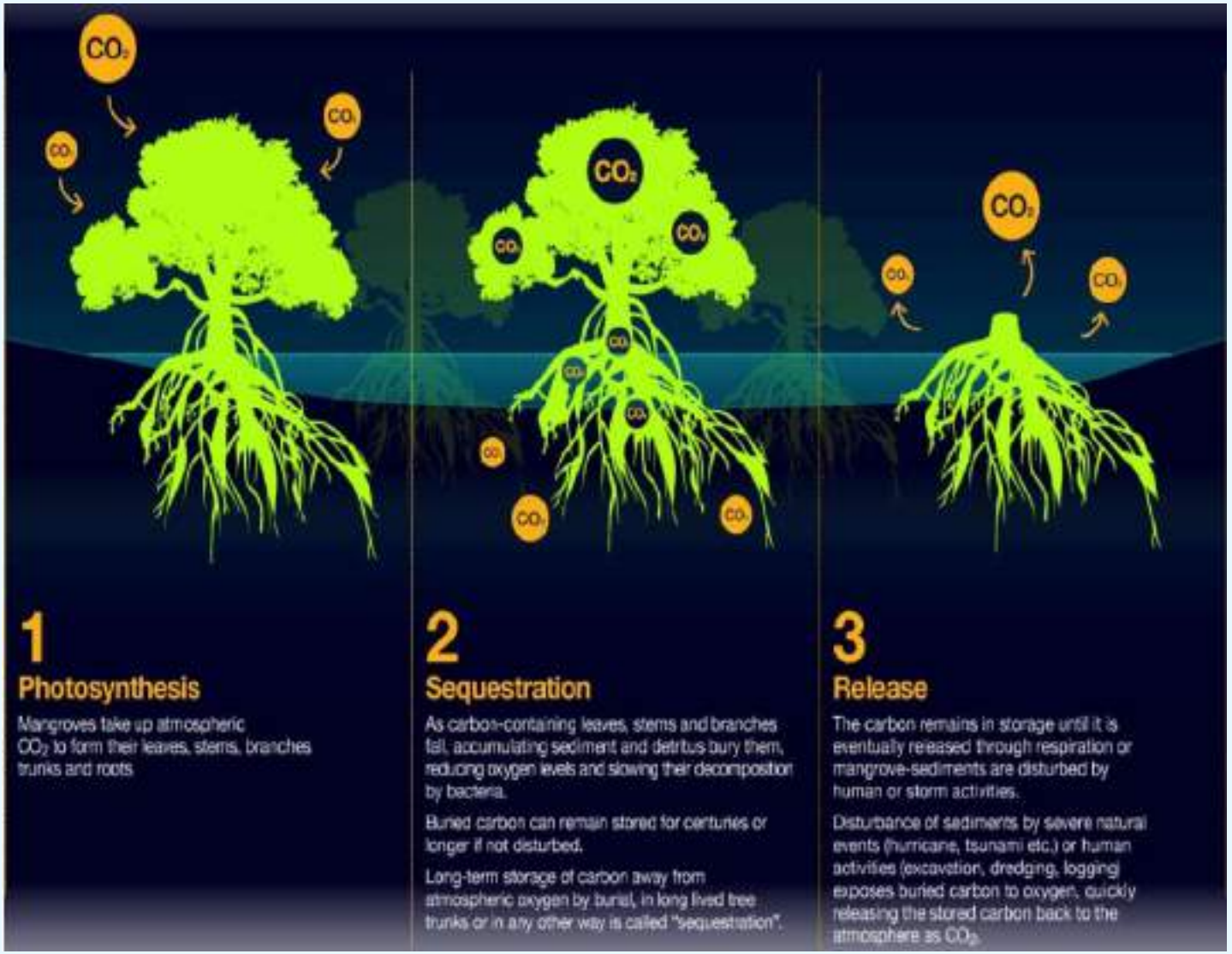
Urbanisation drives mangrove loss and degradation; human population density in coastal regions **3 times higher than global average**[7]

Carbon sequestration in mangroves



Source: Ashokri, 2016. carbon analysis of sediment and vegetation of mangrove forest in carey island. Thesis. Pp.89.

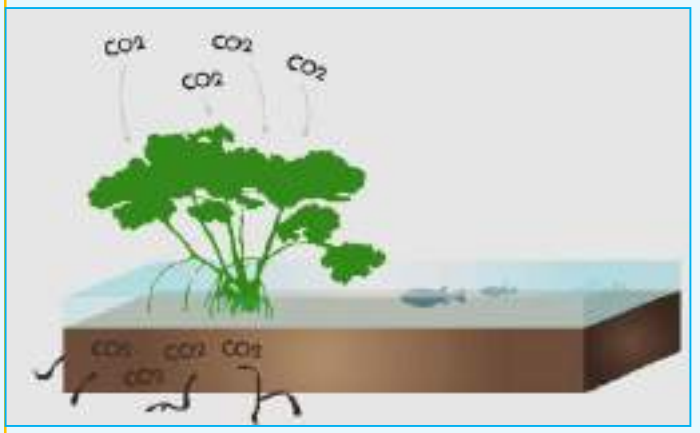
Carbon dynamics in mangroves

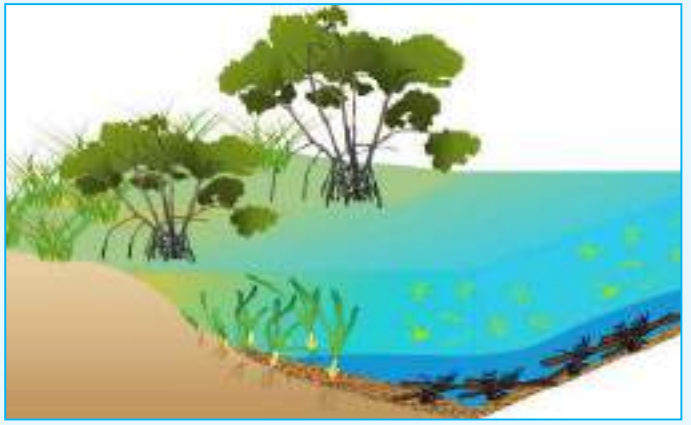


Source: Ocean Health Index, 2020

Rate of Carbon sequestration of Mangroves

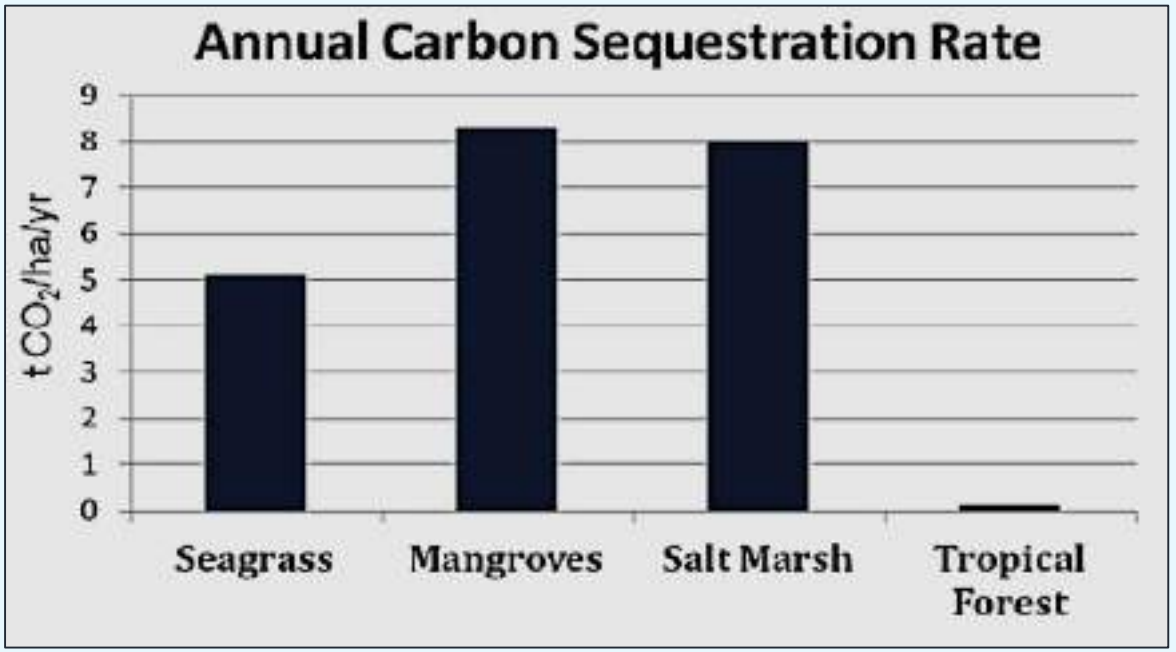
- Mangroves are important sinks of organic carbon (C).
- Mangroves are able to store carbon from the atmosphere from 50 metric tons to as much as 220 metric tons per acre during their growing period.
- Global mangroves are able to sequester more than 24 million metric tons of carbon per year.
- Projecting current mangrove deforestation rates into the future resulted in a total of 678.50 Tg CO_2 emitted from 2012 to 2095.
- Reducing mangrove deforestation rates further would elevate the carbon benefit from climate change by 55–61%.





Source:https://en.wikipedia.org/wiki/Blue_carbon

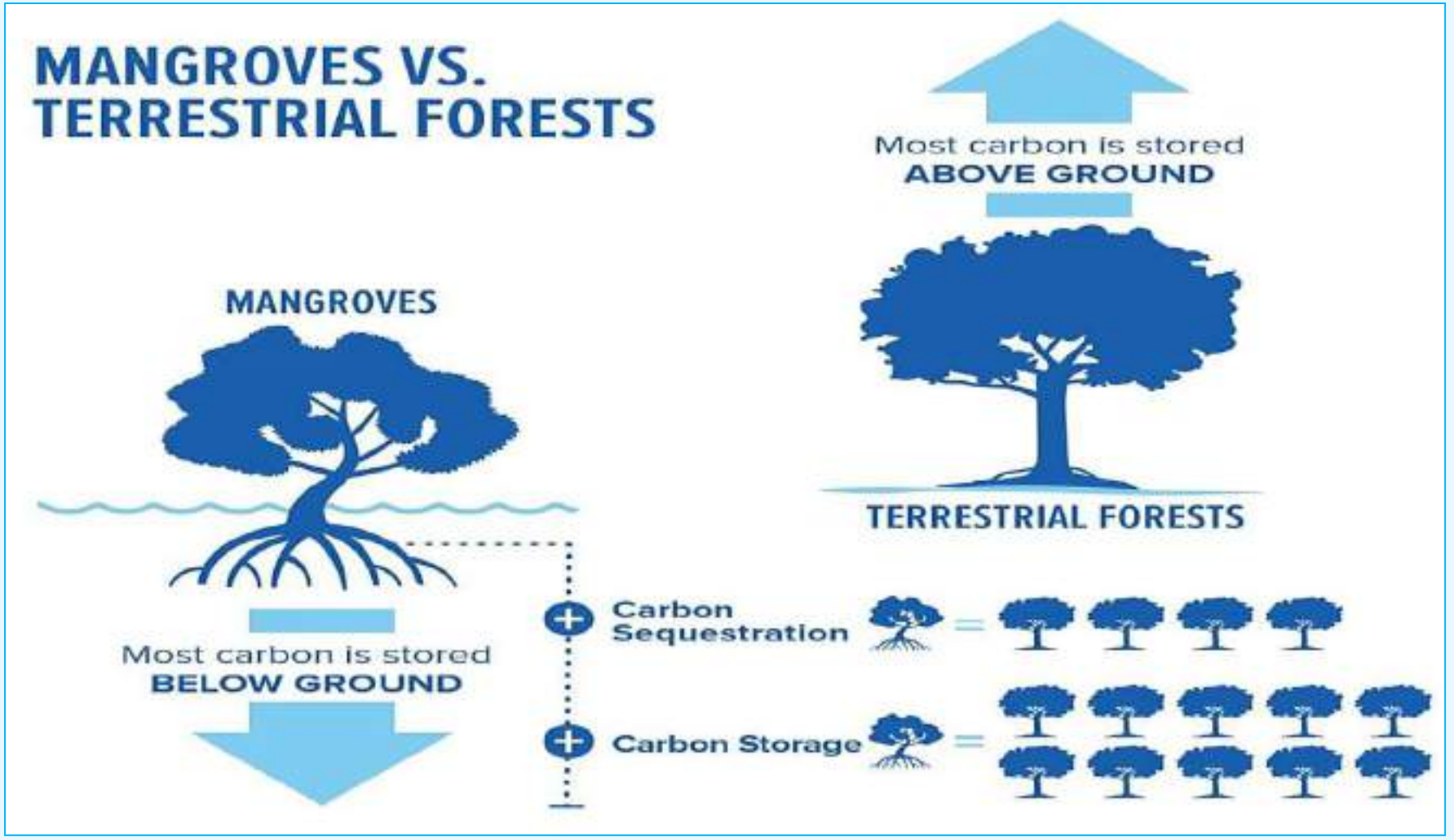
Carbon sequestration by different ecosystems



Source: (The Climate Trust, 2015)

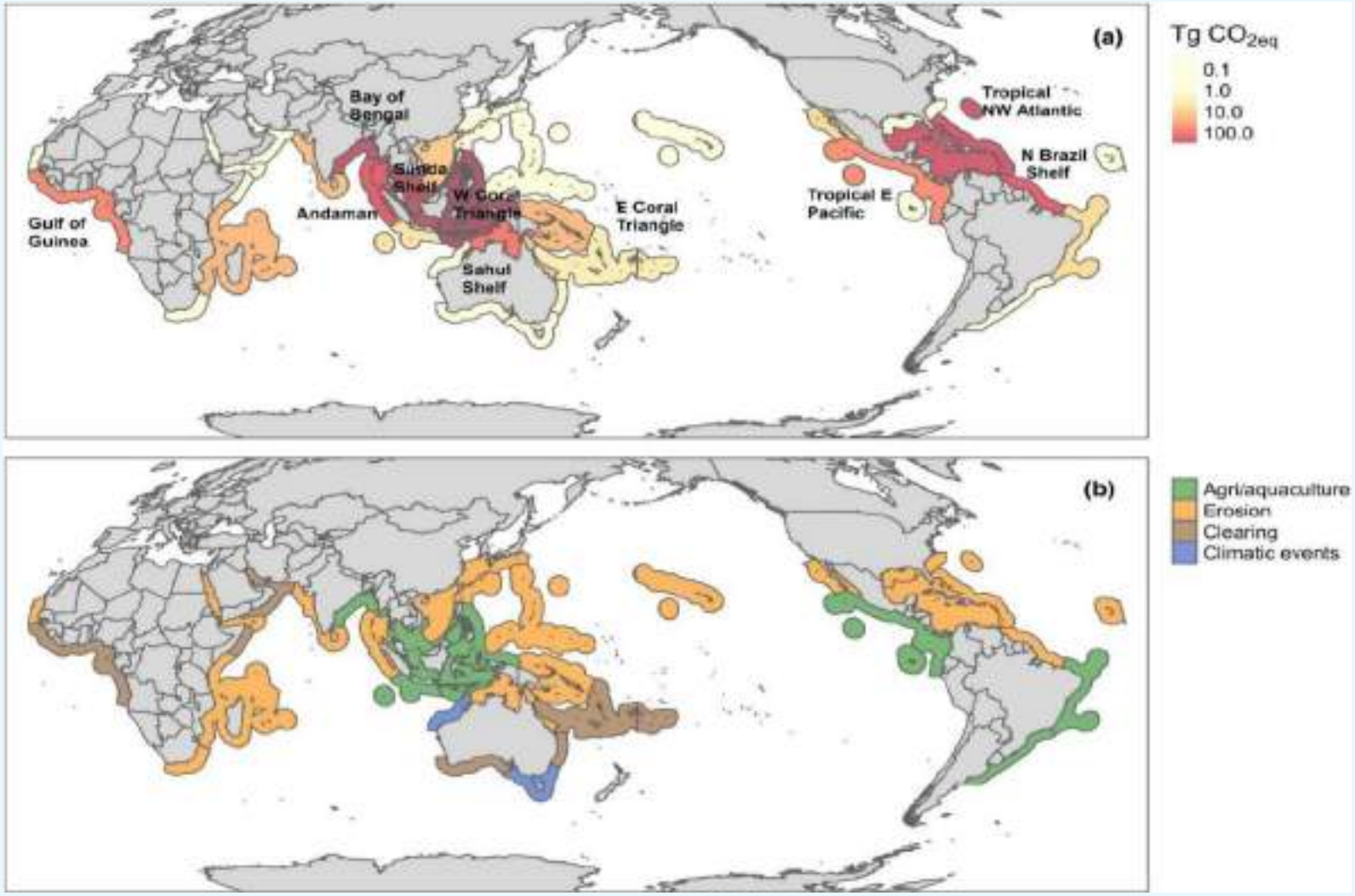
Mangroves have the greatest sequestration rate; that is, they can absorb and store more carbon than that of other ecosystems.

Carbon absorption in mangroves versus terrestrial forests



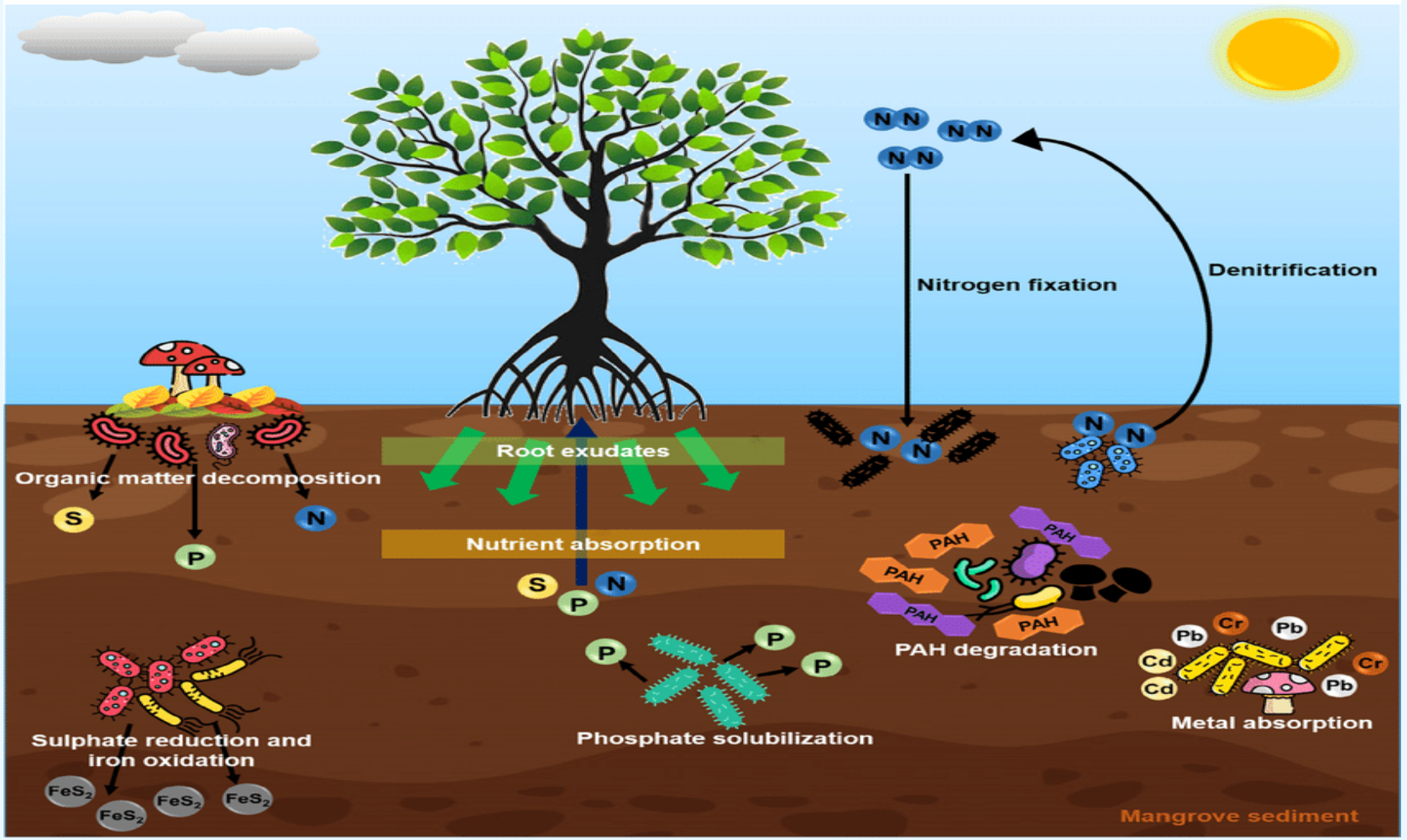
Source: Reef Resiliance Network, 2020

Future carbon emissions from global mangrove forest loss



Global Change Biology, Volume: 27, Issue: 12, Pages: 2856-2866, First published: 28 February 2021, DOI: (10.1111/gcb.15571)

Role of microbes in mangrove environment



Source: Palit, K., et al., 2022. Microbial diversity and ecological interactions of microorganisms in the mangrove ecosystem: Threats, vulnerability, and adaptations. *Environ Sci Pollut Res* 29, 32467–32512.

Economic importance of Sundarban mangroves

Mangrove is a highly productive ecosystem in the coastal environment.

The estimated value of the ecosystem services of Sundarban mangrove forest is worth Rs. 664140.57 millions/ year annually.

Therefore conservation of mangroves is important for economic sustainability.

S.No.	Ecosystem Service	Value (₹ in Millions/ Year)
1	Employment Generation - Through management and Community-based Ecotourism	36.22
2	Fishing	1,600.00
3	Standing Stock	6,28,700.00
4	NWFP	5.50
5	Gene–Pool Protection	2870.00
6	Carbon Storage	24100.00
7	Carbon Sequestration	462.08
8	Biological Control	101.51
9	Moderation of Extreme Events	274.83
10	Pollination	276.84
11	Nursery Function	5170.00
11	Habitat/ Refugia	359.89
12	Recreation	37.00
13	Gas Regulation	110.74
14	Waste Assimilation	1,500.00

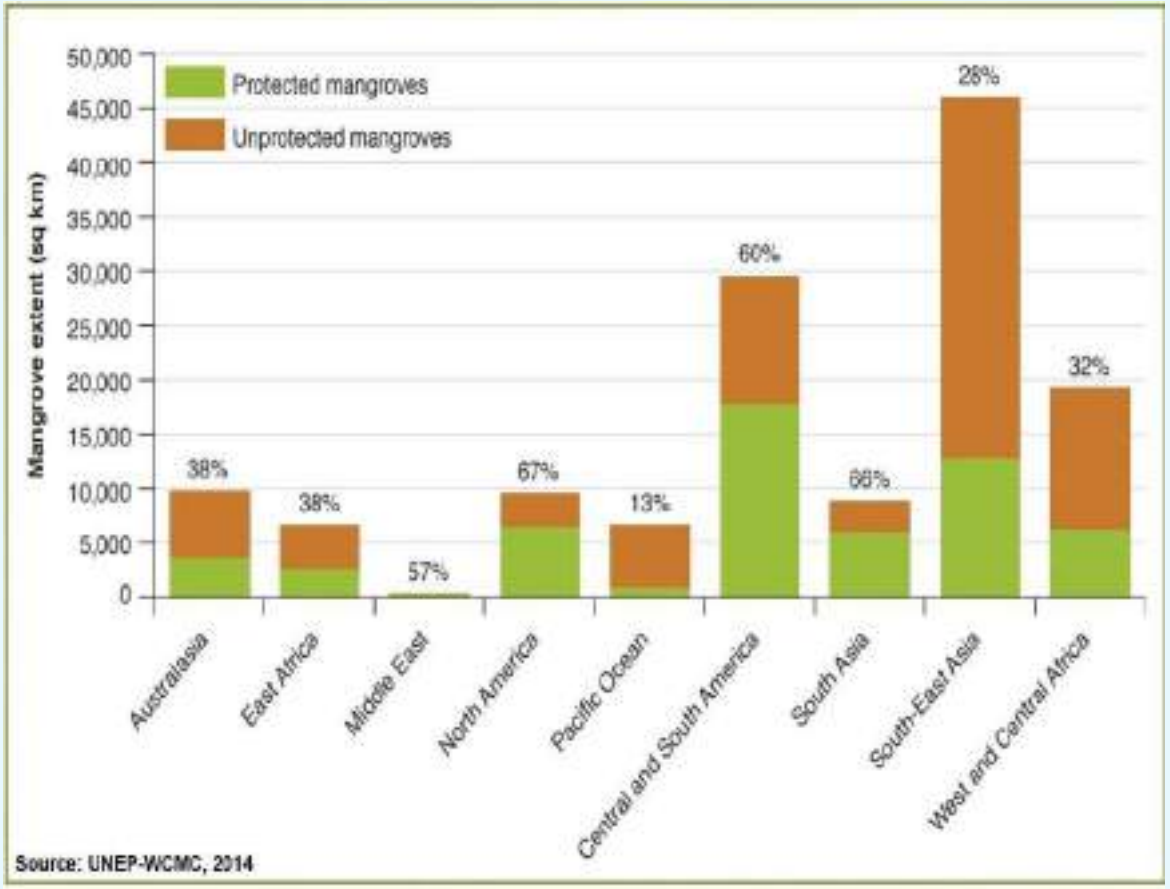
Source: Policy Brief, 2016. No.5 CESME Economic Valuation of Sundarbans Tiger Reserve

Economic values of Pichavaram Mangroves

The economic value of Pichavaram mangroves by direct contribution through fisheries is about Rs.1,65,75,000 and through Ecotourism is about Rs.15,75,00,000. The other indirect use values are about Rs.336,10,51,127 and Non-use values are about Rs.1,05,185. A total value of Rs.353,52,31,312 is being contributed by Pichavaram mangrove annually.

Piyashi DebRoy and R. Jayaraman (2012). Economic valuation of mangroves for assessing the livelihood of fisherfolk: a case study in India. IIFET Tanzania Proceedings, Page 1-11.

Status of Mangroves in different regions



Many nations have established protected areas to prevent further destruction. This is however, highly variable in effectiveness across different countries.

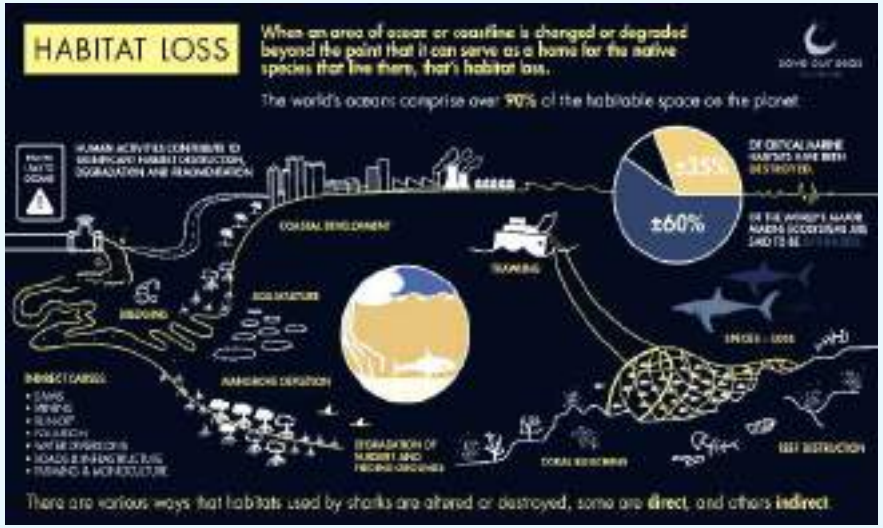
Save mangroves ! Save life !!

The roots and shoots of mangroves obstruct the flow of water and the wind speed during disasters thereby reducing the vulnerability of adjacent coastal lands

Mangrove minimize the Tsunami effects

Non-mangrove area devastated by Tsunami

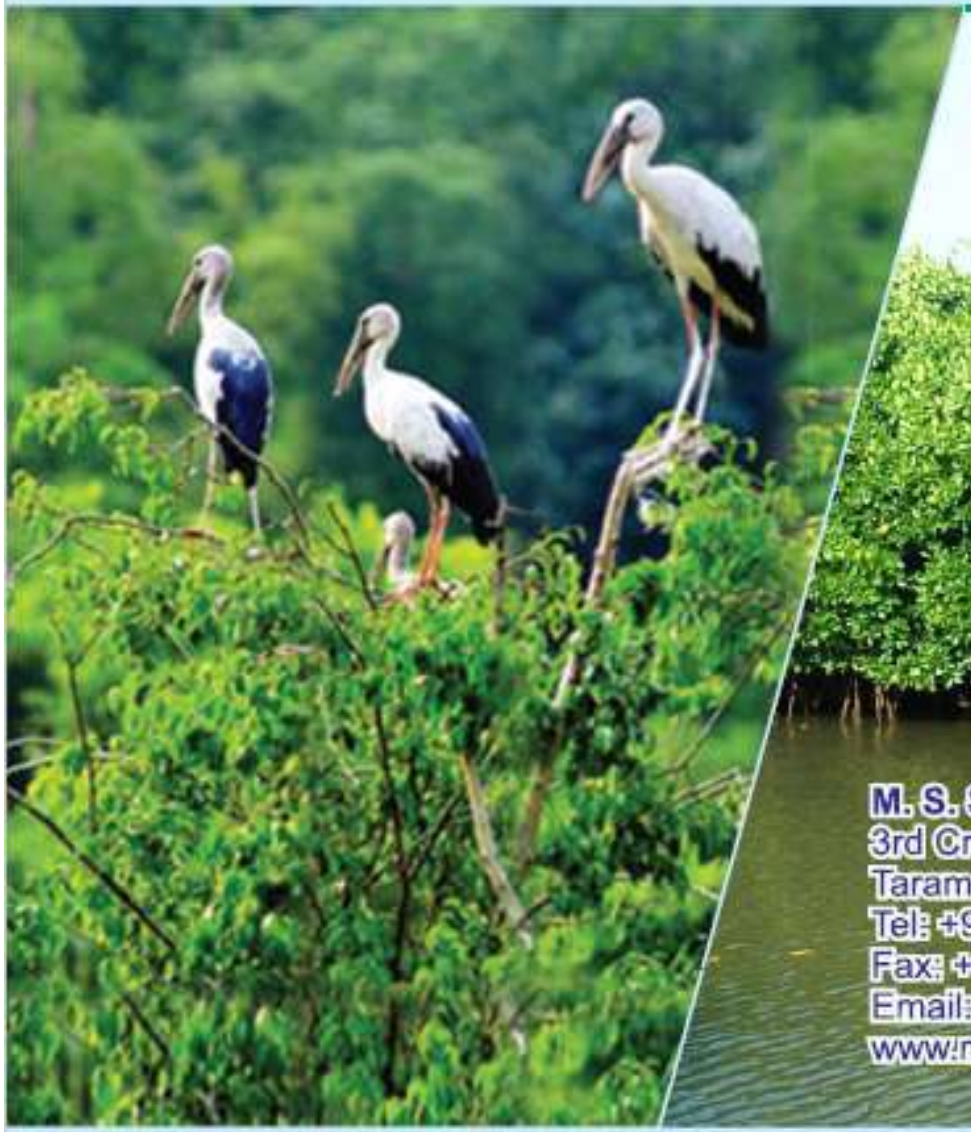
Degradation of mangroves



- Mangroves are disappearing at a global loss rate of 1–2% per year, and the loss reached 35% during the last 20years.
- Climate change (sea level rise and altered rainfall) and human activities (urban development, aquaculture, mining, and overexploitation of timber, fish, crustaceans and shellfish) represent major threats for mangrove habitats.

Key days related to mangrove wetlands

	**World Wetland Day | February 2**	To conserve the wetlands and create awareness on the importance of this ecosystem.
	**World Environment Day| June 5**	To enhance the awareness and action to protect the. globe from pollutants
	**World Oceans Day | June 8**	World Oceans Day is designated by the United Nations. It is an opportunity to raise global awareness of the current challenges .
	**World Mangrove Day | July 26**	The World Mangrove Day is to raise awareness on the importance of mangrove ecosystems to the coastal community and also to manage them sustainably



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