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जहाँ है हरियाली ।  
वहाँ है खुशहाली ।।

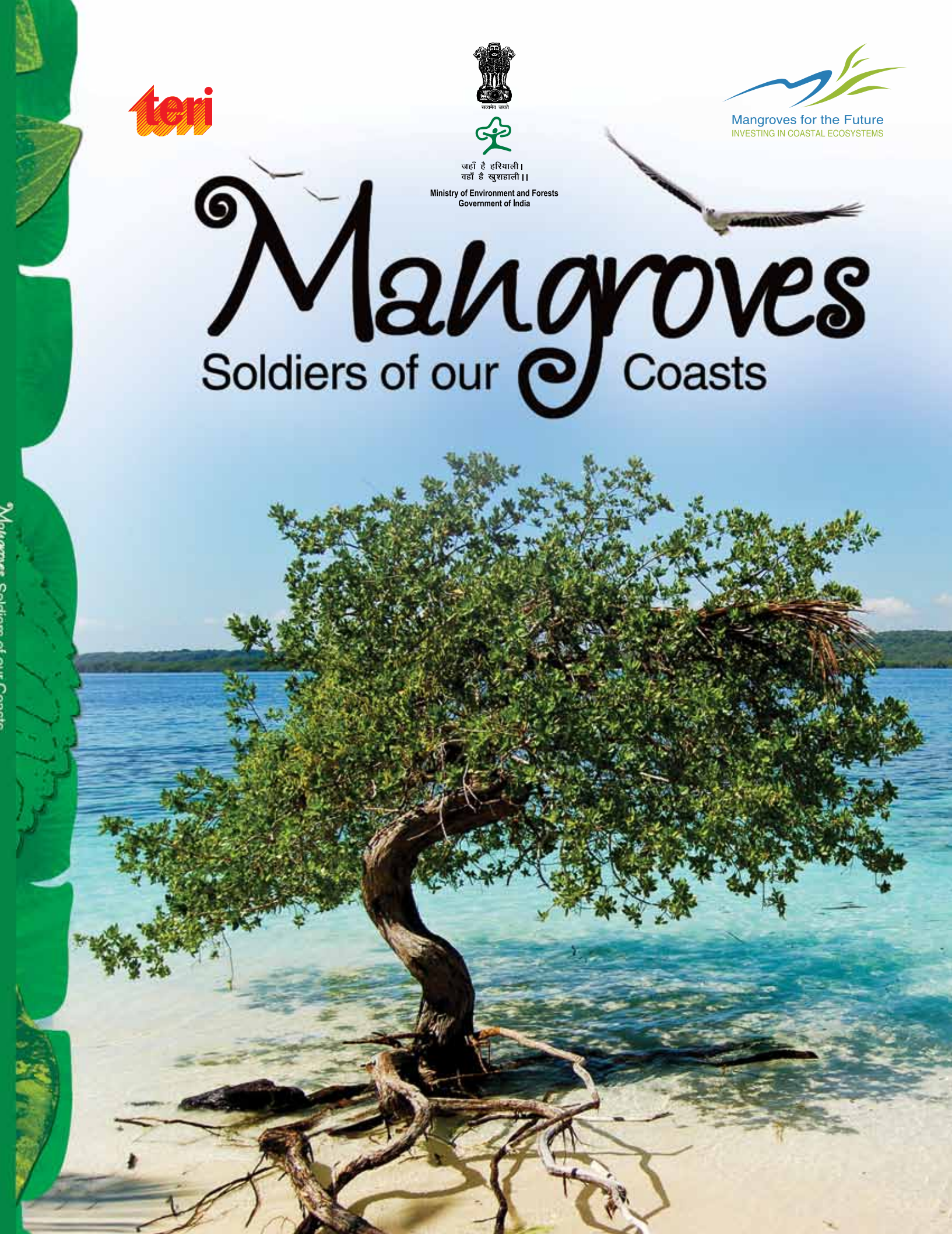
Ministry of Environment and Forests  
Government of India

Mangroves for the Future  
INVESTING IN COASTAL ECOSYSTEMS

# Mangroves

Soldiers of our Coasts

Mangroves: Soldiers of our Coasts



Produced by Mangroves for the Future (MFF) India  
20, Anand Lok, August Kranti Marg, New Delhi-110 049  
with  
financial support of Norad and Sida

© 2010. International Union for Conservation of Nature and Natural Resources.  
ISBN 978-2-8317-1264-2

**Citation:** MFF, India. (2010). Mangroves: Soldiers of our Coasts. New Delhi: TERI, 32 pp

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**Author:** Roshni Sengupta

**Managing Editor:** Madhu Singh Sirohi

**Senior Editor:** Arshi Ahmad

**Creative Head:** Priyabrata Roy Chowdhury

**Design:** Santosh Gautam

**Image Research:** Yukti Garg

**Pre-press:** Mahfooz Alam

**Production Head:** T Radhakrishnan

**Technical Review:** Dr V Selvam (MSSRF), Dr N M Ishwar (IUCN)  
and Dr J R Bhatt (MoEF)

**Picture Credits:** 1-2 Mangrove Fruit: Peripitus; Black Mangrove: Lanaré Sévi; 14-15  
Mangrove Roots: NOAA; 18-19 Deforestation: Joe Hughes; 22-23 Olive Ridley Turtle:  
Bernard Gagnon

First published in 2010 by  
The Energy and Resources Institute  
TERI Press

Darbari Seth Block, IHC Complex, Lodhi Road, New Delhi - 110 003, India  
Tel. 2468 2100/4150 4900, Fax: 2468 2144/2468 2145  
India +91 Delhi (0)11

Email: [teripress@teri.res.in](mailto:teripress@teri.res.in) ■ Website: <http://bookstore.teriin.org>

Available from: IUCN India Office  
This book is printed on recycled paper.



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## Acknowledgements

The publication of this book could not have been possible but for the efforts put in by a large number of individuals. We would like to express our heartfelt thanks to the MFF Secretariat, Bangkok, for their valuable inputs on contents and design. We received support and encouragement from the MFF/IUCN India office and would like to thank them for their technical support and guidance. We also thank Dr V Selvam of the M S Swaminathan Research Foundation (MSSRF) for information and statistics on Indian mangroves. We would like to express our gratitude to the Ministry of Environment and Forests, Government of India, specifically Dr J R Bhatt, and other members of the National Coordinating Body (MFF India), for their valuable advice and assistance. Finally, we would like to thank TERI Press for developing the content, designing, and bringing out the book.

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# GREEN SENTINELS OF THE COASTS

**Did you know that someone protects our coasts and sea shores? No...it is not the Coast Guard. Nor is it the Navy. Our protectors do not speak. They go about their functions silently. That is why they are called the 'silent green sentinels of the coasts'. They are mangroves!**

## **Mangrove's swampy home**

Mangroves occur in the marshy areas between the shore and the sea, called intertidal zones. These areas are flooded by the sea every day. Mangrove forests grow along the coasts of seas with high salt content.

*Intertidal zones are tough places for plants to grow—during low tides, these zones are exposed to air, while during high tides, they are covered by saltwater.*

*Of the total mangrove coverage, more than 40 per cent occur in South and South East Asia.*

## **GREEN ZONE**

Australian aborigines eat the fruit of mangrove trees. But first, they remove harmful tannins from the fruits by soaking them in mangrove mud for three to seven days.

*Photo courtesy: Minna Epps*

# MANGROVES, OLD AND NEW

Mangroves belong predominantly to the family of plants known as *Rhizophoraceae*. The family is divided into different genera. Let's take a closer look at the different types of mangroves.

## East and west

There are two main regions of mangrove vegetation—the Eastern hemisphere (eastern Africa, Asia, including India, and Australasia) and the Western hemisphere (Americas and western Africa). The Eastern hemisphere is considered to be the original home of mangroves, and, thus, the mangroves here are called the old world mangroves. The Western hemisphere mangroves are called new world mangroves.



*Mangrove forests are among the world's most productive ecosystems.*

## A world of difference

The old world mangroves are more diverse, with more species—over 40 species—against about 10 in the new world. There is also a great deal of segregation between the mangroves in the old world and the new world. Two of the main genera of mangrove, *Rhizophora* and *Avicennia*, contain different species in the old and new worlds.

## Mangrove countries

Indonesia has the largest area under mangroves, with 30 per cent of the global coverage, followed by Brazil, Australia and India.

## GREEN ZONE

In India, there are 34 species of true mangroves. Bhitarkanika (Orissa) has 31 species, the Sundarbans have 27, and the Andaman & Nicobar islands have 24 species.

*Globally, there are 60 true mangrove species in 27 genera and 20 families.*



# MANY MANGROVES!

**What are the most common mangrove species? What are their main characteristics and what is special about them? Let's find out.**

## Colour me red!

Have you ever heard of the red mangrove? It is the most common mangrove species in the world. Red mangroves (genus *Rhizophora*) are well adapted to salty water and salty swamps. Black mangrove, white mangrove, and buttonwood grow around red mangrove clusters.

**The red mangrove creates an elongated seed pod from its bark called a propagule. This takes root next to the plant and produces a new tree.**

**Propagule**



**Prop roots**

## What do I look like?

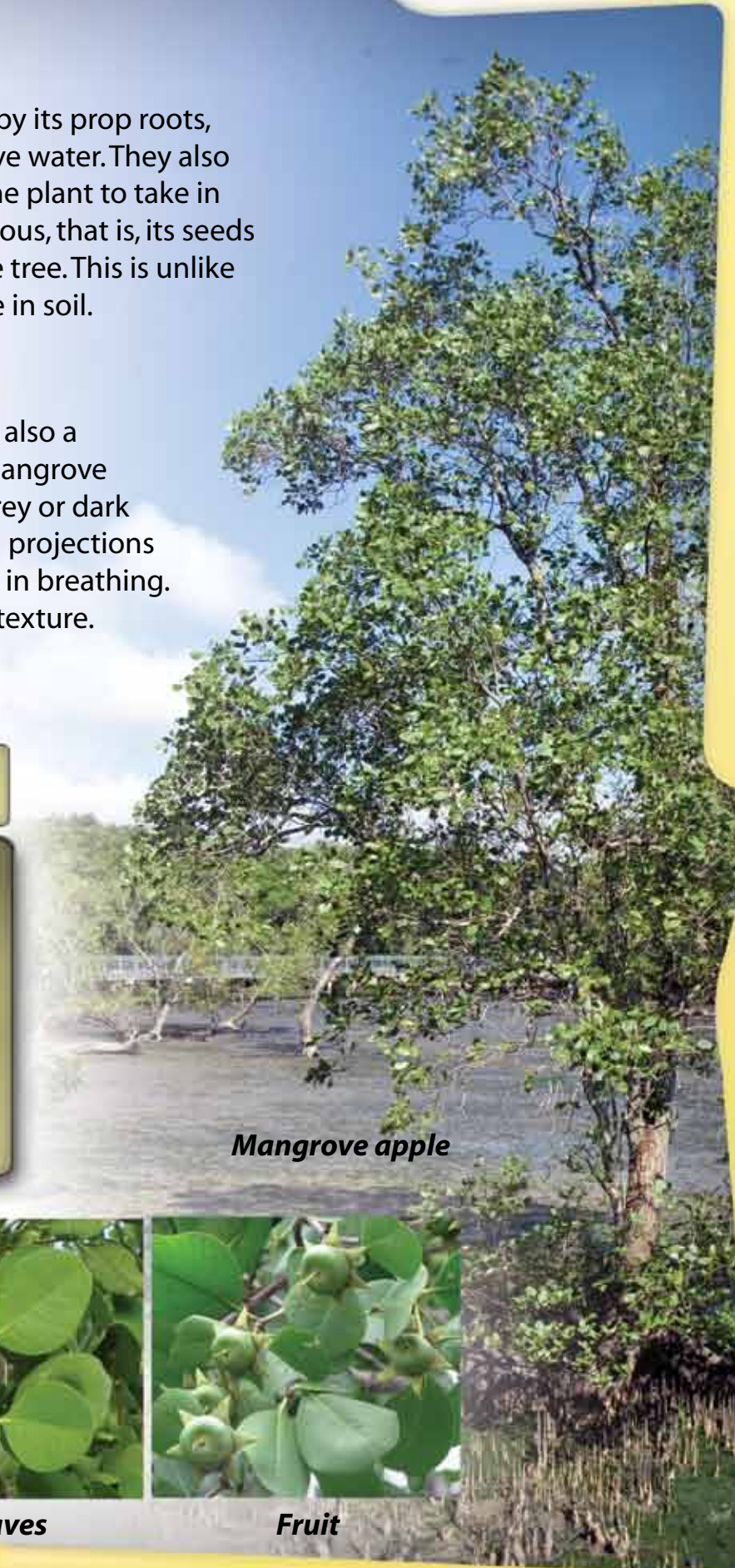
One can recognize a red mangrove by its prop roots, which help the plant to remain above water. They also provide extra support and enable the plant to take in oxygen. The red mangrove is viviparous, that is, its seeds germinate while still attached to the tree. This is unlike most plants, whose seeds germinate in soil.

## Apple of the eye

Mangrove apple (*Sonneratia alba*) is also a common type of mangrove plant. Mangrove apples are cream-coloured with a grey or dark brown bark. They have cone-shaped projections called pneumatophores, which help in breathing. Leaves are rounded with a leathery texture.

## GREEN ZONE

Mangrove trees are hermaphrodites. This means that they have both male and female flowers on the same tree, and pollinate and reproduce on their own.



**Mangrove apple**



**Flower**



**Leaves**



**Fruit**

# IT'S IN THE ROOTS

**How do mangroves survive salty water, waterlogged soil, and lack of oxygen? What is so special about them? Is it their roots?**

## Wonder roots

Mangrove roots not only provide support, but also help the plant to breathe, as well as withstand currents and storms. Their aerial roots have tiny pores called lenticels that take in air. The roots also contain large spaces called aerenchyma, which transport air from one part of the plant to another.

## No salt, please!

Mangroves have special mechanisms to make them salt tolerant. Some mangroves take in salt and excrete it through salt glands, while others filter salts at the root zone itself by means of reverse osmosis, thereby taking in only water. There are some mangroves that accumulate salt in the leaves, which they shed during summer.

## GREEN ZONE

Mangrove roots have spongy tissue inside, through which oxygen passes and spreads throughout the plant.

## Kicking the water habit

Mangrove plants survive in very little fresh water. They have thick, waxy leaves to prevent loss of water by evaporation. Mangroves grow in waterlogged soil with little oxygen. So, their roots absorb gases like oxygen and nitrogen directly from the atmosphere.



*Mangrove roots have three main functions—providing support, obtaining nutrition from the soil, and taking in oxygen from the air.*



*Mangroves have lenticels to take in air, and finger-like roots, or pneumatophores, that project out of the mud in great numbers.*

# ROOTS: THE BIG PICTURE

**Now that we know what mangroves are and the special features of their roots, let's find out what they actually do. How do these special roots help the environment?**

## Cleaning water

Mangrove roots slow the flow of water, enabling sediments to be deposited on the roots. A number of harmful metals and particles get deposited on the roots, thus reducing the contamination of water. Underwater, a number of organisms cling on to the roots and act as filter-feeders. These filter-feeders clean the water of the silt and nutrients. As a result, clean and clear water goes out into the sea, because of which the coral reefs flourish.

*Mangroves slow down the force of sea waves and thus, protect the coastline.*

## GREEN ZONE

India is home to more than 7 per cent of the world's mangrove forests. Mangroves make up for 8 per cent of the Indian coastline. Eighty per cent of these forests are found on the eastern coast of India.

## Protecting the coasts

Mangroves protect coastal areas from erosion by stabilizing the shorelines with their specialized root systems. They also protect the coasts from storms, hurricanes, and tsunamis. The big roots help in cutting down the energy contained in large waves.

## Food and lodging!

Mangroves are home to a large number of fishes, crabs, sea snails, shellfish, and algae. The leaves and shoots are food for monkeys and small insects. The fallen leaves provide nutrients to the surrounding mangroves, as well as to the coral reefs. The mangrove fruit is eaten by people, while the leaves are used as source of tea, medicine, and livestock feed. Mangrove flowers are important in honey production.

## Honey collectors in the Sundarbans

Photo courtesy: Pradeep Vyas



*Roots trap silt and sediments that may contain dangerous heavy metals. As a result, clear water washes out into the sea.*



# MANGROVES AROUND THE WORLD

What are the major mangrove habitats around the world? Let's take a trip along the coasts and discover where these unique forests are found.

## Coast to coast

Mangroves are found in warmer areas, along the tropical and subtropical coasts of Africa, Australia, Asia, and North and South America. The mangroves along the southern coast of Asia are rich in biodiversity. These forests form one of the most important ecosystems in the Indian subcontinent. Many of the islands in the Indian Ocean, Arabian Sea, Bay of Bengal, the South China Sea, and the Pacific Ocean are mangrove habitats.



*Sundarbans, West Bengal, India*

## In river deltas

Mangrove forests are common in the deltas of large Asian rivers. The Sundarbans, in the delta of the Ganga spread over West Bengal in India and Bangladesh, is the world's largest mangrove forest.

## The Asian giants

There are mangroves along the coasts of Borneo, Sumatra, and Sulawesi islands in Indonesia. Large mangals grow in the Andaman and Nicobar islands in the Bay of Bengal and along the coast in the Indian state of Gujarat.

*Mangroves are found in over two-thirds of the saltwater coastal areas of tropical and subtropical Africa, Asia, Australia, and North and South America.*

## GREEN ZONE

In the temple town of Chidambaram, near Pichavaram, Tamil Nadu, the thillai tree (*Excoecaria agallocha*), a type of mangrove, is believed to have active chemicals that cure leprosy.

# AT HOME IN THE MANGROVES

Mangrove forests are home to a variety of animals, insects, amphibians, and fishes. Algae, barnacles, oysters, sponges, and bryozoans, which require a hard surface to support themselves, use the muddy surface of the mangal as a shelter.

## Designed to survive

Sessile organisms (like mussels and barnacles) survive the fast tidal movements in mangrove forests by anchoring themselves to the roots. Mobile fauna avoid the tide by burrowing in the mud (crabs) or climbing up and down tree trunks (monkeys). The mudskipper fish can stay alive out of water because its gills are inside an enlarged cavity that contains both water and air. The tissue within the cavity can absorb oxygen from the air as long as it remains moist.

Lizards in mangrove habitat have a nasal gland that secretes salt into the nasal cavity from which it is sneezed out; crocodiles use a number of salt glands located on the tongue; while sea turtles have salt glands modified into tear glands in their eyes.



**Mangroves are nesting grounds for hundreds of species of birds, which build nests on the branches.**



**Mangrove branches provide shelter for tree-climbing creatures like monkeys.**



**The tangle of mangrove roots hide young fishes and shrimps from larger predators.**

## Safe haven

Tree-climbing crabs and sea snails often climb up mangrove roots to protect themselves from large predators. The tangled roots of the trees provide a resting and hiding place for young fishes and shrimps. Larger animals such as the proboscis monkey and birds like the heron use the mangals as homes and as nesting sites respectively.

## Food and nutrition

Monkeys and small insects living on mangrove branches snack on the shoots and leaves. Fallen leaves are a good source of nutrients within the mangrove habitat. These leaves are also washed away closer to the surrounding coral reefs, where they are broken down by crabs. The tiny remnants of the mangrove leaves are further broken down by micro-organisms and converted into useful minerals.

**Mangrove snails feed on algae and other plant material, and are in turn eaten by the larger fishes and birds.**

## GREEN ZONE

Mangroves are very leafy, and take in a lot of carbon dioxide from the atmosphere to make biomass. This reduces the amount of carbon dioxide in the atmosphere.



# DYING MANGROVES

**Mangroves help in protecting coastlines from erosion and storms, provide timber, and are a breeding ground for fishes. But mangroves are now in danger across the world.**

## Reasons for destruction

Shrimp farming is a major reason for the destruction of mangroves. These forests are the natural habitat of shrimps. Large areas of mangroves are cleared to create artificial ponds for shrimps. This has also led to the loss of habitat for other fish.

## Rising temperatures, rising seas

Rising sea levels due to climate change and the consequent rising temperatures pose a grave threat to mangroves. Large areas of coastal mangroves could be lost if sea levels continue to rise due to the expansion of the oceans and melting of polar ice caps.

## Development at a cost

Mangrove forests are also cleared, filled in and dug under for agriculture, aquaculture, and other development activities. Pollution, including oil spills, is also a major threat to mangroves. Building of ports and jetties is another reason for cutting down of mangroves.

## From the pages of history

During the Vietnam War, 11 million gallons of herbicide known as Agent Orange was sprayed over more than a 1000 square kilometres of mangrove forests in the Mekong Delta. Even today, not a single mangrove plant grows in this region.



***If mangroves are destroyed, migratory birds will no longer have a safe haven to halt and rest.***

## GREEN ZONE

The increasing human population is exerting tremendous stress on the mangroves, with land reclamations and discharge of waste causing their degradation.

***Mangrove deforestation is contributing to decline in fisheries, degradation of clean water supplies, increasing salinity of coastal soils, erosion, and land subsidence.***



# WHY MANGROVES ARE IMPORTANT

The destruction of mangroves will have an impact not only on the animals that live in the mangroves, but also on people who depend on these forests.

## Home of endangered wildlife

The Sundarban mangrove forests are home to more than 35 species of reptiles, 270 species of birds, and 42 species of mammals. Among them is the saltwater or estuarine crocodile—the largest of all living reptiles. In India, this globally endangered species is also found on the Andaman and Nicobar islands.

## Pride of Bengal

About 400 tigers—the largest population of wild tigers—live and swim among the mangrove islands and also hunt scarce prey like chital deer, barking deer, and wild pig. The Sundarbans is also the nesting place of the endangered Olive Ridley turtles, one of the smallest species of marine turtles in the world. Other endangered animals include the white-bellied sea eagles and the Indian smooth-coated otters.

Photo courtesy: Pradeep Vyas



## GREEN ZONE

The unique Sundarbans get their name from the mangrove species *Heritiera fomes*, locally known as Sundari, a common species in the region.

Royal Bengal tiger: pride of the Sundarbans



Olive Ridley turtle

## Life and livelihoods

Coastal communities depend on mangroves for their livelihood. These forests provide wood products like timber, poles, firewood, charcoal, and tannin. Non-wood products include thatch, honey, wildlife, fish, fodder, and medicine. Apart from the products, mangroves provide coastal protection against wave and wind erosion, as well as moderate the impact of storms and cyclones.



Sea eagle



Estuarine crocodile

# SAVE THE MANGROVES

**Efforts are being made to save mangroves and regenerate the lost forests. Various methods are being adopted in different parts of the world.**

## Giving life

'Fixing' or sowing mangrove seeds (propagules) is done in salt marshes, swamps or intertidal zones, which are flooded daily by sea water. The seeds also require rainfall for some time during the growth period. This method is called artificial regeneration. In many parts of coastal India, mangrove forests are being regenerated in a bid to save this unique ecosystem from destruction and protect our fragile coastline. This is crucial for the coastal communities, who benefit greatly from such a healthy ecosystem.

## Lending a helping hand

Mangroves for the Future (MFF) is a major initiative to save the mangroves. MFF works with governments and communities to conserve coastal ecosystems throughout the Indian Ocean region. After the destruction caused to mangroves by the tsunami in 2004, there is a special focus on mangroves. Initially, MFF focused on the countries worst affected by the tsunami—India, Indonesia, Maldives, Seychelles, Sri Lanka, and Thailand. It has recently expanded to include Pakistan and Vietnam.



***Mangrove forests in estuaries are cleared to provide lagoons to raise shrimps.***

## GREEN ZONE

Scientists believe that destruction of coastal mangroves will lead to large-scale flooding of coastal areas if the sea level rises because of climate change.

***Artificial regeneration of mangroves***

# TIME TO ACT!

Mangroves are our natural barriers and defence against severe storms, cyclones, and tsunamis. Their role in coastal protection, and in reducing the loss of human lives and damage to property has been well established, especially after the Orissa supercyclone, Cyclone Nargis, and the tsunami of 2004. In addition to being the soldiers of our coasts, mangroves improve the livelihoods of fishing communities, provide salt-tolerant genotypes and help in carbon sequestration. Therefore, it is important to save this unique ecosystem before it is lost forever.

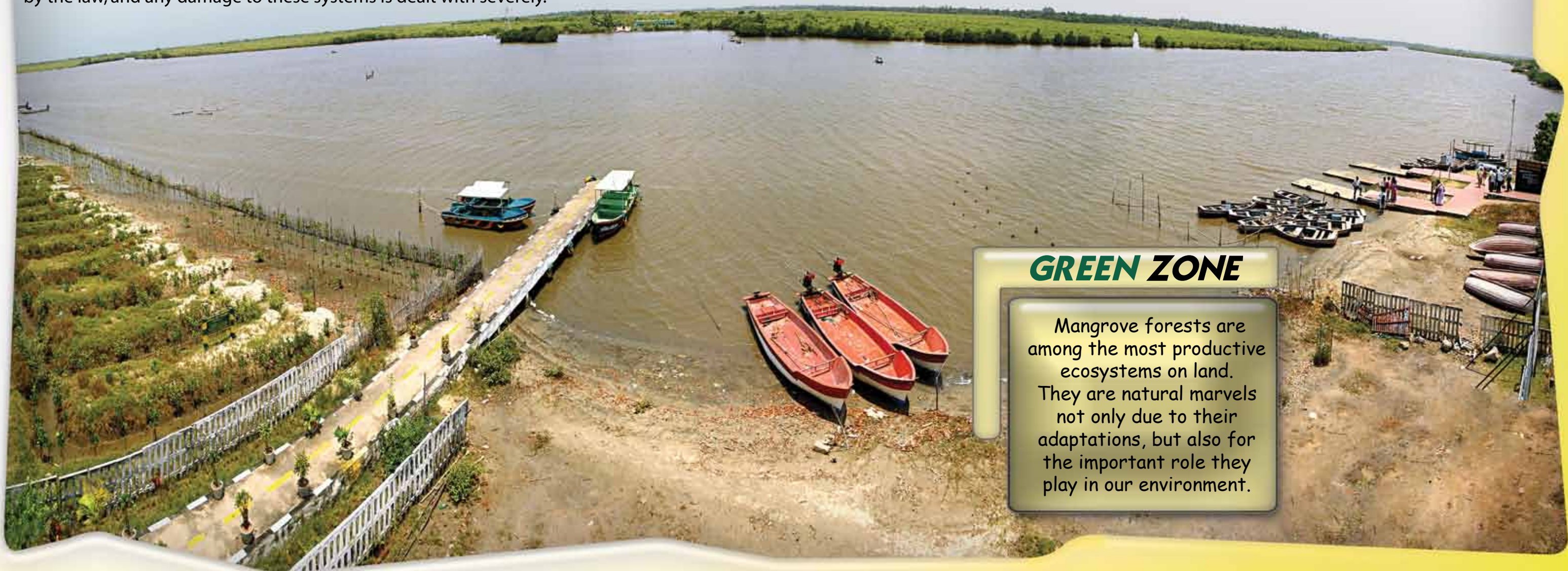
## Helping the mangroves: initiatives of the Ministry of Environment and Forests, Government of India

Planting mangroves is one of the important components of coastal management and the Ministry of Environment and Forests (MoEF) has over the last two decades been supporting the coastal states to raise and maintain mangrove plantations. Thanks to these efforts, the area under mangroves has increased by 58 square kilometres in Gujarat, Orissa, Tamil Nadu, and West Bengal. Mangroves are also provided the highest protection by the law, and any damage to these systems is dealt with severely.

## Benefits from mangroves—as source of salt-tolerant genes

In view of the increasing salinization of coastal regions due to climate change and sea-level rise, there is a real need to develop salt-tolerant crop varieties that can be grown in the coastal areas. It is again the mangroves that have come to our help. Scientists at the M S Swaminathan Research Foundation (MSSRF) have isolated salt-tolerant genes from the common mangrove species *Avicennia marina* and have successfully transferred them to crops like rice, mustard, and black gram. These are undergoing field trials before being commercially produced.

***In Pichavaram district, Tamil Nadu, the mangrove forest along the coast reduced the speed and intensity of the furious waves during the 2004 tsunami. The amount of water carried by the waves was also reduced as most of it was deposited in the forest.***



## GREEN ZONE

Mangrove forests are among the most productive ecosystems on land. They are natural marvels not only due to their adaptations, but also for the important role they play in our environment.

# MANGROVE MASTERMIND

Find the following words in the grid.

- Sundarbans ■ Rhizophora ■ Mangrove ■ Viviparous ■ Orange ■ Animals
- Mekong ■ India ■ Storm ■ Regenerate ■ Tsunami

S	U	N	D	A	R	B	A	N	S	A	B
A	H	L	K	J	I	H	G	F	E	D	C
M	B	R	H	I	Z	O	P	H	O	R	A
N	O	P	I	Q	R	S	T	U	V	W	X
C	Z	D	Y	M	A	N	G	R	O	V	E
F	A	E	G	B	P	C	T	D	R	I	E
N	M	L	K	J	I	H	U	G	A	V	F
T	S	U	N	A	M	I	V	O	N	I	P
T	T	S	H	N	E	N	R	S	G	P	Q
M	O	I	U	I	K	D	V	W	E	A	X
C	R	B	J	M	O	I	Q	A	Z	R	Y
D	M	K	E	A	N	A	F	G	H	O	I
L	M	L	O	L	G	P	R	K	D	U	J
N	O	N	P	S	Q	R	S	T	U	S	V
R	E	G	E	N	E	R	A	T	E	X	W

Can you answer these correctly?

1. Mangrove forests are also called \_\_\_\_\_.  
 (a) Mangas  
 (b) Manglas  
 (c) Mangs  
 (d) Mangals
  
2. Mangrove plants have cone-shaped projections that help in breathing, called \_\_\_\_\_.  
 (a) Propagules  
 (b) Viviparous  
 (c) Pneumatophores  
 (d) Photosynthesis
  
3. To which family do mangroves mainly belong?  
 (a) Rhizophoraceae  
 (b) Avicennia  
 (c) Red mangrove  
 (d) Black mangrove
  
4. Which type of bacteria causes the release of gases and other substances from mangrove plants?  
 (a) Aerobic bacteria  
 (b) Anaerobic bacteria  
 (c) Plasmodium  
 (d) Amoeba
  
5. In which year did the Indian Ocean tsunami occur?  
 (a) 2001  
 (b) 2006  
 (c) 2008  
 (d) 2004
  
6. The Royal Bengal tiger is found in which mangrove forest?  
 (a) Mekong Delta  
 (b) Mangrove forests of Sri Lanka  
 (c) Sundarbans  
 (d) Pichavaram
  
7. The farming of which species is a major cause of destruction of mangrove forests?  
 (a) Lobsters  
 (b) Shrimps  
 (c) Prawns  
 (d) Chinook salmon
  
8. \_\_\_\_\_ was sprayed over mangrove forests in the Mekong Delta during the Vietnam War.  
 (a) Agent Blue  
 (b) Agent Green  
 (c) Agent Red  
 (d) Agent Orange
  
9. Which great Indian river ends in an estuary surrounded by one of the largest mangrove forests in the world?  
 (a) Ganga  
 (b) Yamuna  
 (c) Gomti  
 (d) Narmada
  
10. Mangrove trees are \_\_\_\_\_.  
 (a) Crustaceans  
 (b) Amphibians  
 (c) Hermaphrodites  
 (d) Mammals

Answers: 1. (d); 2. (c); 3. (a); 4. (b); 5. (d); 6. (c); 7. (b); 8. (d); 9. (a); 10. (c)

# GLOSSARY

<b>Intertidal</b>	Of or in the region between the high tide mark and the low tide mark
<b>Estuary</b>	A body of water formed where fresh water from rivers and streams flows into the ocean, mixing with the seawater
<b>Lagoon</b>	A shallow body of water, especially one separated from a sea by sandbars or coral reefs
<b>Genus</b>	Taxonomic category ranking below a family and above a species and generally consisting of a group of species exhibiting similar characteristics
<b>Pneumatophore</b>	An air-filled root (submerged or exposed) that can function as a respiratory organ of a marsh or swamp plant
<b>Viviparous</b>	Plants that reproduce by developing a new plant while still attached to the parent plant; animals that reproduce by bearing live offspring
<b>Lenticel</b>	An opening that allows gases to be exchanged between air and the inner tissues of a plant
<b>Impermeable</b>	Not permeable; not permitting fluids to pass through it





# Mangroves

Soldiers of our Coasts

## Mangroves for the Future

Mangroves for the Future (MFF) is a joint partnership-based regional initiative with UN and donor agencies, NGOs, local communities and the private sector to promote investment in coastal ecosystems. It focuses on eight focal countries (India, Indonesia, Maldives, Pakistan, Seychelles, Sri Lanka, Thailand and Vietnam), plus several outreach countries. MFF provides a unique regional platform for Integrated Coastal Management (ICM), using mangroves as the entry point.

[www.mangrovesforthefuture.org](http://www.mangrovesforthefuture.org)



ISBN 978-2-8317-1264-2



This book is printed on recycled paper

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