



Mangroves Manual

for Junior High and High School Teachers

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Management of Natural Resources in the
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Preface

Mangroves are important wetland forests that grow along tropical and subtropical coastlines. Mangroves forests are a vital part of Viet Nam's natural environment as they:

- Help protect coastlines from storms, erosion and floods;
- Are an important feeding site, home and nursery ground for many fish species, shrimps, crustaceans and other species such as birds and mammals;
- Provide important raw materials for humans, such as food, fibres, medicines, wood and dyes.

Given the importance of mangroves to both the environment and to people's livelihoods, it is essential that students learn about mangroves - what they are, their characteristics and how to protect them.

The GIZ project; 'Management of Natural Resources in the Coastal Zone of Soc Trang Province', in partnership with the Department of Agriculture and Rural Development and the Department of Education and Training, have developed this teachers' manual as a tool to aid teachers in educating their students about the importance of mangrove forests.

This manual is divided into two lessons:

- Lesson 1: What are Mangroves?
- Lesson 2: Why are Mangroves important?

Each lesson contains background and extra information for students and teachers as well as questions for students to answer and a list of suggested activities (such as conducting local research, puzzles etc.) which are designed to enhance students' understanding of mangroves.

Lesson 1: What are Mangroves?

Overview: By the end of this lesson, students will have gained a basic knowledge about what mangroves are including their main characteristics.

Objective: Students will:

1. Explore what 'mangroves' are.
2. Examine the characteristics of different mangrove species.
3. Examine the history of mangrove forests in Soc Trang Province.

Prerequisite knowledge – Teacher

The 'Background Reading' below will give teachers an overview of mangrove forests, their characteristics, their environment and their existence in Soc Trang Province.

'Extra information' sections have been included as an additional resource for teachers in case they receive questions from students, or want to give their students additional information.

Prerequisite knowledge – Students

Students do not need any prerequisite knowledge for this lesson. However, prior to commencing this lesson, it is recommended that teachers gauge what level of awareness their students already have about mangroves. This can be done using Activity 1 ('Mind-Bubble') which is included in Annex 1 of this document.

Potential activities

Annex 1 contains a list of activities that are designed to enhance students' understanding of mangroves. Activities 1 and 2 are particularly relevant for Lesson 1, but activities 6, 7 and 10 may also be useful.

Questions for students to answer

Upon completion of this lesson, students should be able to answer the following questions:

1. Where do mangrove forests grow?
2. How are mangroves able to survive in muddy/brackish water?
3. How are the seeds from mangrove trees spread?
4. Where in Soc Trang Province do mangroves grow?

Lesson 1: Background Reading

1. What are mangroves?

Mangroves are woody, seed bearing trees and shrubs that grow predominantly along sheltered tropical and subtropical coastlines.

Around the world there are almost 70 species of mangroves, which vary in size from 1.5 to 50 metres tall⁽¹⁾. Mangroves can be found in almost every tropical and subtropical country and cover a total area around the world of between 11–18 million hectares⁽²⁾.

Mangroves typically grow in the shallow, muddy areas of estuaries (i.e. river mouths), bays, harbours and shorelines, that are not regularly prone to large waves. In these areas mangroves receive a mixture of freshwater (from rivers and streams) and salt water (from the ocean), both of which provide nourishment for the mangroves.

Did you know?

Mangrove forests are one of the most productive ecosystems in the world.

1.1 Characteristics of mangroves

Conditions in the muddy, brackish water areas where mangroves usually grow are challenging as:

- Oxygen levels in the muddy soils are often low;

- The area is regularly inundated/flooded;
- Freshwater is limited; and
- Salinity can be extremely high – 30,000 to 40,000 ppm (parts per million) for pure ocean water, up to 90,000 ppm in areas where salt is concentrated through evaporation⁽³⁾ – the salinity of drinking water is commonly 100 ppm.

However mangroves have specially adapted features to enable them to flourish in such conditions.

1.1.1 Roots

The roots of mangroves plants help provide stability in soft muddy conditions by growing down from the trunk and/or spreading horizontally underground.

Respiration by mangroves occurs through lenticels (minute openings in the stem or roots). Some mangrove species have developed specialised root systems in order to ensure that the lenticels remain

above tidal waters or mud (which is anoxic or oxygen deprived).

Some mangroves species grow pneumatophores, or roots with lenticels located on them, which stick up out of the water/mud. Some pneumatophores look like a straw/snorkel (see Figure 1), which typically protrudes out of the water/mud by about 30 cm⁽¹⁾.

Did you know?

For mangrove species, the amount of biomass underground is larger than that above ground, thus reducing the chance of mangroves being washed away or blown over.

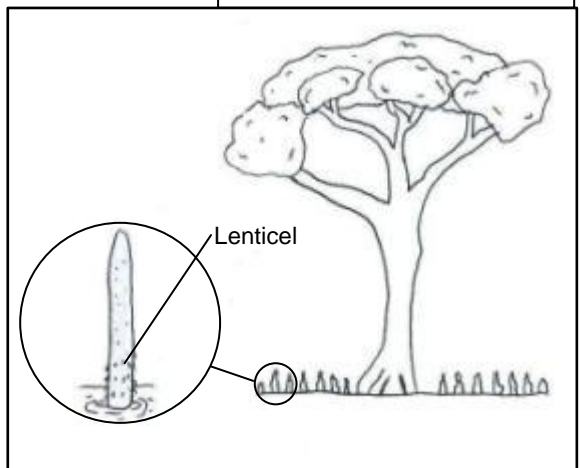


Figure 1: Straw pneumatophores

Other pneumatophores, once they protrude out of the water/mud, bend over and return back underground (and look like a knee – see Figure 2).

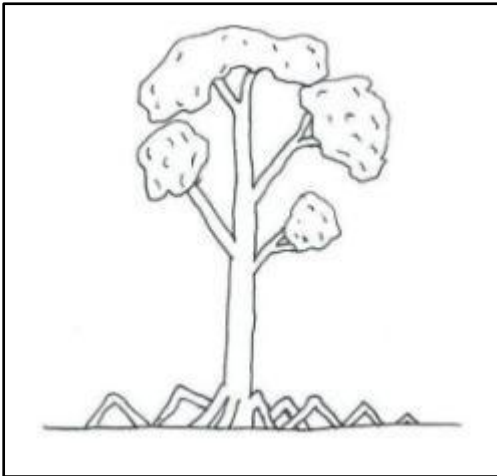


Figure 2: Knee roots

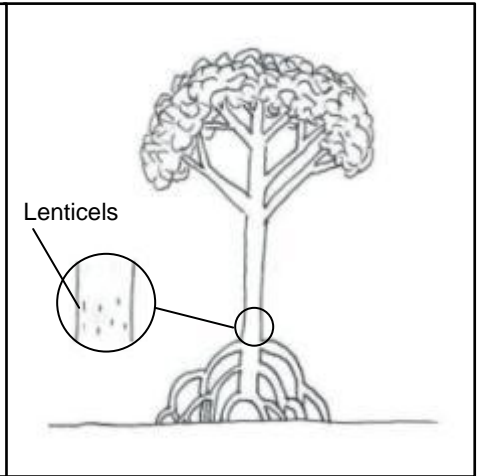


Figure 3: Prop/stilt roots

Other species of mangroves grow roots which prop the stem of mangrove plant, where the lenticels are located, above the mud/water level (see Figure 3).

1.1.2 Salt tolerance

Mangroves are highly adapted to survive in salty conditions. Different species of mangroves use one, or a combination of the following processes to cope with salty conditions:

- Exclusion – some mangrove species have highly impermeable roots, which can act as filters allowing water in but excluding salt;
- Excretion – some mangrove species are able to excrete salt from the main body of the plant through salt glands located on their leaves; and/or

- Accumulation – some species of mangroves deposit accumulated excess salt in their bark or leaves.

1.1.3 Limited freshwater

As freshwater can be limited in the areas where mangroves grow, mangrove plants have developed ways of limiting the amount of water they lose through their leaves. Some mangrove plants can limit the opening of their stomata (pores on their leaves used in gas exchange), while others species can vary the orientation of their leaves to avoid the harsh midday sun.

1.1.4 Seeds

Mangroves produce seeds called propagules which are specially adapted to encourage regeneration in the conditions mangroves live in.

Propagules develop on the mangrove plant. In some species the propagules remain within the fruit of the tree until the fruit ripens and falls off the tree (see Figure 5). In other species the propagules grow through the fruit while still on the tree and can reach a remarkable size before falling into the water (see Figure 4).

Some propagules are buoyant, so when they fall off the tree they can float long distances before they find a suitable home (see Figure 5).



Figure 4: Rhizophora propagule



Figure 5: Sonneratia fruit

Other propagules are not buoyant and when they fall off the tree they just stick into the mud below (which is a suitable environment for survival and establishment – see Figure 5).

Some propagules have the ability to produce their own food through photosynthesis and can survive for weeks, months, or even over a year until conditions are right and/or they reach a suitable environment.

1.1.5 Natural zonation

Each mangrove species has its own characteristics and as such grows best in specific sites along the shore. This may be the primary reason why, on some shorelines, natural zonation can be observed (see Figure 6), with certain types of species located nearer the ocean (in deeper, rougher waters) and other located nearer the land (in shallower, calmer waters).

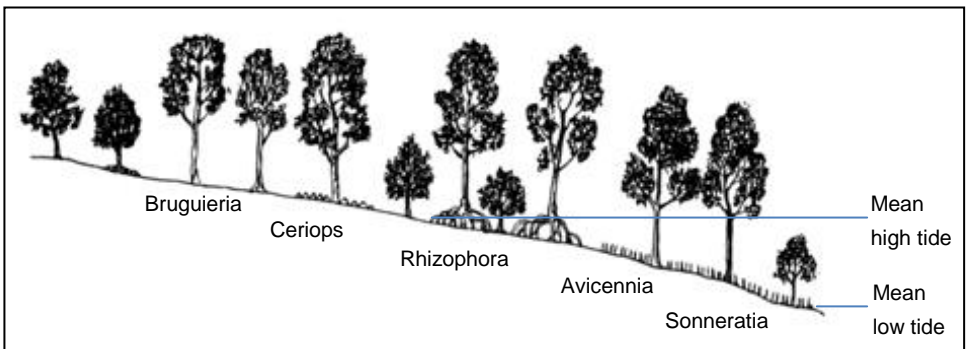


Figure 6: Natural Zonation of a mangrove forest

Adapted from Phan Ngyen Hong and Hoang Thi San (1993)

Extra Information: Planting mangroves

When planting mangroves, it is important to look at the conditions of the site, as certain species of mangroves may not be able to survive due to the natural conditions at that particular site – so planting those species there may be useless.

For example, some mangrove species like shallow water, others like deeper water. Some mangroves like calm conditions, while others can tolerate rougher conditions. Some mangroves like soft mud, while others like harder mud. Some species prefer fresh water, while some can tolerate very salty water.

This is why when you plant mangroves, it is vital to understand the conditions of the site and plant the right species for that site.

2 Mangroves in Viet Nam

There are approximately 37 different types of mangrove species in Viet Nam alone, with the Mekong Delta having the largest amount and greatest diversity of mangroves. In 2005 mangroves covered a total area of approximately 209,741 ha in Viet Nam⁽⁴⁾, with most of this located in the Mekong Delta (total 91,080 ha⁽⁵⁾).

2.1 Mangroves in Soc Trang

Mangroves grow naturally along the coastline of Soc Trang. Available historical documents show that mangroves have existed in Soc Trang for over 100 years, predominantly in the mouths of Hau and My Thanh rivers, but also sporadically along the coastline of Vinh Chau District. However much of this natural mangrove forest was destroyed during the last 50 years through cutting for firewood, conversion into agricultural land or shrimp farms and spraying of herbicides during the American War.

Over the last two decades planting schemes have helped increase the area covered by mangrove forests in Soc Trang and by 2008 mangroves covered an area of approximately 4,200 ha⁽⁶⁾. Large stands of mangroves currently exist near mouths of Hau and My Thanh rivers,

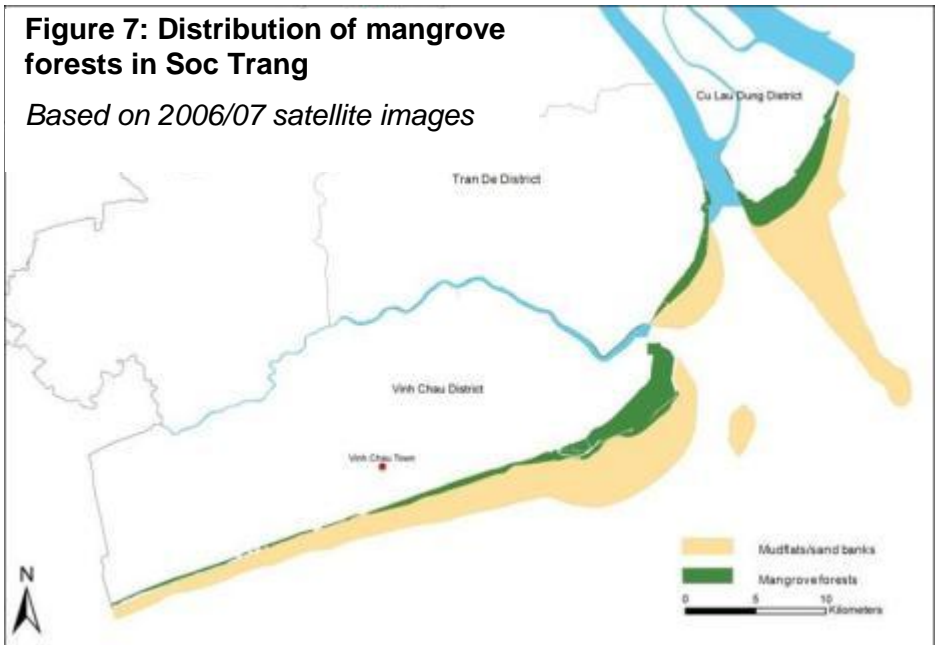
in the districts of Vinh Chau, Trun De and Cu Lao Dung, while a narrow belt of mangroves can also be found along the entire coastline of Vinh Chau District.

Twenty-six species of mangroves have been recorded along the coast of Soc Trang (refer to Annex 2 for a species list). The most common species in Soc Trang are *Sonneratia caseolaris*, *Avacennia marina*, *Rhizophora apiculata*, *Ceriops tagal* and *Bruguiera cylindrical* (refer to Annex 3 for biological descriptions and drawings of each species).

Sonneratia forests occur naturally along estuarine and coastal areas near the Mekong River mouths in An Thanh Nam, An Thanh Ba, Lich Hoi Thuong, and Trung Binh communes.

Avicennia forests occur mainly along the coast of Vinh Hai, Vinh Chau and Lac Hoa communes. *Avicennia* regenerates naturally on soft mud flats further away from the fresh water of the river mouths.

Rhizophora apiculata has been planted extensively during the last 20 years along the coast of Vinh Chau District, particularly in areas which were originally covered by natural *Avicennia* forests.



Lesson 2: Why are mangroves important?

Overview: By the end of this lesson, students will have gained a basic knowledge about why mangroves are important, what is threatening them and what is being done to protect mangroves

Objective: Students will:

1. Explore the benefits that mangrove forests provide for humans and the environment.
2. Examine the threats that mangrove forests are currently facing.
3. Explore how they can help protect mangrove forests

Prerequisite knowledge – Teacher

The ‘Background Reading’ below will give teachers an overview of why mangroves are important, what is threatening them and what is being done to protect mangroves.

‘Extra information’ sections have been included as an additional resource for teachers in case they receive questions from students, or want to give their students additional information.

Prerequisite knowledge – Students

Students will need a basic understanding of mangroves, their characteristics, their environment and existence in Soc Trang Province. This is covered in **Lesson 1: What are Mangroves?**

Potential activities

Annex 1 contains a list of activities that are designed to enhance students’ understanding of mangroves. Activities 3–10 may all be useful for Lesson 2.

Questions for students to answer

Upon completion of this lesson, students should be able to answer the following questions:

1. What benefits do mangrove forests provide for humans?
2. What benefits do mangroves provide to animals?
3. What happens to fish stocks when mangrove forests decrease in size?
4. What are the main ways that mangrove forests are being damaged and destroyed?
5. What are the ways in which humans are damaging and destroying mangrove forests?
6. How can you help protect mangrove forests?

Lesson 2: Background Reading

1. Why are mangroves important?

Mangroves are important because they provide many benefits for humans, animals and surrounding ecosystems.

1.1 Provide livelihood for people

Mangroves provide many materials that humans depend on. Humans eat, collect and sell many of the fish and shellfish that live in mangroves.

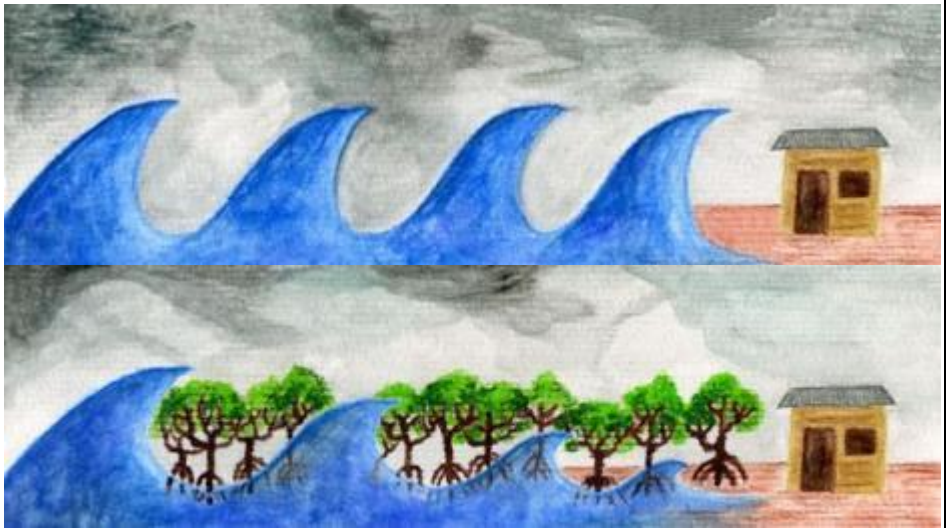
Mangroves also supply many materials which humans regularly use, such as firewood and charcoal (from dead branches), medicines, fibres, dyes, honey and nypa palms for roofing. Mangroves are culturally significant to many people and can attract industries such as tourism.

1.2 Provide protection from natural disasters

Mangroves protect people, houses and farmland from natural disasters such as storms, typhoons, floods and tidal waves. The trunks, branches and roots of the mangroves act as a barrier, helping reduce the impact of waves, flooding and strong winds.

Did you know?

A 50-metre wide belt of mature mangroves can reduce 1 metre high waves to less than 0.3 metres. To reduce the total wave energy of 1 metre waves (i.e. to 0 cm), a 150 metre wide belt of mature mangrove forest is needed.



1.3 Reduce erosion and protect soils

Mangroves have a large system of trunks, branches and roots which protect the coastline and soil from erosion and the impact of waves. Often when mangroves forests are cut down, the river banks and coastlines that they used to protect become severely eroded.

This large system of trunks, branches and roots also help in the process of creating new land by trapping and solidifying sediments. In this way, mangroves help build their own environment.

1.4 Reduce pollution

Mangroves help remove nutrients, sediment and pollution from the ocean and waterways. In this way they help purify water to keep nearby ecosystems (such as coral reefs, seagrass beds and beaches) clean.

1.5 Reduce the impacts of climate change

With climate change predicted to increase the occurrence of severe weather events, such as storms, floods and typhoons, mangroves will become particularly important for protecting people, houses and farmland from these events.

Mangroves are also highly effective at removing greenhouse gases (which cause climate change) from the atmosphere.

1.6 Provide food and habitat for many animals

Mangroves provide a home and a source of food for many types of fish, shellfish, birds and mammals. Some of the animals that can be found in mangroves include: many types of fish; many types of birds; crabs; cockles; clams; oysters; shrimp; snails; rats; bats; and monkeys.

Mangroves are important feeding, breeding and nursery grounds for many types of fish, crabs, shellfish and shrimp. The leaves and bark of mangroves, when decomposing, provide detritus which is an important source of food for many types of aquatic life. Similarly the plankton that gathers around the roots of mangroves is an important food source for many types of fish.

Mangroves are particularly important to many types of commercial fish, with many laying their eggs in roots of

Did you know?

Every hectare of mangroves destroyed, causes a loss of about 1 tonne of fish catch per year.

mangroves for protection. More importantly, 75% of all tropical commercial fish species spend part of their lives in the mangroves.

Mangroves play an important role in large complex foodwebs (see Figure 7), which means destruction of the mangroves can have serious and far-reaching impacts on aquatic and marine life.

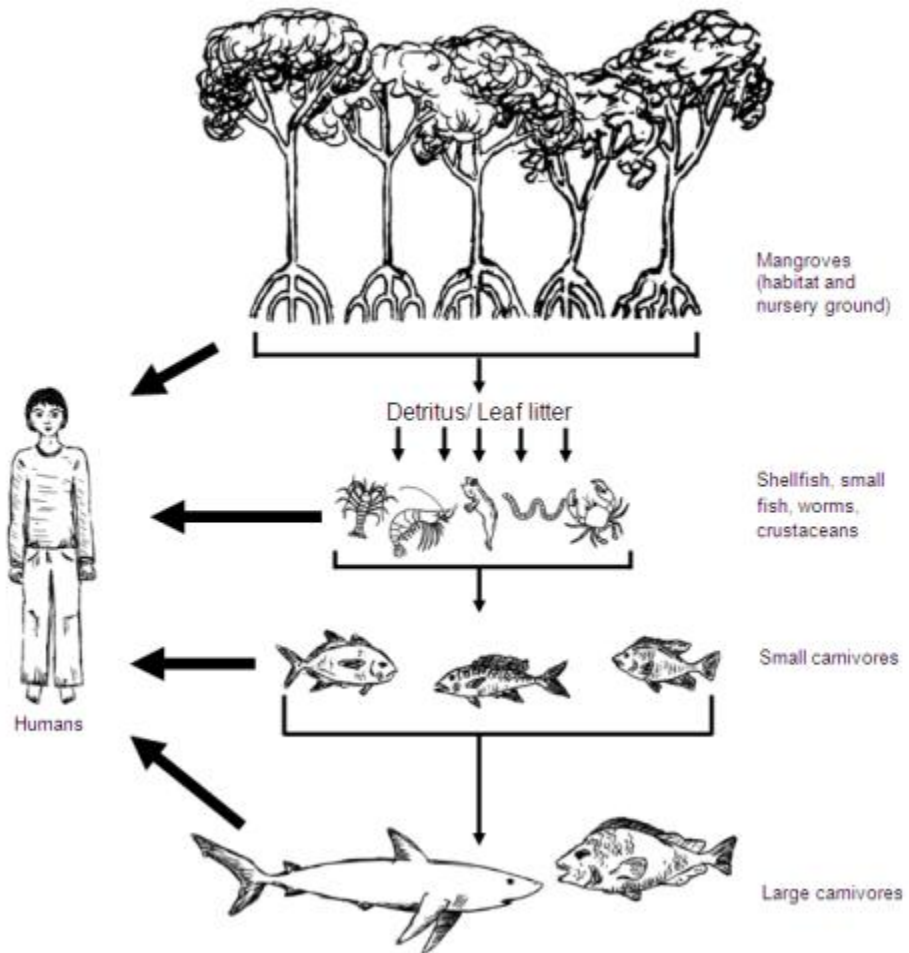


Figure 8: Foodweb associated with mangrove forests

Mangrove degradation is a major cause of the decline in aquatic life, because the mangroves are no longer there to act as nursery or feeding ground for young aquatic life. Consequently aquatic stocks cannot recover. Fish, shrimp, shellfish and crab stocks decrease as mangrove stocks decrease...**No young aquatic life today means: No aquatic life to catch in the future.**

2. Threats to mangroves

In the past, the importance of mangroves to the environment and for human protection was not well understood and subsequently many mangroves around the world were destroyed. Approximately half of the world's mangroves have been destroyed during the last 50 years^(1 & 3).

In Viet Nam, during the period from 1969 to 1990, approximately 33% of the country's mangroves were destroyed, reducing the overall coverage from 425,000 ha⁽¹⁾ to 286,400 ha. In 2002 the area covered by mangroves was just 155,290 ha⁽⁷⁾.

Unfortunately, mangroves are still being destroyed through a number of human activities and natural processes.

2.1 Destruction by humans

The biggest threat to mangroves is destruction by humans. Many people destroy mangroves by cutting them down for firewood and timber, or for land for shrimp ponds, agriculture and other types of developments or infrastructure projects.

Other people uproot and destroy mangroves while digging for worms or crabs. Some fishing practices are also harmful to mangroves – such as push/pull nets which can damage or uproot young mangrove plants.

Did you know?

Approximately a quarter of mangrove forests around the world have been destroyed to create shrimp ponds⁽¹⁾.

2.2 Chemicals and pollutants

Mangrove forests can also be damaged or destroyed by chemicals and pollutants, such as pesticides and fertilisers, which are discharged or runoff from farmland, aquaculture areas and cities, and reach mangroves via rivers and canals.

2.3 Natural threats

Mangrove forests can also be harmed by large waves or natural disasters, such as severe storms or typhoons. Natural pests and diseases also affect mangroves, such as barnacles which damage mangroves by attaching themselves to the trunks and roots of young plants.

2.4 Climate change

In the future sea level rise associated with climate change will pose a serious threat to mangroves around the world. As sea levels rise, some mangrove habitats will become too flooded (or too salty) for mangroves to survive. If the mangroves cannot move to higher ground, due to dykes or other impediments (e.g. farms, settlements), the mangroves will have nowhere to go and will drown.

Climate change is also predicted to increase the occurrence of severe weather events such as storms, floods and typhoons. More of these severe events will cause increased damage to mangrove forests.

3. What is being done to protect mangroves?

Many governments around the world, including Viet Nam, have created laws to protect mangroves, and have started reforestation programmes to increase the area covered by mangroves. By 2005 Viet Nam's mangrove forest coverage had increased from the 2002 level of 155,290 ha⁽⁷⁾ to 209,741 ha⁽⁴⁾.

3.1 How can we protect mangroves?

What can we personally do to protect the mangroves?

The most important way for us to protect mangrove forests is to not cut them down!

Other things we can do to protect mangroves include:

- Be careful when you are in the mangrove forests – ensure that you do not accidentally break or trample mangroves when you enter mangrove forests, or catch resources such as crabs, shrimps or fish.
- Keep the water clean! – Don't dump your waste into rivers, canals or the ocean, as it flows to the mangroves forests. Chemicals and pesticide in particular can harm the mangroves.
- Join in mangrove planting days – the more mangroves we plant the more aquatic resources we have for the future and the more we can be protected by the mangroves.
- Tell others – about the benefits that mangrove forests provide and how they can help protect them – the more people we tell, the more we can protect mangroves.

Mangroves are very important as they provide resources (such as crabs, shrimp, fish and clams) and protection (from erosion, waves, winds and storms) for the people of Soc Trang, so **it is very important that the people of Soc Trang protect mangroves!**

3.2 Mangrove protection in Soc Trang

Planting mangroves is of little use if the plantations are not effectively protected afterwards. Newly planted forests must be protected from human impacts such as destructive fishing methods. In specific sites they must be protected from waves. Furthermore, established mangroves must be managed effectively and protected from human

impact. All this can be achieved effectively through mangrove co-management.

Co-management is based on participatory negotiation, joint decision-making, a degree of power-sharing and fair distribution of benefits among all stakeholders. In the context of natural resource management in mangrove forests of Viet Nam, co-management is a partnership agreement in which a resource user group gets the right to sustainably use natural resources on a defined area of state owned land (protection forest) along with the responsibility to sustainably manage and protect these resources. All stakeholders share the responsibility and authority for the management of a given area or set of natural resources. Resource users and local authorities jointly negotiate a formal agreement on their respective roles, responsibilities and rights.

Testing of mangrove co-management in Au Tho B Village (Vinh Chau District) has clearly shown that co-management can maintain and enhance the protection function of the mangrove forest belt while at the same time provide livelihood for local communities.

Further reading:

Co-management/Shared Governance of Natural Resources and Protected Areas in Viet Nam (particularly pages 5-25 and 91-104)

<http://czm-soctrang.org.vn/Publications/VN/Docs/Proceedings%20co-management%20workshop%20Soc%20Trang%202010%20VN.pdf>

Mangroves of Soc Trang 1965 – 2007

<http://czm-soctrang.org.vn/Publications/VN/Docs/Mangroves%20of%20Soc%20Trang%201965-2007%20VN.pdf>

Mangrove Dynamics in Soc Trang Province 1889 – 1965

<http://czm-soctrang.org.vn/Publications/VN/Docs/Mangrove%20history%201889-1965%20VN.pdf>

Tool Box for Mangrove Rehabilitation and Management

<http://czm-soctrang.org.vn/Publications/VN/Docs/Mangrove%20Management%20Tool%20Box%202010%20VN.pdf>



Picture above: *Avicennia* with fruits



Picture above: *Sonneratia* with pneumatophores



Picture on right:
Rhizophora
with prop roots

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8. Phan Ngyen Hong and Hoang Thi San, 1993: Mangroves in Vietnam. IUCN, Bangkok Thailand.

Annex 1: Potential Lesson Activities

This section contains a list of potential activities which could be included into lessons on mangroves. The activities are designed to enhance students' understanding of mangrove forests, their environment, the benefits they provide and the threats they currently face.

Teachers should choose which activities they feel would best enhance their students' understanding of mangroves. This list of activities is not exhaustive. Teachers should feel free to include other activities as they see necessary.

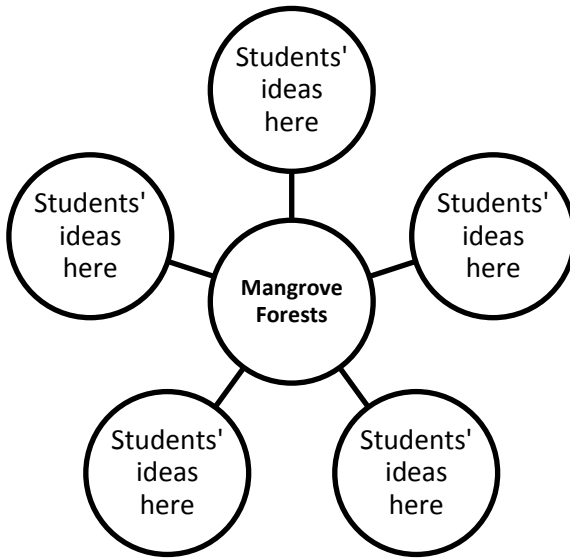
The activities correspond with the two lessons on mangroves. Some activities correspond with a certain lesson while other activities can be undertaken at any stage during the learning process.

Activity 1: Mangroves 'Mind-Bubble'

It is recommended that this activity be undertaken at the start of Lesson 1 as it will help teachers gauge their students existing knowledge of mangroves.

At the start of Lesson 1, ask students to write down what they know about mangrove forests. Students could answer individually or as part of a small group. Write the term 'mangrove forests' in a central bubble on a large piece of paper (or board). Ask students what they have written down, their answers should be summarised into key words or phrases and put into other bubbles surrounding the central bubble. The diagram on the following page shows how the Mangroves Mind Bubble could initially look.

The 'mind bubble' can be added to during the lesson, or during subsequent lessons and may be useful for students to visualise what they have learnt during the lesson(s).



Activity 2: Local research

In this activity, students are required to talk to local people about the mangrove forests in their district. Students could talk to local elders about what changes they have seen to the mangrove forests or ask local fishermen or marine resource collectors what they think about the mangrove forests. Students can then report their findings back to the class and/or write a report on their finding to hand in to the teacher.

Activity 3: Cloze exercise

Below is an extract from a speech delivered by the American Secretary of State Hillary Clinton to Papua New Guinea's Mangrove reforestation project. Some words have been deleted from the speech. Students are to fill in the blank spaces in the speech using the words in the list below.

“We are here both to celebrate and protect the future of Papua New Guinea’s _____. These forests are just one piece of the extraordinary biodiversity that makes Papua New Guinea a place unlike any other in the world. Those of you who live here know that. But for those of us who are here first time, it is so extraordinarily important that we recognize that Papua New Guinea has the largest tropical area in the Pacific – it is the home to the greatest marine biodiversity on the planet, thousands of kilometres of coral reefs and hundreds of animal species, including dozens that have only been recently discovered. So the people of this country are rightly proud of the beauty and richness of their homeland. And I know how important it is to _____ that, and the United States wants to be your partner in doing so.

Now mangroves have many benefits. They prevent tidal _____, they protect coasts from _____. Their _____ are an ecosystem in themselves, home to many sea creatures, and they generate _____ and remove carbon from the atmosphere. Some say they serve as the lungs of the earth. So every time we take one of these little plants and plant it, we are helping to improve the _____ and protect not only animal species, but indeed _____ life as well.

Now because they play several roles, the loss of mangroves and other tropical forests has broad and _____ consequences not only for Papua New Guinea, but for the entire world. _____ of the world’s coastal and interior forests accounts for between 15 and 20 percent of all the carbon emissions that are part of global warming. This statistic is so great, but it points to a solution: If we can protect our forests, if we can prohibit illegal _____, we can make significant progress in protecting this island nation and others from the effects of _____.”

Fill in the blank spaces using the words and phrases from this list:

environment

storms

climate change

deforestation

human

oxygen

preserve

dangerous

mangrove forests

roots

logging

erosion

Activity 4: True or false

Get students to identify if the following passages are true or false:

1. Mangroves grow along sheltered coastlines in tropical and sub-tropical regions.
2. Mangroves only live in freshwater environments.
3. Mangroves protect coastlines from erosion, storms and typhoons.
4. Mangrove tree roots dissipate wave energy.
5. Mangroves are a feeding site for shrimp only.
6. Mangrove forests provide resources for humans such as firewood, food, dyes and medicines.
7. Fertilisers and chemical toxins from shrimp farms are beneficial to mangrove forests.
8. Sea levels rise (due to climate change) could threaten mangrove forests as they may lose their habitats.
9. Some fishing practices are harmful to mangrove forests.
10. I can help protect mangrove forests by keeping waterways clean and free of pollution!

Answers:

- | | | |
|----------|----------|----------|
| 1. True | 5. False | 9. True |
| 2. False | 6. True | 10. True |
| 3. True | 7. False | |
| 4. True | 8. True | |

Activity 5: Tree of Life

Draw a large mangrove tree on the blackboard, making sure that the tree has large leaves which students can write in. Read the following

passage to the students then ask students to write a reason why mangrove forests are important in each of the leaves on the mangrove tree on the blackboard.

Mangroves are important trees for the environment, for many fish and other animals and for our daily life. When a storm or typhoon is coming, mangroves protect the coastline from wind, erosion and floods. Many young fish need the mangroves while they are growing up - young fish can hide amongst the mangrove trees and leave when they are older and bigger. Many species, such as fish, birds and crustaceans, get their food from mangrove forests. Mangroves are also important for people. Mangrove forests are a rich source of fishery products as well as a source of firewood. Products such as fibres, dyes and medicines can also be produced from materials found in mangrove forests.

Activity 6: Importance of mangroves poster

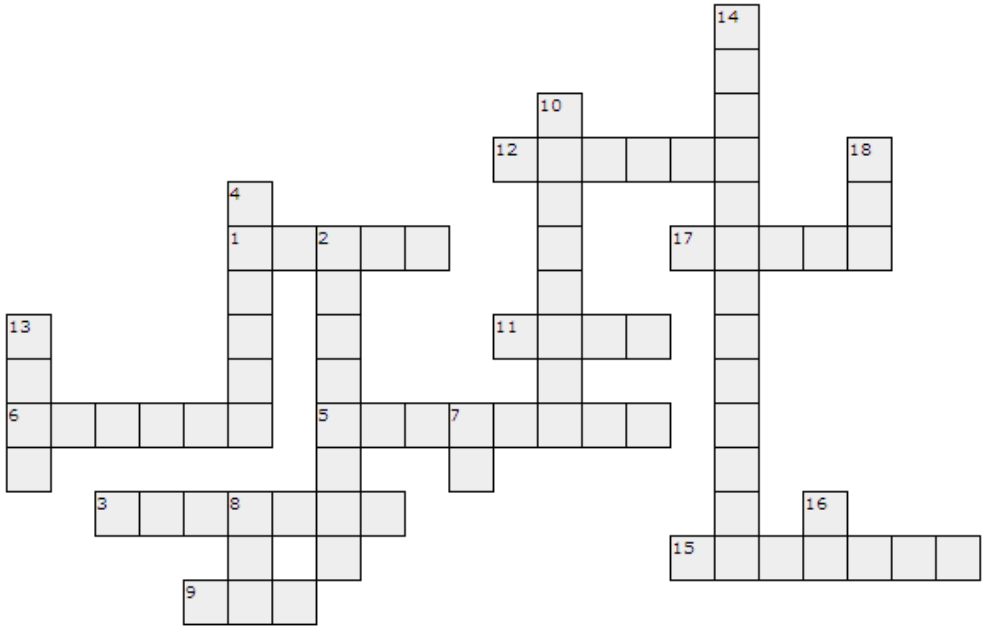
Get students to design a poster about mangroves. The poster could use words and pictures to raise awareness about mangroves and the benefits they provide to humans and the environment. The poster could then be displayed at your school.

Activity 7: Mangrove change art

Get students to create art works with a mangrove forests theme.

Activity 8: Crossword

Using the numbered clues given below, get students to fill in the blank squares in the crossword with the mangrove related word. Students could be given a copy each, or can work in small groups to complete the crossword



Across:

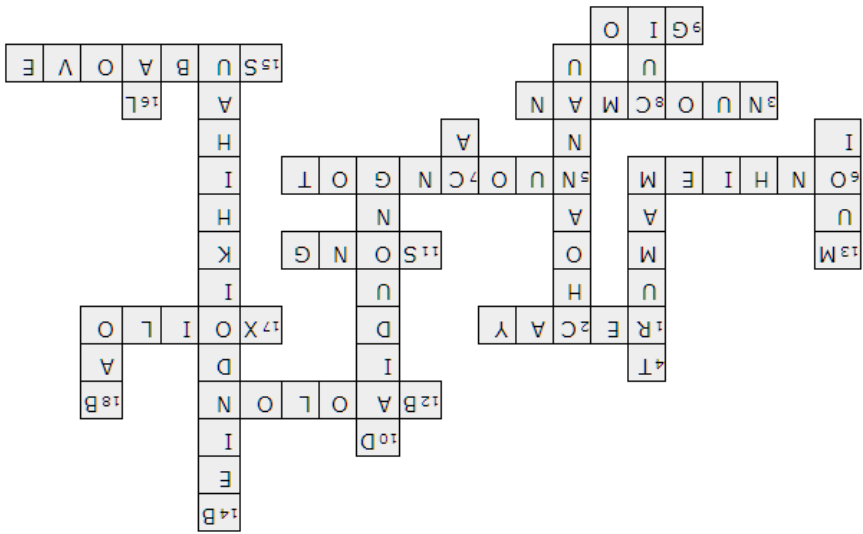
1. Part of the mangrove plant that extends underground (and sometimes back above ground in some species)
3. The ocean is full of this liquid
5. Mangroves need a mix of saltwater and _____
6. Substances, such chemicals or waste products, that move into an area changing natural conditions for the worse
9. Movement of air
11. Mangroves often live at the mouth of a _____

Down:

2. Mangroves provide _____ for aquatic life
4. The type of seed produced by mangroves
7. A type of aquatic animal that spends part of its life in mangroves
8. Dead mangrove branches can be used as _____
10. A vast body of salt water that covers most of the earth's surface
13. Mangroves are adapted to withstand high levels of _____ which is in ocean water
14. When the climate in an area starts

- 12. A violent storm
- 15. Mangroves provide _____ from wind and waves
- 17. Mangroves help stop _____ of land

- to change
- 16. A green part of a mangrove tree
- 18. A heavy fall of rain, or an outbreak of thunder, lightning or strong winds



Activity 9: Word-find

Students are to find the listed mangrove related words below in the word-find. Words are hidden in the word find, and may be horizontal, vertical or diagonal. Students could be given a copy each, or can work in small groups to complete the word-find.

r	n	g	ậ	p	l	ụ	t	s	ổ	ừ	n	x	ơ
s	ô	n	g	b	o	g	ạ	h	ậ	k	o	m	r
m	ự	â	ễ	l	à	r	c	m	l	s	x	d	ừ
ô	h	b	c	ổ	i	n	h	s	ơ	c	ó	e	n
i	v	i	ả	p	c	b	ổ	đ	k	g	i	n	g
t	s	é	e	o	ó	m	ả	b	ã	o	l	ớ	n
r	ậ	n	n	t	v	v	n	u	b	n	ở	e	g
ư	m	đ	s	p	ỏ	ệ	n	t	ơ	r	v	o	ậ
o	đ	ổ	l	g	d	b	á	v	l	x	â	n	p
n	g	i	a	ổ	b	r	u	ô	n	h	i	ễ	m
g	p	k	ặ	h	k	m	ó	i	ư	t	r	e	ặ
s	ạ	h	n	o	m	u	n	ư	ớ	c	m	ặ	n
ó	g	í	x	n	h	ố	l	k	c	n	h	t	a
n	k	h	í	ô	x	i	r	v	n	x	m	ồ	n
g	ặ	ậ	ễ	đ	n	g	ỏ	k	g	h	i	x	i
m	h	u	a	n	t	d	s	a	ọ	p	ổ	n	b
đ	ạ	i	d	ư	ơ	n	g	ễ	t	t	đ	r	ậ

Rừng ngập mặn

Nước mặn

Sự bảo vệ

Ô nhiễm

Nước ngọt

Sông

Biến đổi khí hậu	Lá	Xói lở
Loài có vỏ	Bão lớn	Môi trường sống
Ngập lụt	Đại dương	Chòi
Khí ôxi	Muối	Chỗ ăn náu

Activity 10: Field Trip to forest

Through contacting the Sub-Department of Forest Protection in Soc Trang, teachers may be able to organise a field trip the mangrove forest. A ranger from the sub-department may be available to assist with the field trip and can provide useful information about the mangrove forest. Teachers could get the students to identify different mangrove species, as well as any animals or aquatic life they see.

The best time to visit the mangrove forest is during low tide, so check out the tide times before organising the trip.

Annex 2

Table 1. True mangrove species of coastal zone of Soc Trang Province

No	Vietnamese name	Scientific name
	Họ bần	Sonneratiaceae
1.	Bần đắng (bần trắng)	<i>Sonneratia alba</i> J. Smith
2.	Bần chua	<i>Sonneratia caseolaris</i> (L.) Engl.
	Họ mắm	Avicenniaceae
3.	Mắm trắng (mắm lười đồng)	<i>Avicennia alba</i> Blume
4.	Mắm đen	<i>Avicennia officinalis</i> L.
5.	Mắm biển	<i>Avicennia marina</i> (Forsk.) Vierh.
	Họ Đước	Rhizophoraceae
6.	Đước (Đước đôi)	<i>Rhizophora apiculata</i> BL.
7.	Đưng	<i>Rhizophora mucronata</i> Lume
8.	Vẹt dù	<i>Bruguiera gymnorhiza</i> (L.) Lam.
9.	Vẹt tách	<i>Bruguiera parviflora</i> (Roxb.) Wight & Arn
10.	Vẹt trụ (Vẹt hôi)	<i>Bruguiera cylindrical</i> (L.) Bl.
11.	Vẹt khang	<i>Bruguiera sexangula</i> (Lour.) Poiret
12.	Dà quánh	<i>Ceriops decandra</i> (Griff.) Ding Hou
13.	Dà vôi	<i>Ceriops tagal</i> (Perrottet) C.B. Robinson
14.	Trang	<i>Kandelia candel</i> (L.) Druce
	Họ Bàng	Combretaceae
15.	Cóc vàng	<i>Lumnitzera racemosa</i> Wild
	Họ Ba mảnh vỏ	Europhorbiaceae
16.	Giá	<i>Excoecaria agallocha</i> L.
	Họ Xoan	Meliaceae
17.	Xu ôi	<i>Xylocarpus granatum</i> Koenig
	Họ Cau dừa	Palmae
18.	Dừa nước	<i>Nypa fruticans</i> van Wurmb
19.	Chà Là nước	<i>Phoenix paludosa</i> Roxb
	Họ Ô rô	Acanthaceae
20.	Ô rô biển	<i>Acanthus ilifolius</i> L.

21.	Ô rô trắng Họ Trôm	<i>Acanthus ebrateatus</i> Vahl. Sterculiaceae
22.	Cui biển Họ Ráng	<i>Heritiera littoralis</i> Aiton ex Dryander Pteridaceae
23.	Ráng đại	<i>Acrostichum aureum</i> L.
24.	Ráng đại Họ Bông	<i>Acrostichum speciosum</i> Wild. Malvaceae
25.	Tra	* <i>Threspectia populnea</i> (L.) Soland. Ex Cor.
26.	Bụp	* <i>Hibiscus tiliaceus</i> L.

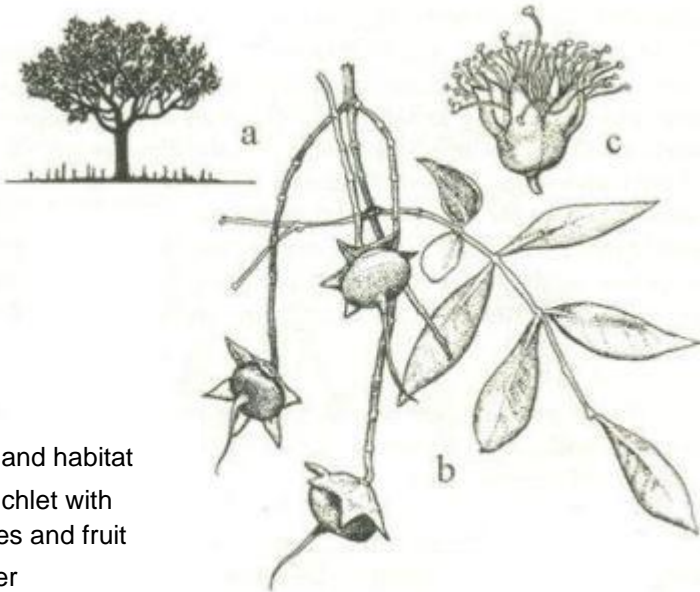
*NOTE: Most authors disagree with the last two (25 & 26) being called true mangrove species.

Annex 3: Different mangrove species in Soc Trang

The main types of species that can be found in Soc Trang are *Sonneratia caseolaris*, *Avicennia marina*, *Rhizophora apiculata*, *Ceriops tagal* and *Bruguiera cylindrica*.

Sonneratia caseolaris (Bàn chua):

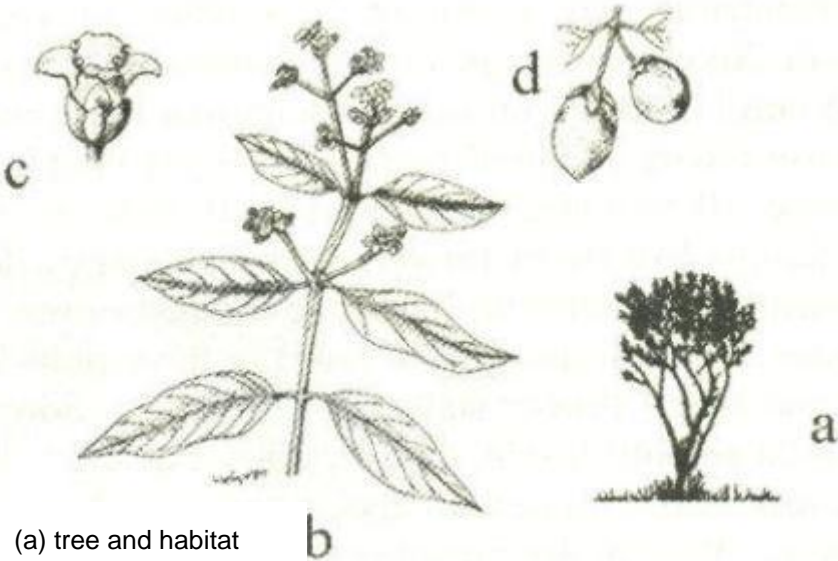
- Is an evergreen tree;
- Grow to a height of between 5–20 metres;
- Elliptical, oblong leaves 5–13 cm long and 2–5 cm wide;
- Grey coarse and flaky bark;
- Pneumatophores which are typically 50–90 cm in height;
- Green fruit with seeds that do not grow through the fruit while attached to the tree; and
- Grow in brackish estuarine areas where inundation of no more than 1 m occurs for 6–12 hrs/day.



(a) tree and habitat
(b) branchlet with
leaves and fruit
(c) flower

Avicennia marina (Mắm biển):

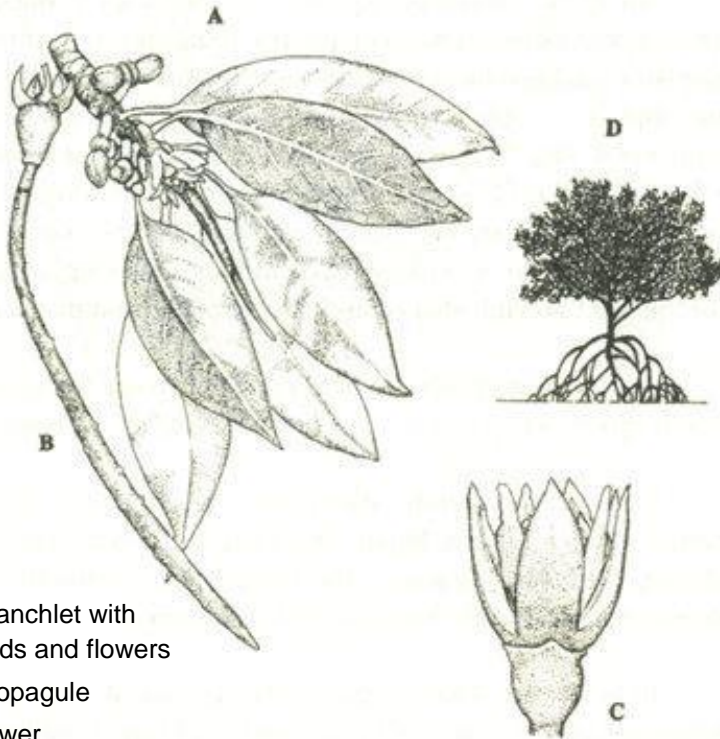
- Is an evergreen shrub or small tree;
- Grow to a height of between 1–10 metres;
- Elliptical, ovate leaves 3.5–12 cm long and 1.5–5 cm wide;
- Whitish to grey smooth bark;
- Pneumatophores which are typically 10–15 cm in height;
- Green fruit with seeds that do not grow through the fruit while attached to the tree; and
- Grow in mudflats far from river mouths, where inundation of no more than 1 m occurs for 6–18 hrs/day.



- (a) tree and habitat
(b) branchlet with fruit
(c) flower
(d) fruit

Rhizophora apiculata (Đước đôi):

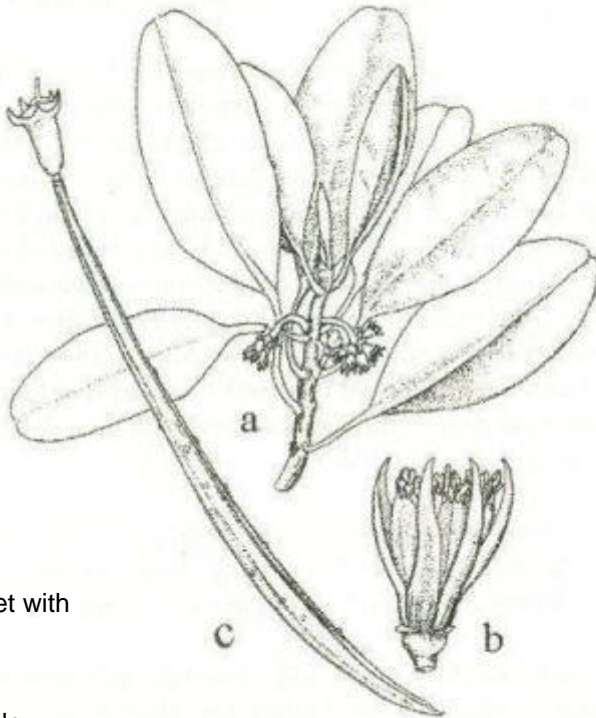
- Is an evergreen tree;
- Grow to a height of between 30–40 metres;
- Obovate leaves 7–19 cm long and 3.5–8 cm wide;
- Dark grey, chequered bark;
- Prop roots;
- Oblong to pear-shaped brown fruits with elongated propagules that grow through the fruit; and
- Grow in sheltered areas where inundation occurs for approximately 6 hrs/day.



(a) branchlet with buds and flowers
(b) propagule
(c) flower
(d) tree and habitat

Ceriops tagal (Dà):

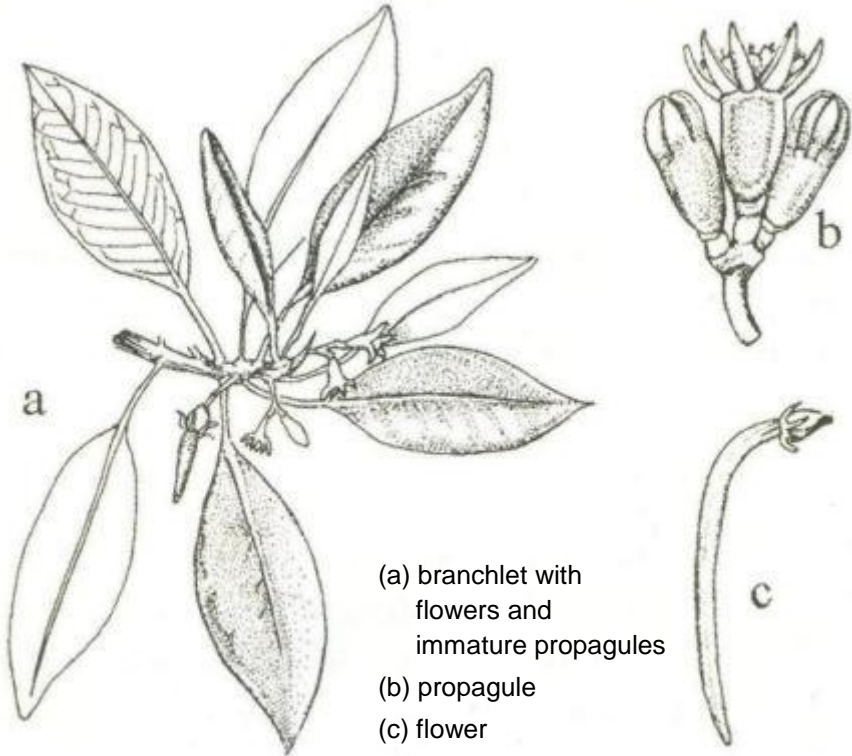
- Is an evergreen tree;
- Grow to a height of between 6–15 metres;
- Obovate leaves 5–10 cm long and 2–3.5 cm wide;
- Grey smooth bark;
- Develops knee-root pneumatophores;
- Long slender propagules; and
- Grow in sheltered areas where inundation occurs for approximately 4 hrs/day.



(a) branchlet with
flowers
(b) flower
(c) propagule

Bruguiera cylindrica (Vẹt trụ):

- Is an evergreen tree;
- Grow to a height of up to 23 metres;
- Elliptical pointed leaves 7–17 cm long and 2–8 cm wide;
- Grey smooth bark;
- Develops knee-root pneumatophores;
- Long slender, often curving propagules; and
- Grows on stiff clay often behind *Avicennia*, can grow on newly formed soils unsuitable for other mangroves.



(a) branchlet with flowers and immature propagules
(b) propagule
(c) flower



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