

Teaching About Mangroves

Benefits for People and the Environment,
Reforestation Efforts and Experiences from San Agustin

- An Education Kit -



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- What all these pictures are about**
-
- 01 - Workshop material
 - 02 - Mangrove nursery in Cabolutan, San Agustin
 - 03 - Everything is connected! - Teaching Biodiversity
 - 04 - Mangrove seedlings with a disease
 - 05 - Goats damaging the mangroves
 - 06 - Workshop with elementary school students
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Information, Learning Exercises and Ideas

Teaching about Mangroves in High Schools and Elementary Schools



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About this Manual

This education kit was created to support you in teaching about the mangrove ecosystem in school. We will provide basic information including benefits, threats and ways to protect mangroves. You will also find learning exercises, methods, worksheets and fact sheets for teaching these issues in class. This material has been tested during several workshops with schools around San Agustin, Romblon. Practical experience from that and the students' feedback also found its way into this education kit. Enjoy reading!

About the Organizations

The Center for Education, Research and Volunteerism in the Philippines (CERV) works with Filipino communities through an international volunteer program. Volunteers from across the globe dedicate between one and five months of their lives to the country and children of the Philippines. CERV primarily addresses health, education and environmental issues through volunteerism.

Meaningful Volunteer is the newest NGO to get involved in the mangrove protection and reforestation project around San Agustin. This organization was founded in 2008 and has set up a project plan document to organize the work on the project. Meaningful Volunteer places international volunteers in developing communities and helps them make a meaningful impact.

Copyright Information

Any parts of this manual may be reproduced and cited freely to widespread the information on the unique mangrove ecosystem. Help us to raise awareness among young and old to stop the fate of the last mangrove forests. References to other sources have been made where necessary.

Full title: “Protecting Mangroves. Benefits for People and the Environment, Reforestation Efforts and Experience from San Agustin. An Education Kit.”

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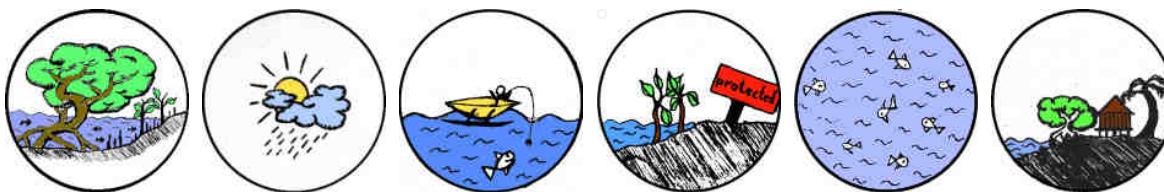
Special Thanks: *Salamat!* - To the people of Carmen, Cabolutan, Sogut and other Barangays in San Agustin who provided information and support for this manual. A huge thank you to all the teachers and students we conducted the workshops with - from Carmen Elementary School, Carmen High School, Cabolutan High School and Romblon State College. Their ideas, feedback and creativity inspired this manual in many ways.

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Foreword

**"When planning for a year, plant corn.
When planning for a decade, plant trees
When planning for life, train and educate people."**
Chinese proverb

Once in 1918, the Philippines' coastal line was covered with 500.000 hectares of mangrove forests. In 1995 only 117.000 hectares remained. This massive decline had negative impacts not only on the environment, but also on the people's communities near and around this unique ecosystem. There have been many attempts in mangrove reforestation in the Philippines, but unfortunately most of them failed due to various factors, primary technical and social in nature. One of the most crucial barriers for successful rehabilitation projects is their lack of community involvement and a missing understanding for the importance of mangroves due to a lack of environmental awareness.

With this education kit we want to support your efforts in raising awareness in school for the need of mangroves. We will provide you with information on the nature and benefits of the mangrove ecosystem, introduce an example of a reforestation project and offer methods and ideas for teaching the issue in elementary and high schools.

This guide follows three major objectives. It is designed:

- ***to raise awareness for the need and benefits of mangroves,***
- ***to support student education by providing ideas for learning exercises and***
- ***to mobilize coastal communities to get involved in mangrove reforestation.***

The project that will be introduced in this manual is based around the town of San Agustin on Tablas Island, Romblon. Like in many other communities in the Philippines, San Agustin's major economic activity depends on traditional fishing grounds. But these already show significant signs of fish stock depletion. The establishment of a marine sanctuary between Carmen and Long Beach should help to improve the situation - with positive effects both on the food security of the local communities and the protection of the marine ecosystem. We will introduce the project activities as well as the failures, successes and the community involvement to you.

So why do we actually need mangroves? What are their benefits, and which threats are they exposed to? Why is it important to protect this marine ecosystem - especially for the coastal communities? And what do the project activities around San Agustin look like? All these questions are important not for the people in and around San Agustin, but to the whole coastal environment and the communities living there.

In this manual we will address these questions. We want to discuss them and present answers in an understandable, practice-based way. This education was created together with the people, teachers and students of the Barangays around San Agustin. It provides information on how to implement mangrove experience in schools. The overarching aim is to raise greater awareness for the benefits and goals of the reforestation of mangroves.

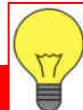
We hope you will enjoy reading and this guide will be helpful for bringing the issue of mangrove forests into your classroom.

The authors

1.1 Ecology - We and Our Environment

Before having a closer look at the mangroves ecosystem, we will first introduce some fundamental information very shortly. This introductory chapter deals with the scientific field of ecology and its most fundamental unit: the ecosystem.

When we talk about mangroves, the marine ecosystem and the interactions between us and our environment, this is all about the scientific field of ecology. For many years, this term was familiar only to specialists in an obscure field. So what is “ecology” all about?



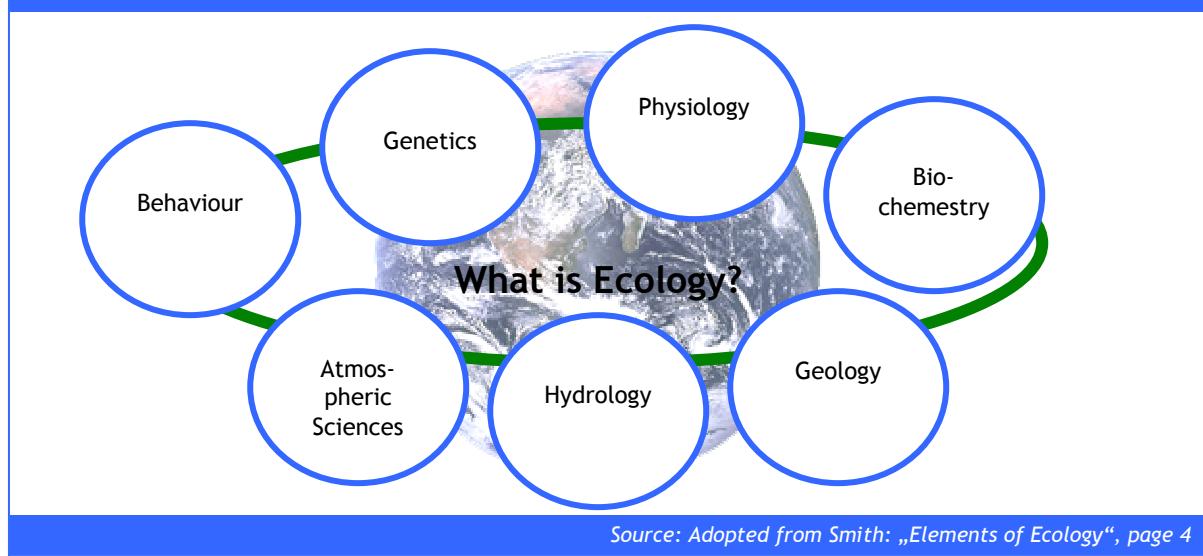
! DEFINITION - *Ecology*

Ecology is the scientific study of the relationship between organisms and the environment.

Relationship in this sentence means interactions with the physical world as well as with members of other species and within the same species. Environment means both the physical and the biological conditions, under which an organism lives.

Ecology originally comes from the words “oikos”, meaning “the family household” and “logy”, meaning “the study of”. So, literally, ecology means *the study of the household*. It has also the same roots as the word “economy”, meaning literally “the management of the household”. Ecology is a multidisciplinary science focusing on the interrelations between organisms and their environment. It is hard to define what belongs and what does not belong to ecology, as it has strong ties to other sciences, such as behaviour and biology.

Figure 1 - Ecology, a Subject of Various Sciences



Ecology interacts with many elements of physical and biological sciences. Aspects of biochemistry, genetics and physiology all play an important role in the field of ecology.

“ *The science of ecology includes everything from global processes, the study of various marine and terrestrial habitats to individual interspecific interactions like predation and pollination. (wikipedia.org)* ”

Ecology is a very complex science, involving numerous other sciences. But apart from its theoretical meaning, ***ecology is also a highly applied science***. Much of natural resource management, such as forestry, fisheries, wildlife management and habitat conservation as well as many problems in agriculture, urban development and public health are directly related to ecological sciences. But a very simple thing will be always important: Ecology has something to do with ***us and the environment we live in***. Ecology IS actually the environment. Not surprising that "ecology" is sometimes used as a synonym for the natural environment. Likewise "ecological" is often taken in the sense of environmentally friendly.

The major unit of ecology is the ecosystem (see chapter 1.2 in this manual). The ecosystem is the context, in which organisms interact with each other and their environment. The word "system" already implies, that this is about a complex structure of interactions, that support the system as a whole. Consequently, even little changes in interaction patterns will affect the whole ecosystem and can also put it at risk. Every ecosystem relies on ***living and physical (abiotic) interacting components***. Abiotic factors are geological, geographical, hydrological, and climatological parameters. Specific abiotic factors include: water, air, soil and light.

Table 1 - Living and Physical Components in Ecosystems

Examples for living components	Examples for physical components
<ul style="list-style-type: none"> ▪ The number of plants and animals ▪ The variety of species ▪ Members from the same specie 	<ul style="list-style-type: none"> ▪ The atmosphere ▪ Soil and water ▪ Climate and weather conditions

A very short history of ecology

Ecology as a scientific discipline is relatively young, reaching prominence mostly in the second half of the 20th century. However, systematic ecological studies can trace roots to ancient times, with Aristotle and Theophrastus, for example, making early observations on animal migrations and plant biogeography respectively.

The term "ecology" itself was first coined by the German biologist Ernst Haeckel in 1866, who defined it as "***the comprehensive science of the relationship of the organism to the environment***." The first significant textbook on the subject (together with the first university course) was written by the Danish botanist, Eugenius Warming. For this early work, Warming is sometimes identified as the founder of ecology. (Source: wikipedia.org)

What is an "ecological crisis"?

Generally, we speak of an ecological crisis when species or populations fail to adapt to changing environmental conditions threatening its survival. There might be various reasons for this: Species can lose adaptive capacity because of changed physical ecological factors (e.g. increase in temperature), because of changing food chains and the human influence (e.g. overfishing) or because of overpopulation in a certain area. A local crisis will have more or less significant consequences, from the death of many individuals to the total extinction of a species.

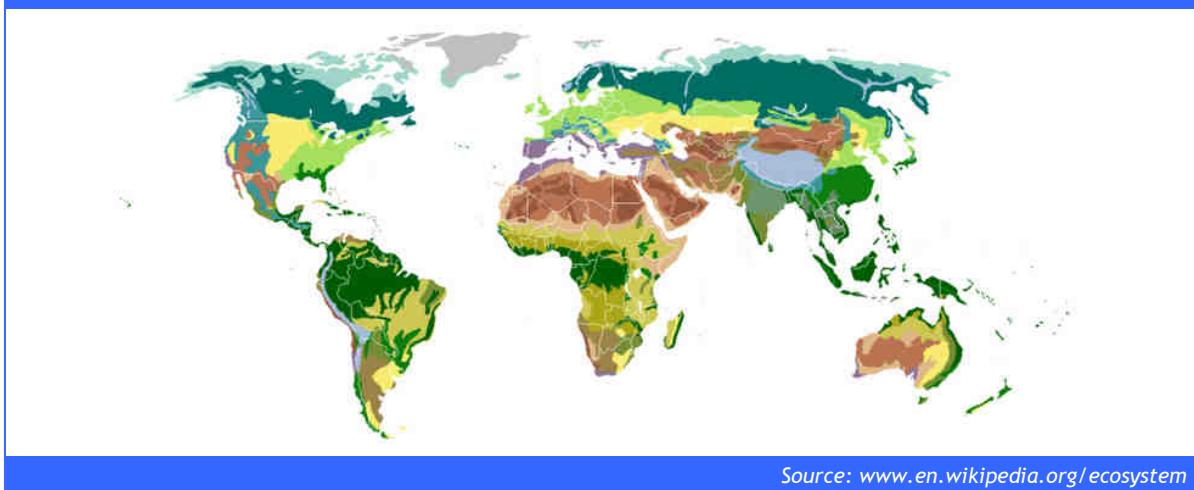
Ecological crises vary in length and severity, occurring within a few months or taking as long as a few million years. They may be local (as an oil spill) or global (a rise in the sea level due to global warming). Due to the increases in technology and a rapidly increasing population, ***humans have more influence on their own environment than any other ecosystem engineer!***

1.2 Talking About Ecosystems

When thinking about life, we mostly associate it with individual species and organisms. But *sustaining life* on Earth requires more than individuals or even populations or species. Life is sustained by the interaction and interdependence of many organisms. They all function together in an ecosystem. It is the basic function of an ecosystem to sustain life. Organisms can interact with each other and with their environment in an ecosystem. In this chapter we will have a closer look at the complexity of an ecosystem.

The following map gives you a first impression of the huge variety of ecosystems existing all over the world, although this map features only some of the major so-called *biomes* - such as tropical rainforests (dark green), deserts (brown), boreal forests (light green) or savannas (yellow/brown). A *biome* is a homogeneous ecological formation that exists over a large region. All of the Earth's biomes from the highest mountains to the depths of the oceans - meaning the entirety of places where life is possible - is called *biosphere*.

Figure 2 - A World Map of Biomes



Source: www.en.wikipedia.org/ecosystem

Ecosystems have become particularly important, since the Convention on Biological Diversity (CBD) defines "*the protection of ecosystems, natural habitats and the maintenance of viable populations of species in natural surroundings*" as a commitment of the countries. This has created the political necessity to identify ecosystems and distinguish among them. The CBD defines an "*ecosystem*" as a "*dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit*". (Source: www.wikipedia.org/ecosystem)



! Something to say about... *the relationship between ecosystems*

Ecosystems are not isolated from each other, but they are interrelated. For example, water may circulate between ecosystems by means of a river or ocean current. Water itself, as a liquid medium, even defines ecosystems. Some species, such as salmon or freshwater eels, move between marine systems and fresh-water systems.

Central to ecosystems is the idea that living organisms interact with every other element in their local environment. Ecosystems have three fundamental characteristics: A certain *structure*, basic *processes* and although they are stable, they can and certainly will *change* over time.

→ **Structure**

An ecosystem is made up of two major parts: nonliving and living. The nonliving part is the whole physical- chemical environment (atmosphere, water, soil etc.). The living part, called the ***ecological community***, is the interaction of the species within the ecosystem.

→ **Processes**

Two processes occur in an ecosystem: a cycling of chemical elements and a flow of energy.

→ **Change**

Every ecosystem depends on certain environmental conditions. Changes in these conditions will also change the ecosystem itself. This process of change can take a very long time.



! DEFINITION - Ecological Community (biocenose)

An ecological community is a set of interacting species found in the same place and functioning together to make possible the persistence of life.

As we have just read in chapter 1.1, an ecosystem consists of physical and living components of the environment. All these factors form an interactive system, called the ecosystem. All ecosystems, both aquatic and terrestrial, have three basic components:

→ **Producers**

Producers are largely green plants. They use the energy of the sun to transform inorganic compounds into simple organic compounds (photosynthesis).

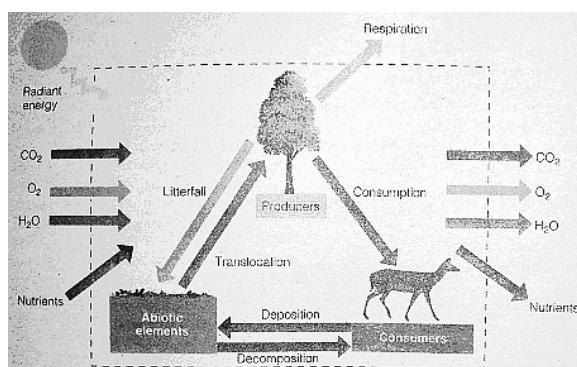
→ **Consumers**

Consumers use the organic compounds produced by the producers as food. They eventually transform complex organic compounds into simple inorganic compounds again, which are once again used by the producers. This process is called decomposition. Decomposers break down dead matter into inorganic substances.

→ **Abiotic Component**

The third abiotic component consists of soil, sediments, dissolved organic matter and litter. These are all non-living components. The driving factor of this system is the energy from the sun. It flows from producers to consumers to decomposers before dissipating as heat.

Figure 3 - Schematic diagram of an Ecosystem



Source: Smith: „Elements of Ecology“, page 4.

Ecosystems vary greatly in structure complexity and in the clarity of their boundaries. Ecosystems vary in size, the numbers of species and their overall variation. Although scientists define certain types of ecosystems, it is often hard to define the borders of an ecosystem. Think for example of a pond: At first examination, it is clearly separated from the surrounding terrestrial environment. But at a closer look you will find plants along the shoreline partially submerged in the surrounding land and amphibians moving between the shoreline and the water. But for a better understanding of interactions, ecosystems have spatial boundaries.

Scientists define an ecosystem by its flora and fauna as well as the physical conditions of the environment. Usually, we differentiate between the following ecosystems: Grasslands and savannas, shrublands and deserts, tundra and taiga, temperate forests, tropical forests, lakes and ponds, freshwater wetlands, streams and rivers, oceans, intertidal zones and coral reefs, estuaries, salt marshes, and mangrove forests. This alone shows the huge variety of ecosystems.



! Something to say about... *the boundaries of an ecosystem*

Ecosystems are real and important, but it is often difficult to define the limits of a certain system or to find out about all the interactions that take place within the ecosystem.

How “productive” is an ecosystem?

In an ecosystem each individual consumes the preceding one and is consumed by the one following, in what are called ***food chains or food networks***. In a food network, there will be fewer organisms at each level as one follows the links of the network up the chain, forming a pyramid. These concepts lead to the idea of ***biomass***, the total living matter in an ecosystem, and of ***productivity*** (the increase in organic compounds and production of living matter). Ecosystems differ in biomass and productivity, and direct comparisons of biomass and productivity may not be valid.

Humanity's actions over the last few centuries have seriously reduced the amount of the Earth covered by forests (***deforestation***) - including mangroves, and have increased agro-ecosystems. The areas occupied by extreme ecosystems such as deserts have also increased (***desertification***).



CHAPTERS 1.1 and 1.2 - Summarizing Questions

- How would you describe “ecology” and an “ecological crisis”?
- What is the difference between “ecosystem” and “ecological community”?
- What can you say about the boundaries of an ecosystem?



How to teach? (Refers to chapter 4 of this manual)

- Exercise 03 - Interview With Experts, Scientists and People Affected
- Exercise 05 - Everything is Connected

Further reading (See chapter 5 for full titles)

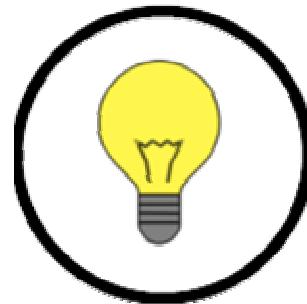
- Botkin, Daniel B. / Keller, Edward A. 2005.
- Smith, Robert Leo / Smith, Thomas M. 2002.

CHAPTER 2 | Mangroves and Coastal Resources in the Philippines

Though they are defined as individual systems, ecosystems are interlinked with each other. Changes in mangrove forests will affect nearby ecosystems, such as intertidal zones or coral reefs. This chapter will provide general information on the connections between coastal resources and mangroves, the benefits and threats, conservation efforts and practical experience in reforestation from San Agustin, Romblon.

In this chapter we will answer the following questions:

- How do coastal ecosystems such as coral reefs, sea-grass beds and mangroves depend on each other?
- What can be said about the situation of the mangroves in the Philippines?
- What is the nature of the mangrove forest ecosystem?
- What are the benefits both for humans and the environment?
- Which threats put the mangroves in danger?
- How do we recover and conserve the mangrove ecosystem?
- What are the experiences gained from reforestation efforts around San Agustin, Romblon?
- Which efforts can you as an individual make to protect the mangroves?



2.1 Coastal and Marine Resources in the Philippines

The Philippines consist of more than 7.000 islands. The country's shoreline is more than 36.000 kilometres long and characterized by a huge variety of marine resources.

Here are some interesting facts about the Philippines' coastal and marine resources.

- ***One of the longest coastal lines in the world***

With its thousands of islands, the Philippines has one of the longest coastlines in the world – estimated at 36,289 kilometres. The coastline extends 2,000 kilometres from north to south, with 25 major cities lying on the coast. It is estimated that more than 60 percent of the nation's total population of 87.8 million lives in the coastal zone.

- ***Dependence on marine resources***

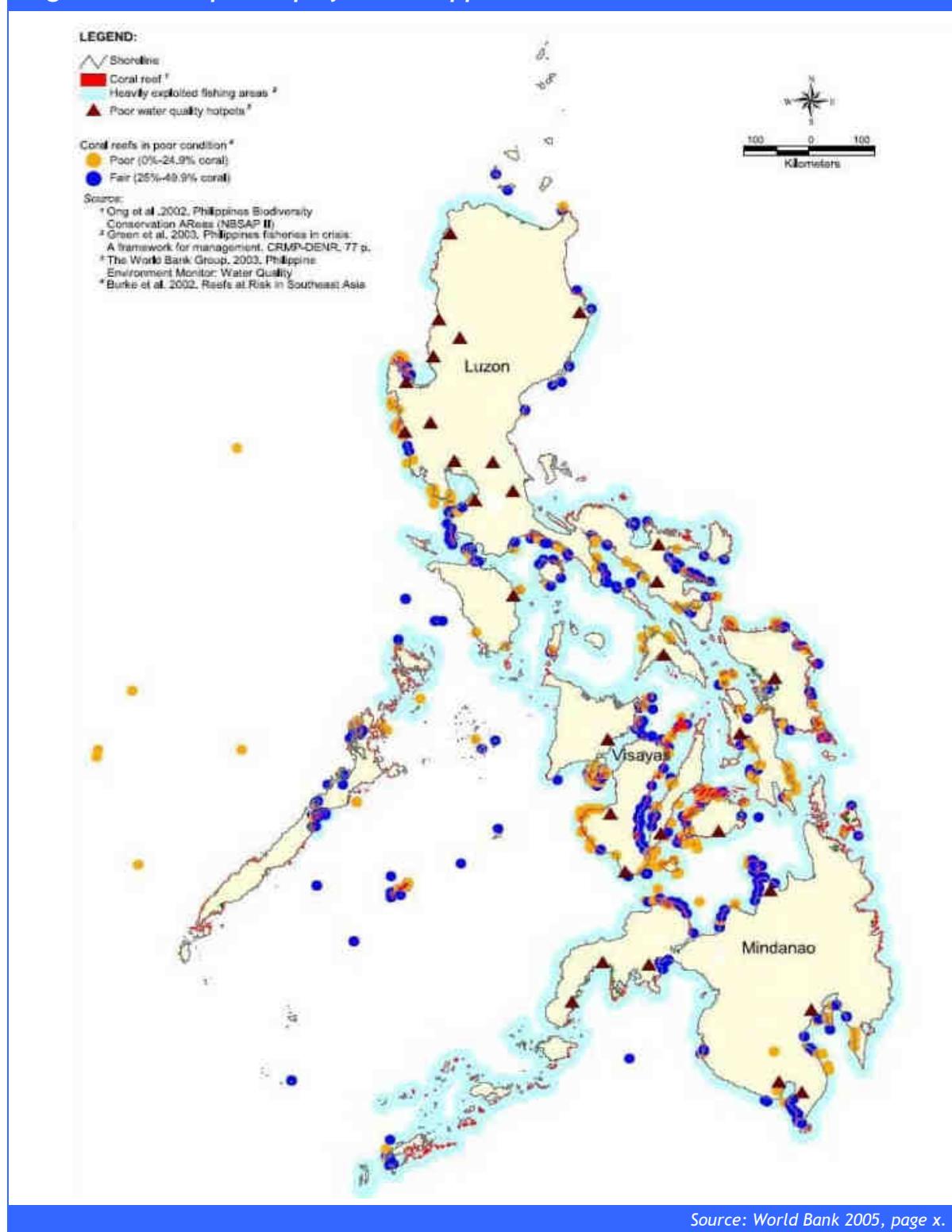
The country depends heavily on its rich coastal and marine resources for the many economic, employment, and biodiversity values and services they provide.

- ***An abundance of species***

Philippine waters and coastal regions contain some of the world's richest ecosystems, characterized by extensive coral reefs, sea-grass beds, and dense mangrove forests.

This map shows the Philippines and its coastal hot spots, where the environment is in danger.

Figure 4 - Hot Spot Map of the Philippines Coastal Resources



Trends in the Philippines

Table 2 - Trends in the Philippines Coastal Resources

State of Coastal and Marine Resources



Although reefs are considered to be declining nationwide, active coastal and marine protected areas in the Central Visayas are showing improvements in coral cover and fish abundances.

In 1918, mangroves covered 500,000 hectares as opposed to 117,000 hectares today. Presently, mangroves are relatively stable - only increasing in selected areas of management in Visayas. At least the overall rate of decline has lessened.

The main fish species and marine organisms are showing severe signs of overfishing. Despite the continued expansion of the country's commercial fishing fleet, total fish catch levelled off in the early 1990s.

All fisheries are showing decline in total catch and per unit effort (total number of fish caught per unit of time) despite increasing effort. Fish are being harvested at a level 30 to 50 percent higher than the natural production capacity.

Pressure on Coastal Zone and Fishermen



About 62 percent of the population lives in the coastal zone. The Philippines has one of the highest population growth rates in the world with an average annual rate of increase of 2.75 percent during the last century.

Estimates show that if the present rapid population growth and declining trend in fish production continue, only 10 kilograms of fish will be available per Filipino per year by 2010, as opposed to 28.5 kilograms per year in 2003.

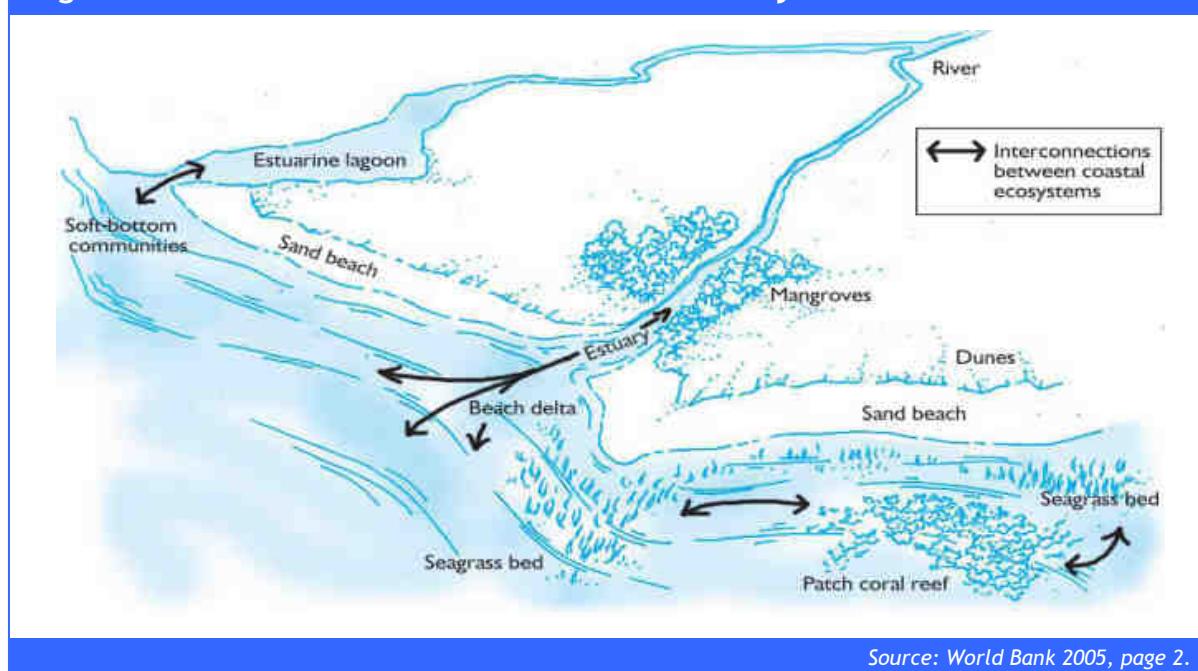
Eighty percent of municipal fishing households are living below the poverty line. This can be attributed to a lack of alternative sources of income and decreasing catch per unit effort for most municipal fishers.

Source: World Bank 2005.

Coastal Ecosystems depend on each other

The coastal zone is the interface where the land meets the ocean. The Philippines' diverse coastal zone consists of a variety of tropical ecosystems, including sandy beaches, rocky headlands, sand dunes, coral reefs, mangroves, sea-grass beds, wetlands, estuaries, and lagoons. The various ecosystems are interconnected, making it virtually impossible to alter one feature of the coastal zone without affecting another, either directly or indirectly.

The following figure illustrates these various interactions between different coastal ecosystem - such as mangroves, sea-grass beds, estuaries and coral reefs.

Figure 5 - Interconnections Between Coastal Ecosystems

A Matter of Interconnectivity

Mangrove forests, along with coral reefs, sea-grass beds and estuaries, belong to the major life-support systems of the coastal zone - and they are all interlinked with each other:

- Different species of fish and invertebrates pass, feed and spawn in each of these ecosystems.
- Mangroves stop eroded soil from upland terrain to filter the sediments flowing to estuarine areas. Sea-grass beds stabilize the bottom with its roots, whereas coral reefs reduce potential damage to mangrove forests that can be caused by wave and current actions.
- Litter material from mangrove forests is filtered by the sea-grass beds, before it continues downwards to the coral reef.

! Something to say about... *interconnectivity*



The coastal zone is the interface where the land meets the ocean. The destruction of any coastal ecosystem due to human impact largely affects other coastal ecosystems! The Philippines' diverse coastal zone consists of a variety of tropical ecosystems, including sandy beaches, rocky headlands, sand dunes, coral reefs, mangroves, sea-grass beds, wetlands, estuaries, and lagoons. The various ecosystems are interconnected, making it virtually impossible to alter one feature of the coastal zone without affecting another, either directly or indirectly.

Coral Reefs, mangrove forests and sea-grass beds provide many direct and indirect benefits.

Coral reefs...

...provide many benefits, including food, livelihoods, recreation, protection from erosion, and extremely high levels of biodiversity. But coral reefs are also the most sensitive of all ecosystems to climate change and pollution. Destructive fishing and overexploitation are the most prevalent problems affecting the coral reefs of the Philippines - like in many other parts of the world

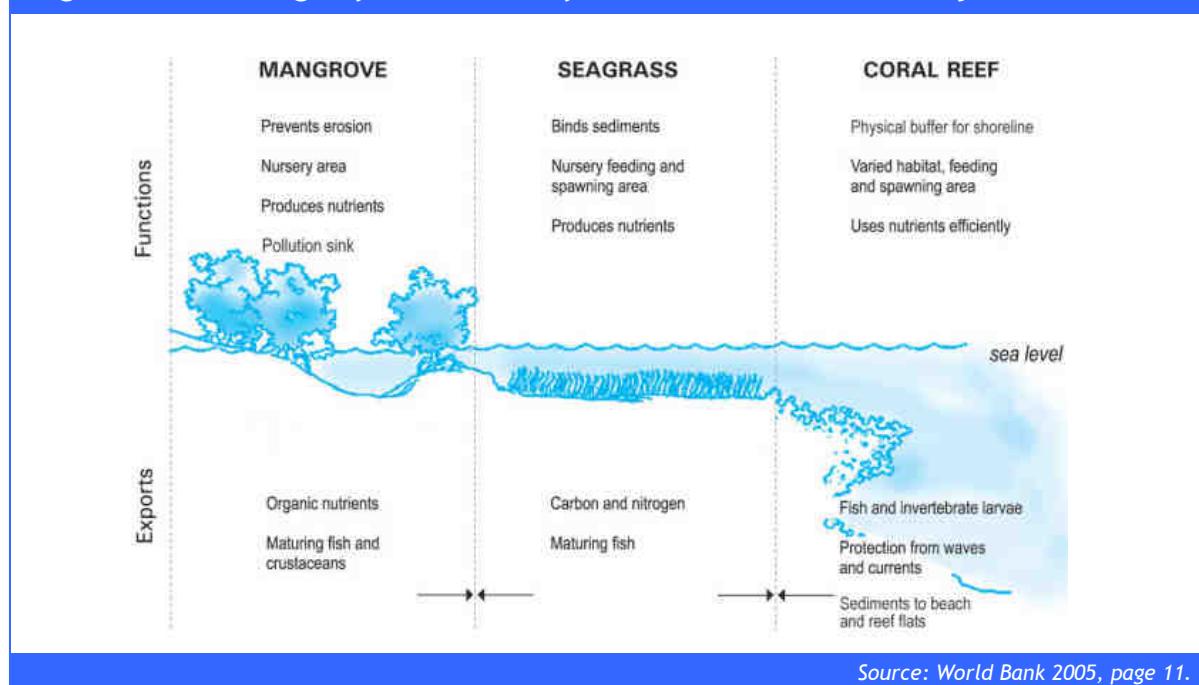
Mangroves...

...protect coasts from storms, erosion, and floods. They also help purify water. Mangroves are important feeding sites for many fish species, shrimps and other species such as birds or amphibians. The next chapter will provide you with more detailed information on the nature of the mangrove ecosystems, its benefits and threats.

Sea-grass beds...

...are vital resources for underwater life. Sea-grass beds provide the intermediate buffer necessary for coral reefs to protect coasts and mangroves from strong waves and surges and for mangroves to protect reefs from erosion and sedimentation.

Figure 6 - Exchange of Mutual Benefits Between Coastal Ecosystems



**CHAPTER 2.1 - Summarizing Questions**

- What facts about the Philippines' coastal & marine resources do you know?
Is there any pressure on the coastal zone and fishermen?
- What is "interconnectivity" all about?
- How are coral-reefs, mangroves and sea-grass beds interrelated?

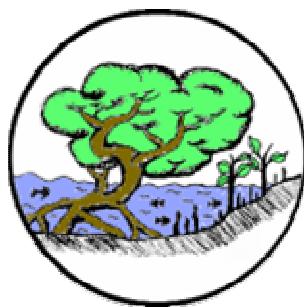
**How to teach? (Refers to chapter 4 of this manual)**

- Exercise 03 - Interview With Experts, Scientists and People Affected
- Exercise 04 - Changing Environment
- Exercise 05 - Everything is Connected
- Exercise 09 - The Tree of Life

Further Reading (See chapter 5 for full titles)

- Department of Environment and Natural Resources (DENR) 2001.
- Fortes, M.D. / Santos K.F. 2004
- White, A.T., / Cruz-Trinidad A. 1998.
- World Bank 2005.

2.2 The Mangrove Forests Ecosystem



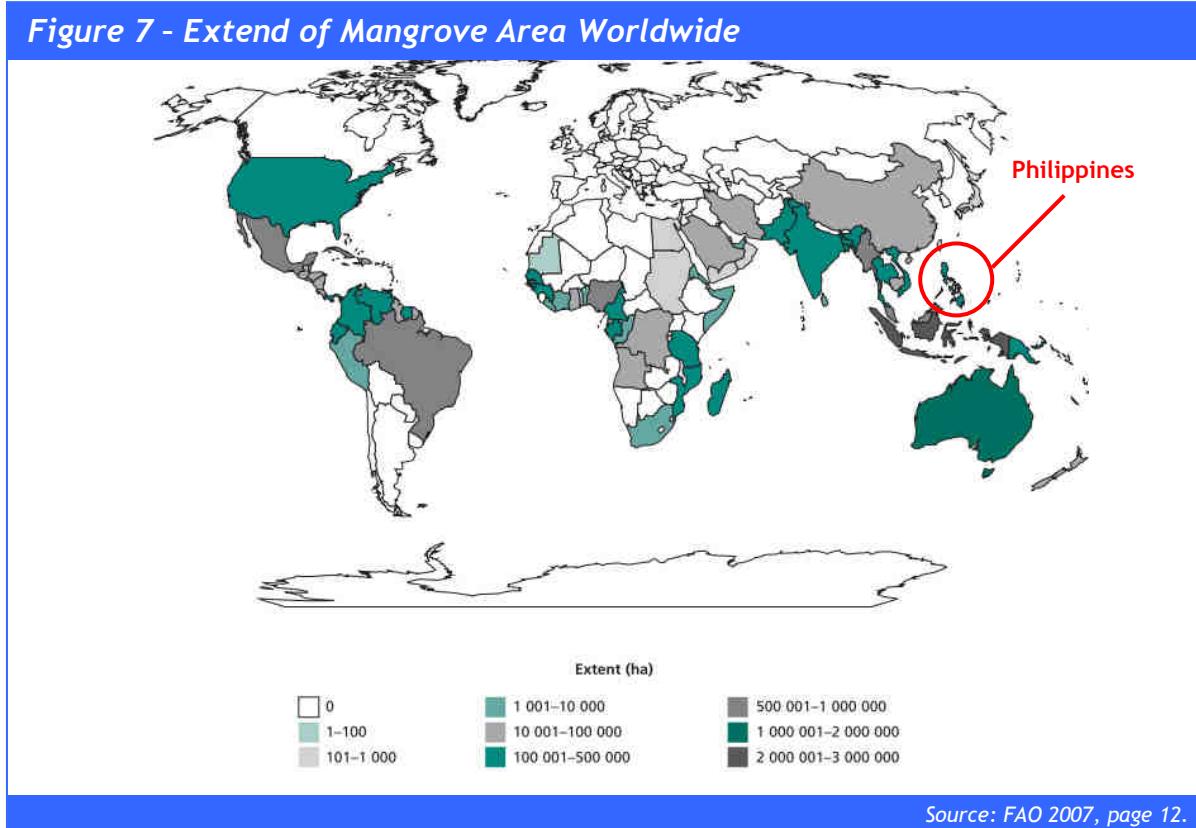
Coral reefs, sea-grass beds, and mangrove forests are all critical resources supporting ecosystems and livelihoods in coastal areas of the Philippines. These ecosystems are also interlinked with each other. This chapter will now focus on the importance of the mangrove ecosystem. For information on the other ecosystems - such as coral reefs - see the "further reading" section of this manual.

Mangroves grow in *tropical and subtropical regions all over the world* - not only in the Philippines. There are mangroves in Kenya, Nigeria and Madagascar (Africa), in many parts of the tropical and subtropical coastal zones of North, South and Central America, on the south coast of Asia, throughout the Indian subcontinent, in all the southeast Asian countries, and on islands in the Indian Ocean, Arabian Sea, Bay of Bengal, South China Sea and the Pacific as well as in Australia.

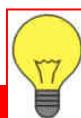
There are almost 70 species of mangroves in the world, covering an estimated area of 24 million hectares. The most important genera of mangroves are *Rhizophora*, *Avicennia*, *Bruguiera* and *Sonneratia*. Mangrove trees grow in shallow and muddy salt water or brackish water and only on shores sheltered from strong wave action. *The mangrove is shallow rooted*, with roots spreading

horizontally or shooting down from the trunk. Many mangroves have root extensions coming from the ground. They extend even to the water surface, acting as aerating organs, allowing the plant to receive oxygen in the anoxic mud in which they grow. They take oxygen for the roots.

Figure 7 - Extend of Mangrove Area Worldwide



While the extensive branches are *sanctuaries to bird and other terrestrial organism*, the tangled masses of arching roots below water are *home to snails, crabs shrimps and some fish*. Some mangrove trees can become as high as 30 meters - under excellent conditions and high sun intensity even up to 40 or 50 metres. Other species can be very small in size, not taller than 1,5 or two metres.



! DEFINITION - *Mangroves*

Mangrove forests are tree wetlands located on the coastlines in warm tropical climates. They are generally “trees and shrubs that grow in saline coastal habitats in the tropics and subtropics. They need slow currents, no frost and plenty of fine sediment for root attachment. The specialization and distribution of the species is based on the salinity and substrate gradients. The Philippines is endowed with one of the most diverse mangrove ecosystems, consisting of 35-40 mangrove species and a rich fauna with threatened animals.”

(Source: <http://samutsaringbuhay.wordpress.com/2007/07/23/floods-coasts-and-mangrove-forests/>, 3/26/2008)

Where do mangroves grow?

Mangroves flourish in different environmental settings: pure clay, peat, sand or coral rubble. They are found in tropical and sub-tropical tidal areas, and as such have a high degree of salinity. Areas where mangroves occur include estuaries and marine shorelines. They are most likely to survive under certain conditions, such as

- *a moderate salinity and neutral acidity,*
- *year-round warm temperatures,*
- *regular surface-water flushing and*
- *exposure to moderate freshwater run-off*

Mangroves are a unique ecosystem. While real land-animals such as birds, snakes and monkeys live in the trees, various fish and other species of the sea live among the roots of the mangrove trees on the shorelines. A huge variety of flora and fauna lives from and within mangrove forests. Together with tropical rainforests and coral reefs, the mangrove ecosystem is one of the most productive ones.

Dozens of different mangrove species exist all over the world. All of them are able to exploit their habitat by developing physiological adaptations to overcome the problems of anoxia, high salinity and frequent tidal inundation. Each species has its own capabilities and solutions to these problems. This is why, on some shorelines, ***mangrove tree species show distinct zonation*** - with specific species at the waterfront and others closer to the land. The mix of species at any location within the intertidal zone is partly determined by the tolerances of individual species to physical conditions, like tidal inundation and salinity, but may also be influenced by other factors such as predation of plant seedlings by crabs.

How do mangroves survive in such an environment?

Mangroves live in salt or brackish water under extreme living conditions - and they have successfully adapted to their environment. Their tolerance to salty water is remarkable. Mangroves have glands to emit the salt from the water in the sea. They are also able to store water like cactuses to thin high concentrations of salt.

The ***roots of the mangroves*** are very special. Like every other plants they need oxygen to survive. But there is no oxygen in the muddy ground where the roots are. Mangroves have therefore developed roots growing from the ground upwards and even beyond the surface of the sea. They can be 30 centimetres or even up to 3 metres long. This is the way mangroves breath.

Red mangroves, which can live in the most inundated areas, prop themselves up above the water level with stilt roots and can then take in air through pores in their bark. ***Black mangroves*** live on higher ground and make many "pneumatophores" (specialised root-like structures which stick up out of the soil like straws for breathing) which are covered in lenticels. These "breathing tubes" typically reach heights of up to thirty centimeters, and in some species, over three meters.

Red mangroves exclude salt by having significantly impermeable roots which act as an ultra-filtration mechanism to ***exclude salts from the rest of the plant***. Analysis of water inside mangrove plants has shown that anywhere from 90% to 97% of salt has been excluded at the roots. Any salt which does accumulate in the shoot is concentrated in old leaves which are then shed. Other mangroves can secrete salts directly through salt glands at each leaf base.

Because of the limited availability of freshwater in the salty soils of the intertidal zone, mangrove plants have developed ways of limiting the amount of water that they lose through their leaves.

Like succulents they can restrict the opening of their pores, which exchange carbon dioxide gas and water vapour during photosynthesis. They also vary the orientation of their leaves to avoid the harsh midday sun and so reduce evaporation from the leaves.

The **seeds** develop right on the mature mangrove tree and reach a remarkable size before falling down. Normally, they develop into a seedling with leaves and roots on the tree, grow to a certain size, then drop into the water, and float upright until they reach water shallow enough for their roots to penetrate the mud. A mature seedling can be transported great distances. This is a form of adoption, as seedlings have to be strong enough to survive waves and changes in tides.



! Something to say about... propagules

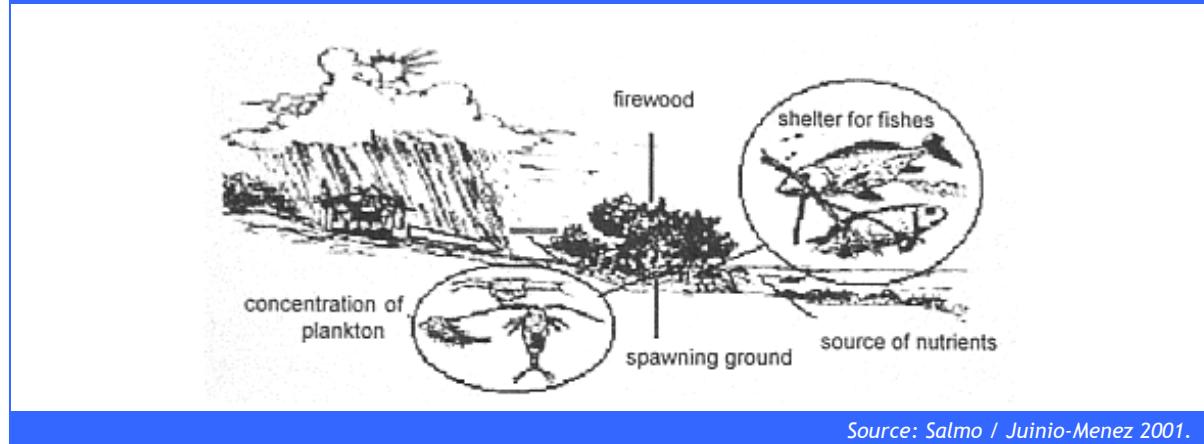
The mangroves seedlings are called propagules. They are ready to survive and can produce its own food via photosynthesis. They can survive desiccation and remain dormant for weeks, months, or even over a year until they arrive in a suitable environment. Once a propagule is ready to root, it will change its density so that the elongated shape now floats vertically rather than horizontally. In this position, it is more likely to become lodged in the mud and root. If it does not root, it can alter its density so that it floats off again in search of more favourable conditions.

2.2.1 Why Do We Need Mangroves?

Mangroves are a multiple-function resource. They are important both for the environment as well as for human communities. Mangroves are not only a nursery for many fish and provide food for various species and organisms; they also protect coastal lines from erosion and are a natural protection for human settlements against storms.

The following picture illustrates some reasons why mangroves are important:

Figure 8 - Benefits From Mangrove Forests



Source: Salmo / Juinio-Menez 2001.

Mangroves **protect the coast from erosion, storm, and typhoons.** Their massive root system is efficient at dissipating wave energy. Likewise, they slow down tidal water enough that its sediment is deposited as the tide comes in and is not re-suspended when the tide leaves. As a result, mangroves build their own environment. Because of the uniqueness of the mangrove ecosystems and their protection against erosion, they are often the object of conservation programs.

Mangroves support unique ecosystems, especially on their intricate root systems. The mesh of ***mangrove roots produces a quiet marine region for many young organisms.*** In areas where roots are permanently submerged, they may host a wide variety of organisms, including algae, barnacles and oysters, which all require a hard substratum for anchoring while they filter feed. Shrimps and mud lobsters use the muddy bottom as their home.

Mangrove crabs improve the nutritional quality of the mud for other bottom feeders by mulching the mangrove leaves. The habitats also host several commercially important species of fish and crustaceans. In Vietnam, Thailand, the Philippines, and India, mangrove plantations are grown in coastal regions for the benefits they provide to coastal fisheries and other uses. ***Despite replanting programs, over half of the world's mangroves have been lost in recent times.***

Ecological Importance

- Mangroves help maintaining coastal water quality and purify water!
- Mangroves protect coasts from storms, erosion and floods!
- Mangroves are important feeding sites for fish species, shrimps and other animals!
- Mangroves function as a nursery for fish!
- Mangroves play an important role in the food chain!



! Something to say about... a food chain mangrove forests ecosystems

Food chains occur in every ecosystem on earth. A food chain basically means that one species depends on other species that also eat other species and so on.

In mangrove forests for example, algae grow on the mangroves' roots, where the sun intensity is high. These algae are food for various small organisms such as crayfish or shell. These organism are again the basic food for many small fish. This food chain can be even continued - leading to bigger organisms and species such as birds eating these fish. It shows the complexity of an ecosystem and the interdependencies within it.

Importance for the people

- Mangroves are an abundant source of forest products such as firewood or charcoal!
- Mangroves are a rich source of fishery products!
- Mangroves protect areas of human settlement from storms and erosion!



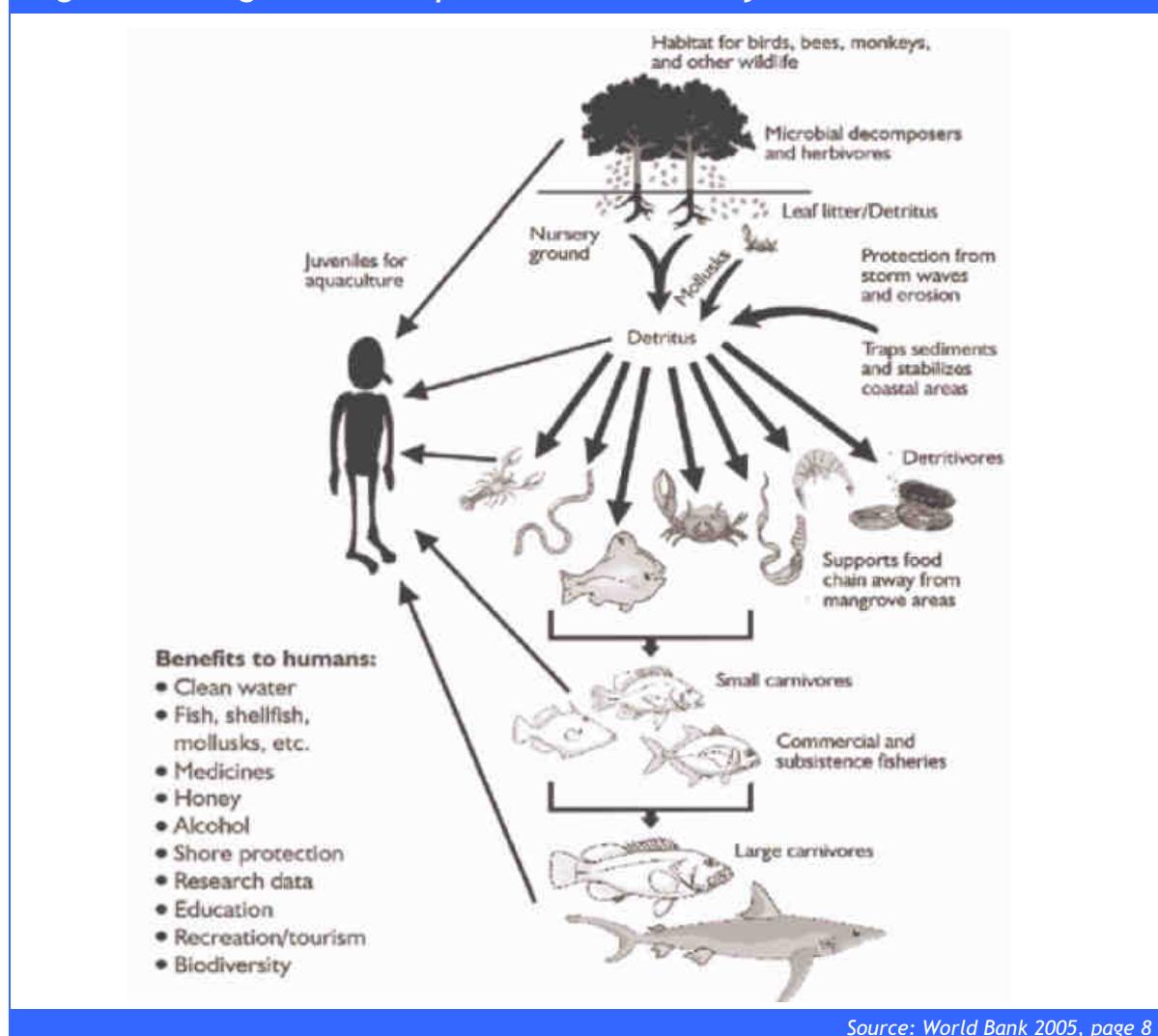
! Something to say about... overfishing

While demand for fish and fishery products has been growing in recent decades, there are less and less fish caught by the fishermen. All main fish species and marine organisms are showing severe signs of overfishing. Destructive fishing methods such as dynamite and cyanide are making the situation even worse.

Mangrove degradation is also a major cause of the decline in fisheries productivity, because their function as a nursery for young fish gets lost. Consequently fish stocks cannot recover anymore. No young fish in the present means: No fish to catch in the future.

The figure illustrates the various benefits of mangrove forests for humans and the environment.

Figure 9 - Mangroves: An Important Coastal Ecosystem



2.2.2 An Ecosystem under Threat?

Mangroves can be found in almost every country with tropical and subtropical conditions. But approximately more than 50 percent of all mangroves worldwide have been destroyed during the last years.



Asian countries such as the Philippines lost millions of hectares of mangroves within only decades. See the table below for a detailed overview for some Asian countries.

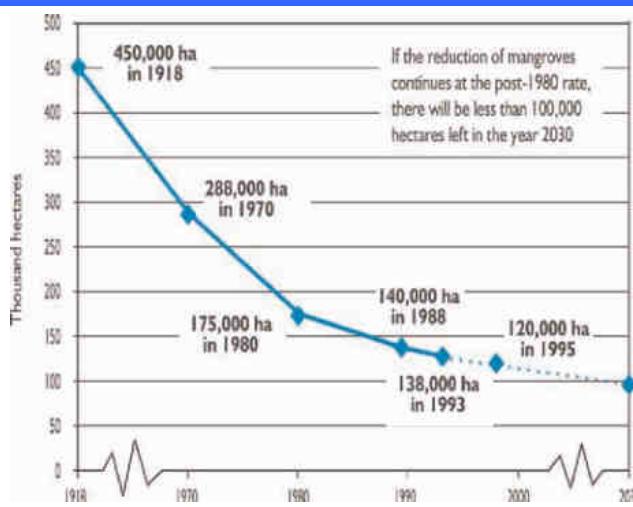
Table 3 - Endangered Mangroves in Asia

Country	Period of time	Area before	Area now	Loss
Bangladesh	1963 - 1990	685.000 ha	587.000 ha	14 %
Thailand	1961 - 1993	300.000 ha	219.200 ha	27 %
Vietnam	1969 - 1990	425.000 ha	286.400 ha	33 %
Indonesia	1969 - 1986	4.220.000 ha	2.176.000 ha	48 %
Philippines	1968 - 1995	448.000 ha	140.000 ha	69 %
Kerala (India)	1911 - 1989	70.000 ha	250 ha	96 %

Source: Lighthouse-Foundation

The United Nations Environment Program has estimated that a quarter of the destruction of mangrove forests stems from shrimp farming. In 1918, mangroves covered about 450.000 hectare of coastal line in the Philippines. In 1995 not even 120.000 hectares remained. About 289.000 hectares of these losses was due to a conversion of former mangrove forests into fishponds. They mainly cultivated milkfish and shrimps, but became useless after the first very few productive years. The following graph gives you a visual impression of this massive decline.

Figure 10 - Decline of mangrove forests in the Philippines



Source : World Bank 2005

Old-growth mangrove forests are mainly found in Mindanao (4,582 hectares) and Palawan (5,317 hectares). However, mangroves are under threat - both because of direct human activity and environmental change.

Direct human intervention

- Conversion of Mangrove forests into fishponds, shrimp farms and saltbeds
- Reclamation for housing projects, human settlements. other construction developments and infrastructure projects
- Pollution and siltation (brackish water gets saltier)
- Dikes and structure obstructing waterways
- Overexploitation / utilization
- Disturbance due to gleaning, fish landing etc.



! Something to say about... *fishponds*

Fishponds or shrimp farms pollute mangrove swamps with organic and inorganic fertilizers, chemical toxins, and antibiotics. They are very productive only during the first three to five years, but they become useless afterwards, because they are highly contaminated with chemicals and toxics. A rehabilitation of intensively used fish ponds is extraordinary difficult and a reforestation with mangroves becomes almost impossible, because the pollution with chemicals and medicaments is enormous. The use of seawater for fishponds also causes the sanitization of the ground water and adjacent lands, including agricultural lands - such as in Central Visayas.

“ Even though mangroves are often used for the collection of wood forest products and as a source of subsistence for local populations, removal of wood and non-wood forest products is rarely the main cause of the loss of mangroves. Human pressure on coastal ecosystems and the competition for land for aquaculture, agriculture, infrastructure and tourism are often high and are major causes of the decrease in area reported.” ”

(FAO 2007)

Indirect threats (natural phenomena)

- Pests and diseases
- Typhoons and heavy storms
- Global warming and climate change



! Something to say about... *indirect threats*

Even without human interference, natural events such as typhoons have always put the Mangroves under threat from time to time. However, these phenomena have drastically increased since the last decades due to human activity. Global warming is happening because of human activity. Due to changes in weather patterns, typhoons have become stronger and have more frequently occurred.

The Philippines are recognized as a *biodiversity hotspot*. This means, that the Earth's biological wealth is most distinctive and rich and where its loss will be most severely felt if conservation efforts are not successful. The coastal and marine waters of the Philippines contain some of the world's richest ecosystems, characterized by extensive coral reefs, sea-grass beds, and dense mangrove forests.

Impacts Due to Climate Change

Global warming and change in weather patterns are a huge threat to the mangrove ecosystem. Because of a **rise in sea level** mangroves lose their habitats and the brackish water they need gets saltier. **Extreme weather events** such as typhoons and floods become more likely and will occur more often. This causes stronger destruction of the mangrove forests. The figure below illustrates these impacts due to climate change.

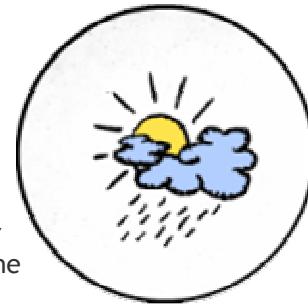
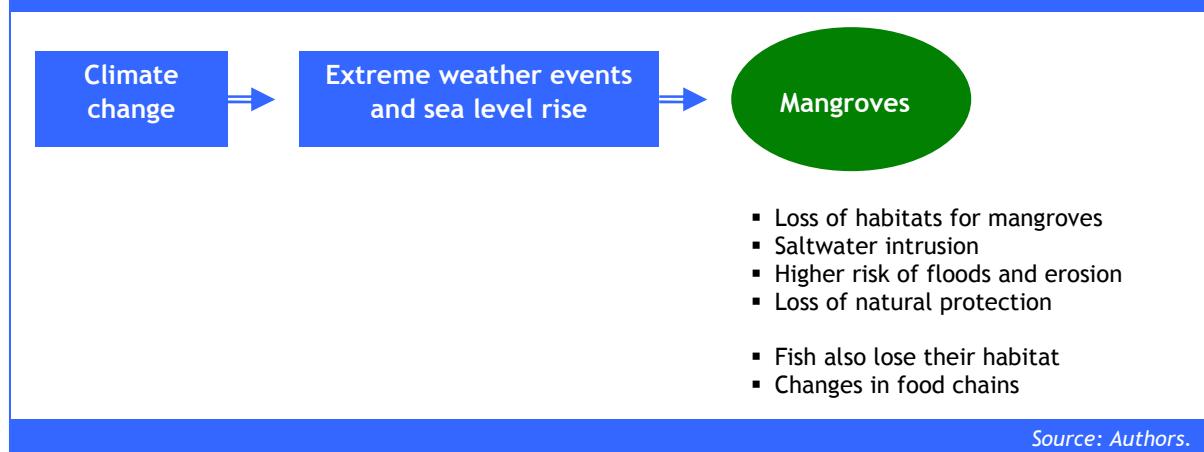


Figure 11 - Impacts Due to Climate Change



What are the Effects of Sea Level Rise?

Sea-level rise can have various consequences for the mangrove forests all over the world. The picture on the next page shows different scenarios:

A) No change in relative sea level

When sea level is not changing relative to the mangrove surface, the mangrove margins will remain in the same location.

B) Relative sea level lowering

When sea level is dropping relative to the mangrove surface, this forces the mangrove seaward and landward boundaries to migrate seaward.

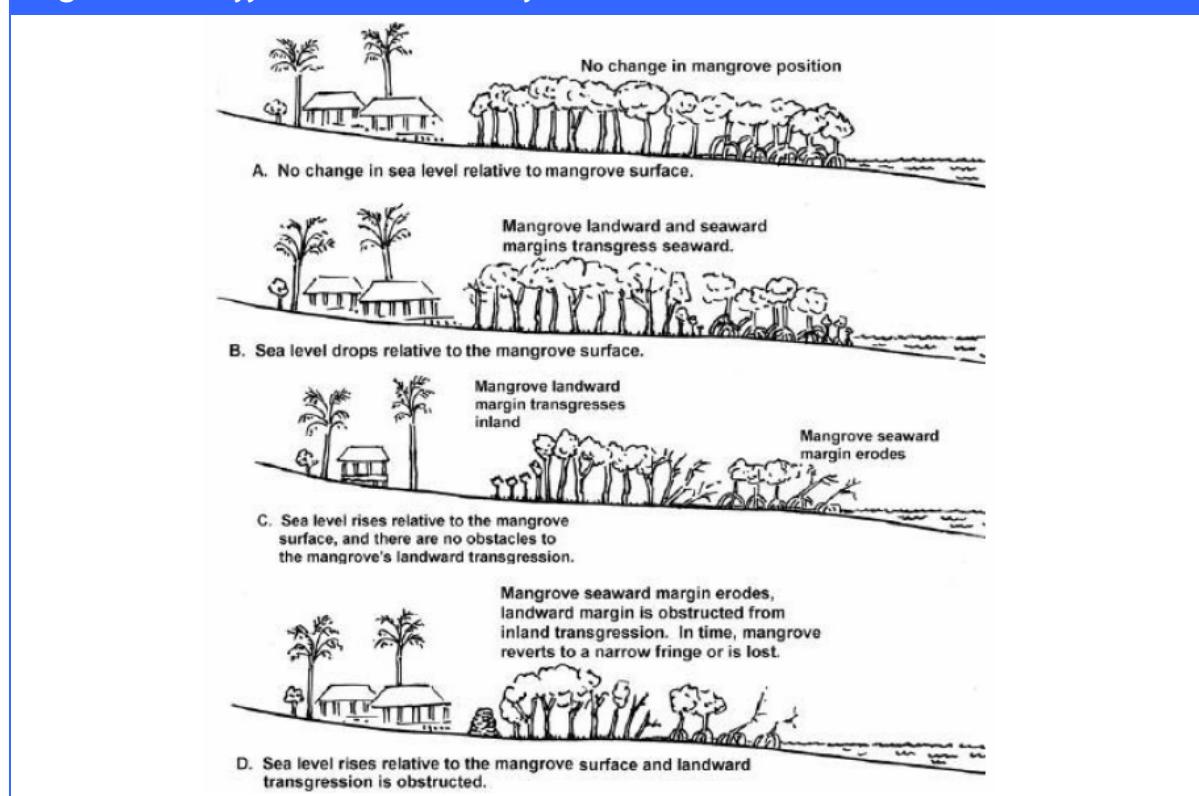
C) Relative sea level rising

If sea level is rising, the mangrove's margins move landward when possible. This enables them to maintain their preferred environmental conditions, such as period, frequency and depth of inundation and salinity.

D) Reversion to a narrow mangrove fringe or extinction of the mangrove community

This is also depending on the ability of individual true mangrove species to colonize new habitat at a rate that keeps pace with the rate of relative sea level rise, the slope of adjacent land, and the presence of obstacles to landward migration of the boundary of the mangrove such as seawalls and other shoreline protection structures.

Figure 12 - Different Scenarios of Sea Level Rise



Source: <http://i168.photobucket.com/albums/u184/samutsaringbuhay/MangroveResponses.jpg>



CHAPTER 2.2 - Summarizing Questions

- *Where do mangroves normally grow?*
- *Why do we need mangroves?*
- *What direct and indirect threats put the mangroves in danger?*
- *What are the effects of climate change and sea-level rise on the mangrove forests ecosystem?*



How to teach? (Refers to chapter 4 of this manual)

- Exercise 01 - Mangroves Are Cool! - Visiting Nearby Mangroves
- Exercise 02 - With and Without Mangroves
- Exercise 03 - Interview With Experts, Scientists and People Affected
- Exercise 04 - Changing Environment
- Exercise 06 - Erosion: The Ocean-bowl Experiment
- Exercise 07 - Wind Versus Mangroves
- Exercise 09 - The Tree of Life
- Exercise 10 - Visualizing Threats to Mangroves
- Exercise 11 - Role Play: Fish Ponds versus Mangroves
- Exercise 13 - Untrue Statements
- Exercise 14 - Mangroves in the News

Further Reading (See chapter 5 for full titles)

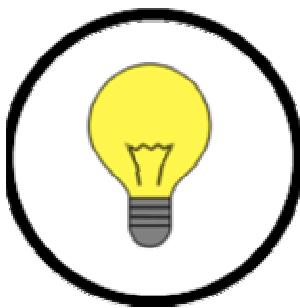
- Brown, W.H. and A.F. Fisscher 1918.
- Hutchings, P. & Saenger, P. 1987
- Lugo, A.E. / Snedaker, S.C. 1974
- Primavera, J.H. 2005
- World Bank 2005

CHAPTER 3 | Reforestation Efforts and Practical Experiences from San Agustin

This chapter will now introduce one specific mangrove reforestation and maintenance project to you. This case study from San Agustin on Tablas Island reflects the challenges, benefits and difficulties of such a project and will give you a vital impression of the general information just provided in part two of this manual. Before doing so, general remarks on conservation and protection will be made.

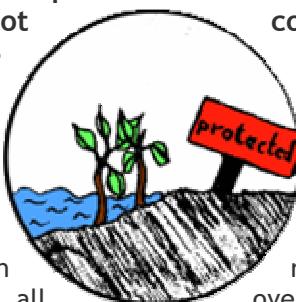
In this chapter we will answer the following questions:

- Which conservation and reforestation efforts can be undertaken?
- What are the mangrove project and the marine sanctuary in and around San Agustin all about?
- What are the challenges to protect mangroves in this project?
- What are the benefits from the project both for the people and the environment?



3.1 Conservation and Protection

Mangroves naturally prevail over environmental and socio-economic stresses, continuing to re-establish and adapt to various conditions. However, the natural regeneration of mangroves cannot compensate for the alarming rate of destruction of mangrove forests in the past. That is why reforestation projects are undertaken all over the world, the global loss of mangroves - most of them with only little success.



Grassroots efforts to save becoming more popular as the more widely known. But although implemented in the Philippines and all mangroves forests is still around about one percent per year.

mangroves from development are benefits of mangroves are becoming reforestation projects are over the world, the global loss of

When people plan mangrove reforestation, their overall intention is to restore the mangrove ecosystem and regain all of its benefits that got lost due to mangrove destruction. Basically, reforestation entails planting of seedlings or transplanting wildlings to the reforestation site.

The objectives of mangrove reforestation are:

- to compensate for the lost ecosystem services due to destruction of mangroves;
- to protect the coastal area against ecological disasters such as typhoons; and
- to restore a natural source of resources and use it in a sustainable way.

Mangrove habitat around the world can self-repair or successfully undergo secondary succession in 15-30 years if:

- 1) *the normal tidal hydrology is not disrupted, and*
- 2) *the availability of waterborne seeds or seedlings of mangroves from adjacent stands is not disrupted or blocked.*

Restoration planning should first look at the potential existence of stresses such as blocked tidal inundation that might prevent secondary succession from occurring, and plan on removing that stress before attempting restoration.

Mangrove reforestation usually takes place, where natural regeneration has failed or will be very unlikely in the future because of various reasons. Natural regeneration would always be a better way, but because of heavy destruction in most cases mangrove reforestation is needed.

Table 4 - Comparing Natural Regeneration and Mangrove Reforestation

Natural Regeneration	Mangrove Reforestation
<ul style="list-style-type: none"> ⓘ The forest is very likely to be more similar to the original mangrove vegetation ⓘ No or only very little labour and finance is needed ⚡ Limited seeds, weed competition and poor natural regeneration take a long time to reforest an area ⚡ Low natural recruitment and survivorship 	<ul style="list-style-type: none"> ⓘ Specie composition, number and distance of seedlings can be regulated and changed ⓘ Difficult and heavily destructed areas can be more easily restored ⚡ Expensive, because labour and finance needed ⚡ Timing of planting can be constrained the availability of seedlings and natural conditions

The mangrove reforestation project should be *community based and support ways of cooperation* between locals, people's organizations, local government units and non-governmental organizations. Academics should also be involved in the project planning.

While it is important to have a core implementing institution that will implement the day-to-day management of the project, it is also necessary to ensure the local people's support and understanding of the project. Eventually they will be responsible for the maintenance, protection and sustainable use of the mangrove forest.

3.1.1 Reforestation Step by Step

The implementation of a mangrove reforestation project does not only include the actual planting of mangrove trees. Many other steps have to be undertaken before, during and after planting to ensure the survival of the mangroves. So what is important when planning the reforestation of mangroves? Here are eight crucial steps that have to be kept in mind.

Step 1 *What is reforestation about? (environmental education)*

The community's understanding of the project and its environmental awareness are a must for successful reforestation. Environmental education will also help to encourage locals to participate in undertaking mangrove reforestation and protect the mangroves.



Step 2 *Who can help? (community mobilization)*

Mangroves have benefits for the whole community. Local people therefore should be directly involved in the project maintenance. This strengthens the relationship between people and the mangroves and it will be easier to understand the benefits of the plants.

Step 3 *Where to plant the mangroves? (mapping and site selection)*

Do you know that most mangrove reforestation projects fail because of wrong or very poorly chosen planting sites? Very often, the newly planted mangrove seedlings have just no chance to survive in the environment where they were planted. That is why Information on the geography, the coastal line and environment of the mangrove sites is very important for the project.

Step 4 *Which species grow best? (species selection)*

If you found out about the environment of the project sites (freshwater, substrate etc.), you have to chose the mangrove species that fit best. The best thing to find out is to know about the original mangrove forest at the project site. When you know which species grew at a selected site before, you should choose the same species for planting, as they are much more likely to survive at that site.

Information about where and what to plant and the community's support are important. Knowing this you can start collect seedlings and actually plant young mangroves.

Step 5 *How to start? (collection of seedlings)*

Before planting mangroves, you need - of course - seedlings. Ideally, seeds can be collected from already existing healthy grown up mangrove trees in the area. Flowering and fruiting growth periods may vary from specie to specie. These seeds can be either planted directly on the project site or if necessary grow up to more developed seedlings in a nursery before planting.

Step 6 *How to plant a mangrove? (planting)*

There are various ways of planting mangroves. Keep in mind to put the seedling about one third of the length in the soft ground in an upright position. Plant the seedlings during low tide and at least 4 months before the stormy season with a distance of about 1 metre to each other. To protect them from waves, young seedlings can be tied with a stick.

The project doesn't stop with the planting of the seedlings. Actually this is just the starting point of a long period of maintenance and monitoring - to see how successful the project really is.

Step 7 *What follows the planting? (maintenance and monitoring)*

This is what has to be done by volunteers and the community after planting the mangroves: removal of waste, cleaning, photo documentation and regular patrolling. It is also very important to monitor the growth and survival of the seedlings to find out about the quality of the project site and to adapt to changes.

Step 8 *Successful or not? (documentation and evaluation)*

Mangrove reforestation is an ongoing process. The project activity should be constantly monitored to adapt to changes. Evaluation should take place regularly to see success and failure. Where did the mangroves grow best since planting? What are the conditions like at these sites? What is the coastal communities' reaction on the project? All these questions should be considered in a regular evaluation. A clear and generally open documentation is vital for a critical evaluation of the project activity.

3.1.2 Why Do Reforestation Projects Usually Fail?

As we have just learned, reforestation is a complex process including various steps. A sustainable reforestation and regeneration of mangrove forests needs much more than the actual planting of new seedlings.

The efforts to restore destroyed mangrove sites have been immense in the Philippines, especially during the last decades. However, only very few projects can be described as successful. Why is this the case?

■ *Planting mangroves in areas without mangroves*

Deforestation of mangrove forests in the Philippines has been massive: 337.000 hectares or 75 percent of all mangrove habitats have been lost - mostly due to the conversion into brackish water fishponds. During the last two decades, more than 44.000 hectares of mangrove forests have been replanted - mostly in nonmangrove areas and sea-grass lands.

■ *Planting of monoculture Rhizophora*

Compared to other mangrove species, the seedling of Rhizophora can be handled more easily. They may also not require nursery culture before planting in frequently flooded areas. Rhizophora has been planted in various locations, although the conditions were bad for this species and Rhizophora has never before existed in this area. Consequently, the seedlings experienced high mortality and only a few survived but did not grow properly.

The widespread practice of converting "available" mudflats, sandflats and sea-grass beds into often monospecific Rhizophora forests should be considered as there will be only little ecological

gain. It would be far more appropriate to reforest some of the former mangrove areas - currently used as brackish water fishponds.

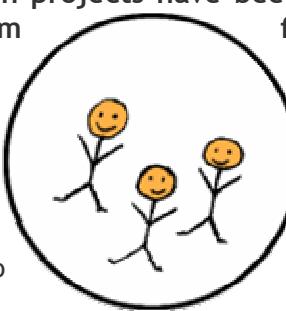
Not only environmental, but also social factors can limit the success of a mangrove reforestation project. To increase the chance for success, the project-site should be well-chosen and several questions should be raised before planting:

- *Have there been mangroves before at the project site?*
- *What species grow best under the prevailing conditions?*
- *Do the coastal communities support the reforestation activities?*

3.1.3 What Can I Do to Protect the Mangroves?

Although mangrove reforestation projects have been implemented in the Philippines for several years, most of them failed because of technical, management-related and social factors - such as just mentioned above.

Success can however be achieved by a strong interaction between the people actually affected by the project. When the importance of mangroves for it will be more likely for them to support the reforestation and protection of mangroves.



by a strong interaction between the people actually affected by the fishermen for example know about the fish stocks and their daily catch, actively support the reforestation and

Mangrove reforestation projects should raise the local people's awareness of their coastal resources and empower them to be responsible stewards in resource management and environment protection. That is why it is so important to get the community directly involved in the maintenance of the project.

! Something to say about... *communities' involvement*



Mangrove reforestation projects are much more successful, if the community has direct involvement in the maintenance of the project by replanting, repair of fences, clean-ups and performing other relevant tasks!

What you can personally do to protect the mangroves?

- *Keep the water clean!* - Don't dump your waste into the sea.
- *Look for the planting sites!* - Keep them clean and protect them from animals.
- *Watch the mangroves!* - Monitor their growth and survival.
- *Talk to people!* - Confront them with the benefits of mangroves.
- *Get involved!* - Help planting and maintaining the mangroves.

***CHAPTER 3.1 - Summarizing Questions***

- Why is the involvement of the local communities important for the success of a mangrove reforestation project?
- What steps have to be undertaken before, during and after the actual planting of the mangrove seedlings?
- Why do reforestation projects usually fail?
- What can you personally do to support mangrove reforestation?

***How to teach? (Refers to chapter 4 of this manual)***

- Exercise 02 - With and Without Mangroves
- Exercise 04 - Changing Environment
- Exercise 06 - Erosion: The Ocean-bowl Experiment
- Exercise 08 - I need protection! Waste and a Seedling
- Exercise 09 - The Tree of Life
- Exercise 15 - What Comes Next? - Steps for Reforestation

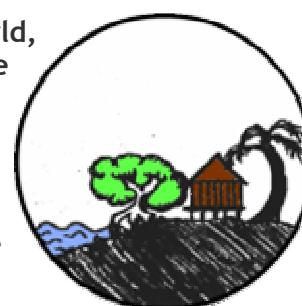
Further Reading (See chapter 5 for full titles)

- Lewis, R.R. / Streever, B. 2000
- Salmo III, Severino G. / Juinio-Menez, Marie Antonette 2001.
- White, A.T., / Cruz-Trinidad, A. 1998.
- Zamora, P.M. 1990.

3.2 Experiences from Around San Agustin

With the help of volunteers coming from all over the world, CERV, Meaningful Volunteer and other organisation support the communities' efforts to protect and reforest mangroves in the area around San Agustin on Tablas Island, Romblon.

Several mangrove plantations have been selected along the coastline of the 15 Barangays, such as Long Beach, Sogut or Carmen. Additionally, a nursery has been developed in the Barangay of Cabolutan, where mangroves are raised and prepared for plantation.



The reforestation program around San Agustin on Tablas Island, Romblon involves various local and other actors. The project mainly focuses on the three following issues:

- ***Protection of existing mangroves and reforestation efforts***

Mangroves along the coastal line are mainly found near freshwater sources. Existing ones are partly protected and new ones are planted from time to time on various spots - often protected by the already existing ones.

- ***Stabilization of coastal ecosystems***

A marine sanctuary has been developed and established in the Barangay of Carmen to put mangrove trees, fish as well as other animals under the protection of a marine sanctuary.

- ***Raise of mangroves in a protected environment***

A mangrove nursery, located in the Barangay of Cabolutan, has been set up to create a safe environment to raise mangroves before they are planted at the coastal line.

*Mangroves near Long Beach.
(July 2009)*



*The mangrove nursery in
Cabolutan.
(July 2009)*



*New planted Mangroves behind
already existing ones near Carmen.
(July 2009)*



As it is very important to choose the best positions for mangroves planting, the project also involves monitoring and evaluation of planting over time. There are several NGOs (Non-Government Organizations) and LGAs (Local Government Agencies) interested in reforesting the mangroves in San Agustin.

Non-governmental organizations

▪ ***CERV (The Center for Education, Research and Volunteerism)***

The Center for Education, Research and Volunteerism in the Philippines (CERV-Philippines - www.volunteerphilippines.com) is a Non-Government Organization. It seeks to help Filipino communities better their quality of life by harnessing the goodwill of the peoples of the world through an international volunteer program. CERV is based in Quezon City and has placement areas both in the marginalized communities of the capital Metro Manila and Romblon, one of the Philippines' poorest provinces. They have planted over 10,000 mangroves in Dumangas, Iloilo and established a mangrove nursery and planted hundred of mangroves in San Agustin.

▪ ***Meaningful Volunteer***

Meaningful Volunteer was founded in 2008 and is the newest NGO to get involved. All of its findings, research and documentation can be found at www.meaningfulvolunteer.org. Meaningful Volunteer places international volunteers in developing communities - such as St. Agustin - and helps them to make a meaningful impact. Project Mangrove is one of the programs that it offers.

▪ ***SIKAT***

SIKAT (Sentro Para sa Ikaunlad ng Katutubong Agham at Teknolohiya, Inc) is a Philippines based NGO that started in the nearby island of Romblon, where it established fourteen sanctuaries in each barangay on the island. It also has a mangrove planting program. SIKAT envisions communities composed of empowered families who recognize equality between men and women; whose basic needs are met through safe and secure access to food and water, health and education; with respect for the environment and the dignity of a person and with faith in God Almighty. SIKAT primarily deals with the Romblon Passage. According to Filipino law, each municipality has jurisdiction over the water that extends fifteen miles from its coast. This puts the Romblon Passage under the jurisdiction of three municipalities. SIKAT does a lot of work on integrated policies that all municipalities can agree on. SIKAT has a strong focus on empowering local communities and ideally want the local residents to care and protect for their own environment - including their mangroves.

Local authorities

▪ ***Local Agriculture Department***

The Local Agriculture Department (LAD) in San Agustin receives its funding from the local government. It has approximately five full time staff. It assists the locals in many areas of agriculture including farming, fisheries and environmental projects such as mangrove reforestation. They have worked with Peace Corp volunteers and often enlist students from local high schools to assist them with planting. They have targeted a mangrove reforestation project in each of San Agustins' fifteen barangays.

Some of the plantations have succeeded. Some haven't. Some of the reasons for the failures are discussed here. They are targeting the area where there are mangroves currently and look to expand the area. The new seedlings are often planted with a bamboo stick to protect them from large waves and other hazards. At present, they have no nursery, but are looking to plant one in the barangay of Sogud.

- ***BFARMC and MFARMC***

Each of the fifteen barangays in the St. Agustin province has a BFARMC. The BFARMCs are responsible for local environmental activities in the barangay. BFARMC consists of local volunteers who are passionate about the environment. The BFARMC volunteers are a wealth of information about the history of the targeted areas. MFARMC acts as a covering organization at the municipality level.

Local actors interested in mangrove reforestation

- ***Local Fishermen***

Mangroves provide a vital part of the life-cycle of many species of fish. Plankton gathers around the mangrove's roots, fish use it as a place to lay their eggs and as a place of protection. Fish stocks increase as mangrove stocks increase. Consequently, fishermen are a very interested party for mangrove protection. Note also that some fishermen see mangroves as a nuisance as it gets in the way of them docking their boats. There have been some instances of fishermen cutting mangrove seedlings at their base.

- ***Shellfish gatherers (see picture)***

When low tide comes, many locals head out onto the mudflats to collect shellfish. Once again, the greater number of mangroves, the greater the number of shellfish. Also, just like the fishermen see the mangroves as a hindrance, shellfish gatherers see the mangrove seedlings as a hindrance and have been known to cut them off at their base. Special attention needs to be given by the shellfish gatherer maintenance worker once the seedlings have been planted. Inadvertent stomping could be a real problem.



The shellfish density should be measured throughout the mangrove reforestation project. Locals could be used to help with this. If they could see the increased shellfish production as a result of the increase of the number of mangrove trees, then they are unlikely to chop them down again.

3.2.1 Success and Failure around San Agustin

During the past three quarters of the century, the deforestation of Philippines mangroves has been massive. About 75 percent of all mangroves have been lost, the bulk of which occurred between 1950 and 1990.

Across the Philippines, this has been mostly due to the conversion of mangroves into fishponds. Also the mangroves have been cut down for timber, firewood, charcoal and coastal development. However, there are also unusual circumstances in the project area of San Agustin.

What is unique to the surrounding of San Agustin and Tablas Island?

- **No Brackish Water Fishponds**

Brackish water fishponds account for 60 percent of the mangrove deforestation in the Philippines. There appears to be no fishponds in San Agustin. The reasons for this are unclear. If fishponds were such a (short-term) boom for other areas of the Philippines, why didn't it make it to San Agustin? There may be fishponds in other municipalities on Tablas Island.

- **Firewood and Charcoal**

The bulk of the mangroves in Romblon were lost to firewood and charcoal harvesting. Bakeries - for example - were powered by mangroves. The timber from the mangrove gave a better quality charcoal than other native species of trees. It is now illegal to cut mangroves down in the Philippines. There was an isolated incident in the barangay of Carmen in 2008 where a man cut down a single tree. He was ignorant of the law and was suitably reprimanded. It is very uncommon for any established mangrove to be cut down nowadays. However, seedlings are often cut off at the stem by fishermen and shellfish gatherers as they are seen as a hindrance for their activities.

- **Reclaimed Land**

The barangay of Poblacion is built largely on reclaimed land. Many mangroves were removed to make way for buildings. This issue has to be considered before actually planting mangroves.

- **Riverbank Deforestation**

There has been large scale deforestation on the island of Tablas. This has released a lot of sediment that ends up in the river. The sediment collects in the root systems of river-side mangroves. This tends to clog up the river and - when the heavy rains come - it increases the likelihood of flooding. The local council chose to remove the riverside mangroves in the barangay of Poblacion as opposed to paying the high cost of removing the sediments from the mangroves.

- **Typhoon Frank (2008)**

On the 24th June 2008, Typhoon Frank hit the Philippines. An estimated 600,000 people were displaced. St. Agustin was one of the worst affected provinces. Typhoon Frank destroyed many - if not all - of the planted mangrove seedlings. Frank also destroyed many established mangroves.

However, typhoon Frank also resulted in a new appreciation of mangroves. Many wooden houses that were not behind mangroves were swept away, while many wooden houses that did have mangrove protection survived.

Failed Reforestation Projects

Despite the best efforts of many organizations, it is not obvious that there have been any successful reforestation projects on the stretch of coast between Long Beach and Poblacion.

What were the past failures and successes in the region?

Successes

At present, Meaningful Volunteer has conducted a land survey and resulting map from Long Beach to Poblacion. We have seen many naturally established mangrove plantations, but precious little evidence of artificial plantings.

Failures

Each barangay has a BFARMC group operating within it. The people within these groups are reservoirs of knowledge about where the mangroves were originally and where mangrove plantations have been attempted. They also know about the failures previously made.

- ***Poor Location Choice (see picture)***

Some of the mangroves planted by the Agriculture Department have failed due to poor location choice. Why it was a poor location is still unclear and more research needs to be done on that issue.



- ***Animal Grazing***

Cows and goats especially often are left to self-graze. Goats - being goats - will eat anything including mangrove seedlings.

- ***Mollusks***

Small mollusks are often left on new mangroves. A maintenance program would help here.

- ***Direct Human Destruction (see picture)***

Some of the mangrove seedlings have been destroyed by humans. Some has been purposeful cutting. If the mangrove seedlings either block docking points for local fishermen or hinder shellfish collection, then humans will just cut the mangrove seedling off at the base. Other mangrove seedlings have been damaged or even destroyed by massive waste - especially plastic bags.

A successful mangrove reforestation project will need to:

- Provide fishermen with access points



- Continue to allow the locals to collect shellfish
- Address indirect human destruction
- Reduce the rubbish in the form of plastic bags and discarded fishing nets that often washed up on the shore and entangles with the mangroves.

▪ ***Failure to Transplant***

Some propagules were directly planted under the shade of existing mangroves. The propagules became seedlings and grew to a significant height - far too high and therefore too late to be transplanted to another location.

▪ ***Typhoon Frank***

In 2008, Typhoon Frank hit the Philippines. An estimated 600,000 people were displaced. St. Agustin was one of the worst affected provinces. Typhoon Frank destroyed many - if not all - of the planted mangrove seedlings. Frank also destroyed many established mangroves.

3.2.2 Reforestation Project Activities

One of the challenges with doing a mangrove replanting project is coordinating all the research and documentation that needs to be done. Meaningful Volunteers has therefore created a project plan covering activities already done, in progress and still to be done.

Despite promoting the advantages of mangroves in this area and the creation of a project activity plan, there are still a lot of things to be dealt with and questions to be answers to ensure an effective and sustainable planting of the mangroves. Activities deal with the past, the present and future plans. Further project activities are based on these questions:



▪ ***THE PAST - If we are to replant mangroves, we must understand the past!***

Most mangrove reforestation project fail because of various reasons. One way to limit the lose of mangrove seedling is to get information about the past mangrove sites around San Agustin. The following questions have to be answered:

- *Why and how were the mangroves destroyed in the first place?*
- *How did the community use the mangroves?*
- *What did the original mangrove forest look like?*

▪ ***THE PRESENT - What is happening now?***

Despite a lack of knowledge about the past situation of mangrove forests around San Agustin, there are already plantations in this area - all with different forms of success and failure. Most of the following question deal with the current situation and are still open.

- Who are the local actors interested in restoring the mangrove?
- Who currently owns the land or has use rights to the land?
- Is the area currently productive?
- What are the tidal levels of this region?
- How will we restore this mangrove area?
- Where does the water come from that feeds this mangrove area?
- What species are we planting and why?
- What species are present? What are the depth, duration and frequency of tidal inundation? What is the soil salinity? How much fresh water is available?
- How do the mangroves in the project area naturally replenish?

▪ **THE FUTURE - What comes next?**

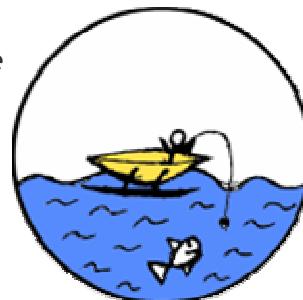
Looking at the open questions from the past and present situation of the mangroves around San Agustin on Tablas Island already shows the further steps to undertake. Currently a map of the target area is under development. It is an interactive map including various information about the mangrove sites. The following questions will be vital for the future:

- How will we protect the planted and existing mangroves?
- How will the community look after this mangrove once it is restored?
- What activities will be allowed / disallowed in the mangrove area?
- Who will enforce village regulations and how will the community be involved?
- Is co-management with the government an option?
- How will you protect the mangroves from outside developers/investors?

3.2.3 Benefits for People and Environment

Involvement of the local community where mangrove rehabilitation is taking place is essential to the long term survival of the restored forest.

The reasons for replanting mangroves around San Agustin are similar to the general benefits of mangrove ecosystems for local communities, the environment and the coast line. The project especially aims to highlight the following functions of the mangrove ecosystem:



▪ **Mangroves protect the coastal areas from typhoons and flooding**

The islands of Romblon are exposed to storms and typhoons all over the year - especially during typhoon season. In June 2008 typhoon Frank hit the Philippines. An estimated 600,000 people were displaced. San Agustin was one of the worst affected provinces.

Most of the planted mangrove seedlings were destroyed. Frank also damaged or even destroyed many established mangroves. Many wooden houses that were not behind mangroves were swept away, while many wooden houses that did have mangrove protection survived.

- ***Mangroves function as a nursery for various fish and other species***

Most of the people in the Barangays around San Agustin are farmers or fishermen. Agriculture and fishing are the main sources of income and vital for the everyday food supply. Fish stocks decreased drastically in recent years due to overexploitation of fishing grounds and excessive fishing methods such as dynamite or cyanide fishing. Mangroves function as a nursery for many fish. A sustainable reforestation of mangroves would eventually lead to more fish and better conditions for the fishermen.

- ***Mangroves are a vital feeding ground for shellfish***

At low tide, many locals head out onto the mudflats to collect shellfish. The greater the number of mangroves, the greater will be the number of shellfish. New mangrove plantation will therefore increase the number of shellfish in the region.

- ***Restoring lost mangrove sites and education efforts***

Most mangrove reforestation have no or only little success. This is often because of a badly chosen planting site and the lack of involvement of the local communities affected. CERV and Meaningful Volunteer work very hard on these serious issues together with local authorities and the communities - to get them involved and raise awareness.

A map of former mangrove sites, a variation in species and a constant monitoring of the mangrove planting sites should help to increase the survival of the planted mangrove seedlings. Both shellfish gatherers and fishermen see mangroves as a hindrance for their activities and have been known to cut them off at their base. Special attention needs to be given of shellfish gatherer maintenance once the seedlings have been planted. Education efforts in schools should raise awareness among students and teachers for the meaning and importance of mangrove forests in the region.



CHAPTER 3.2 - Summarizing Questions

- *What is special about the San Agustin site?*
- *What were the major failures in the past?*



How to teach? (Refers to chapter 4 of this manual)

- Exercise 01 - Mangroves Are Cool! - Visiting Nearby Mangroves
- Exercise 03 - Interview With Experts, Scientists and People Affected
- Exercise 06 - Erosion: The Ocean-bowl Experiment
- Exercise 07 - Wind Versus Mangroves
- Exercise 08 - I need protection! Waste and a Seedling

Further Reading (See chapter 5 for full titles)

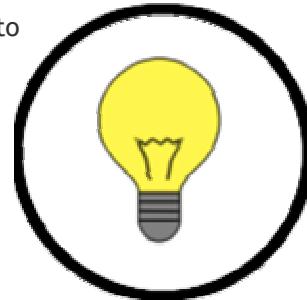
- CERV: www.volunteerphilippines.com
- Meaningful Volunteer: www.meaningfulvolunteer.org

CHAPTER 4 | Teaching Material & Learning Exercises

This chapter should support teachers in their work on mangrove ecosystems. It includes conclusions and suggestions based on several workshops on the issue of mangrove protection as well as ideas for teaching methods and material.

This chapter covers the following content:

- Our experience with students, who participated in workshops to learn more about the mangrove ecosystem, tried and evaluated learning exercises.
- Worksheets and Fact Sheets ready for class as a help for teachers to provide learning material.
- Ideas and units of Learning Exercises to support teachers in implementing the issue of mangrove forests protection in school. With the help of these exercises greater awareness for the importance of mangrove ecosystems should be raised.



4.1 Working with the Students - Our Experience



Chapters one to three of this education gave you a first impression of the broad topic of coastal resources, mangrove forests, their benefits and threats as well as reforestation efforts. This information is only the first step towards successful education on mangrove ecosystems. This chapter will now put the just learned theory into practice. Several worksheets, learning exercises, games and experiments will support you to raise awareness in your class.

The material has been tested between August and September 2009 in several three to four hours long workshops in elementary and high schools around San Agustin. This education kit, lessons plans and exercises have been changed and modified according to the students' feedback and comments from teachers and experts. Only their vital input, their comments and criticism made this practice-based education kit possible. At the end of every workshop, students were asked to answer the following questions:

- ⇒ Which parts of the workshops did you like and which not?
- ⇒ What was easy / difficult to understand?
- ⇒ What did you learn about mangroves?
- ⇒ What do you want to learn more about?

We would like to thank all the students and teachers who participated in the workshops! Workshops have been conducted in the following schools in the municipality of San Agustin (Romblon):

- ⇒ Carmen Elementary School - Grades 5 and 6
- ⇒ Carmen High School - 1st to 4th Year
- ⇒ Cabolutan High School - 1st to 4th Year
- ⇒ Romblon State College Cabolutan (High School) - 3rd and 4th Year

The exercises and learning input have been changed accordingly. This chapter gives you information on the lesson plan developed from the workshop experiences, the students' reactions and the feedback from the teachers.

Our Overall Experience - Things to Keep in Mind

Apart from individual experience from every single workshop, the following guidelines can be seen as our overall lessons learned from working with students and teachers, their comments and feedback. These are some simple guidelines we have learned during our first workshops in Carmen and Cabolutan. They apply both for elementary and high schools.

⇒ **Keep it simple!**

Students do not like never ending, high level, sophisticated, scientific lectures. But they DO like to get active! Let them play the major role in the workshop and keep the content of your lectures as simple as possible. Avoid scientific language and let the students find the answers themselves instead of explaining everything to them. PowerPoint presentations or similar extravagant teaching methods will not only be impossible in most rural areas in the Philippines, they would also make only little sense. It won't attract the students' attention for a very long time and the only way to keep their attention high is by getting them actively involved with simple, but easily understandable activities.

⇒ **Less text, more visualization!**

Use visuals whenever you can! Lecturing in front of class will make the students feel bored very rapidly - especially when it is in English. Do the worksheets with the students, let them create visuals such as leaves with the answers on it, build mind maps together with them on the blackboard, let them try the experiments themselves and do as many activities with the students as possible. There is nothing worse than bored pupils! The lessons are designed for students, so let them get involved!



Visualize the topic and let the students be creative!

⇒ **Watch your language!**

English is NOT the first language of many Filipinos. Especially students in rural areas know only very little English. Many of them don't speak it at home at all. Keep this in mind and always ask for understanding - particularly when it comes to key terms such as "ecosystem" or "biodiversity". Explain it to the students by using visuals. Find out the translation in their native language with the help of the kids. And a "Yes!" might not always be a proof for their understanding.

⇒ **Get the students involved!**

Especially when lecturing in English keep in mind many of the students will lose attention quite quickly. Keep the inputs as short as possible! Integrate the pupils as soon as possible! Get them involved and do as much as you can together with the class.

⇒ **Even more suggestions to keep in mind!**

- Provide snacks and drinks especially in elementary school! This helps to keep students concentrated.
- Rewards for active students in experiments and activities can help to motivate also other pupils!
- Find an "assistant teacher" - a student who is good in English who can translate tasks for the others!
- Get the teachers involved and motivate them to watch the workshop!
- Allow breaks (especially in long workshops) and give the students the chance to refresh!
- Be patient and give the students the time they need! Activities can be very time-consuming!
- Plan plenty of time for the students' active exercises - it will take much longer than expected!
- Take time for feedback! Find out about students' likes and dislikes to improve further workshops!
- Expect the unexpected! (The number of students, their level of English etc.)
- Make sure to get your material back (marker, scissors etc.) You will need it for the next workshop.

Teaching in Elementary Schools (Grades 5 and 6)

Most of the learning material has been tested in several three hours long workshops in elementary schools (grades 5 and 6). The following lesson plan is the result of our experience. It is designed either for a whole day long workshop on mangrove forests with room for further exercises and discussions or for six single sessions - each about one hour long.

After a short introduction into the topic and what the workshop is about, we conducted workshops in elementary schools. Based on our experiences we suggest the following lesson plan:

1. introduction	Exercise 16 - <i>Visualizing the Topic with the Help of Pictures</i> Input I (2.2)* - <i>Mangrove forests ecosystem (2.2)</i> Exercise 17 - <i>No One Likes Salty Water - Except for Mangroves</i> Worksheet 4 a) - <i>What is a mangrove?</i>
2. benefits of mangroves	Input II (2.2.1) - <i>Why do we need mangroves? (2.2.1)</i> Worksheet 1 a) + b) - <i>Have you ever seen a mangrove? / Benefits of mangroves</i> Exercise 9 - <i>The tree of life</i> Exercise 6 - <i>The ocean-bowl experiment</i> Exercise 7 - <i>Wind versus mangroves</i> Exercise 5 - <i>Everything is connected</i>
3. mangroves in danger	Input III (2.2.2) - <i>An ecosystem under threat (2.2.2)</i> Worksheet 2 a) + b) - <i>Where do mangroves grow? / Something has changed</i> Exercise 4 - <i>Changing environment</i> Exercise 8 - <i>Waste and a seedling</i>
4. getting involved	Input IV (3.1) - <i>Conservation and protection (3.1)</i> Exercise 15 - <i>What Comes Next? - Steps for Reforestation</i> Input V (3.2) - <i>Experience from San Agustin (3.2)</i> Worksheet 4 b) - <i>What Can I Do?</i> Exercise 12 - <i>What Can I Do? - Finding Solution</i> Exercise 18 - <i>Visual Summary - Create a Poster for Class</i>
5. evaluation	<ul style="list-style-type: none"> ▪ A short test on the topic to check the students' understanding ▪ General discussion and open questions ▪ Comments from the students: What did they like? / What did they not like? ▪ Interest: Do students want to learn more about mangroves and get involved? ▪ Feedback from teachers and other persons involved

Material needed	<ul style="list-style-type: none"> ▪ worksheets 1; 2 and 4 ▪ big paper, normal paper, markers and pens, cardboard in green and different colours, strong cardboard, scissors, tape ▪ a transparent plastic bowl or box, plastic bags, box ▪ string straw rolls ▪ sand and water ▪ mangrove seedlings from a nursery ▪ various pictures from mangroves, their environment, benefits and threats ▪ two bottles of water, glasses and salt
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* Numbers in () refer to the chapters used in the mangrove education kit.

Inputs and learning exercises from this education kit have been tested with 5th and 6th year elementary school students. Here is a summary of our general impression and lessons to learn.

Our conclusions

Conducting the workshops with **elementary school students** was a more challenging task than expected - also compared to the workshop with high school students (see next page for our experience). Nevertheless, their overall reactions and comments were very positive.

Their understanding of English varied greatly within one class and so did their understanding of complex relations or terms such as "ecosystem". However, experiments, pictures and activities such as the "Wind Versus Mangroves Game" turned out to be not only appropriate to teach about mangroves without saying many words, but they also broke down the complexity of certain topics.

Students in grades 5 and 6 worked concentrated and were very energetic from the first moment on. However, students easily lose attention and got restless after about two hours. This has been experienced especially during workshops with students from grade 5.

The students' answers showed signs of simple repetition and were mostly not self formulated. Instead of naming certain benefits of mangroves for example, whole paragraphs were copied and retold word by word.

We experienced highly motivated, open and excited students willing to learn about the mangrove forests ecosystem, although this topic was often not easy to understand for many pupils.

Finally they were all excited about learning more about mangrove forests and particularly requested to plant mangroves.

The **elementary school teachers'** feedback showed a great support for the workshops on mangroves. They acknowledged the efforts being made and requested further activities such as lectures and exercises in school as well as practical planting activities together with the students.

All teachers in grades 5 and 6 were very open to new teaching methods. Particularly the open space activities outside the classroom as well as experiments such as the seedlings with waste or the "ocean-bowl" caught the teachers' attention

However, it is a long way to put the topic of mangrove education into the elementary schools' curriculum. It needs proactive teachers and principles to promote the idea of mangrove education in a sustainable way. Talks with Barangay officials, local government authorities are needed to raise awareness for this topic.



a) Integrate students into the workshops as soon as possible.



b) Students enjoy the ocean-bowl experiments.



c) Students love games such as "wind versus mangroves".

Teaching in High Schools (1st to 4th Year)

The education kit has not only been tested in elementary schools, but also in various **three hours long workshops in high schools (grades 1 to 4)**. Based on our experience made in these workshops, a lesson plan on mangrove education has been developed (see below). It is designed either for a whole day long workshop on mangrove forests with room for further exercises and discussions or for six single sessions - each about one hour long. After a short introduction we conducted workshops in high schools. Based on our experiences, we suggest these teaching units:

1. introduction and coastal ecosystems	Input I (1.2) - <i>Talking About Ecosystems (1.2)</i> Worksheet 3 a) - <i>One Coastal Line - Many Ecosystems</i> Input II (2.1) - <i>Coastal and Marine Resources in the Philippines (2.1)</i> Worksheet 3 b) - <i>What happens when...?</i>
2. mangroves and their benefits	Exercise 16 - <i>Visualizing the Topic with the Help of Pictures</i> Input III (2.2) - <i>The Mangrove Forests Ecosystem (2.2)</i> Exercise 17 - <i>No One Likes Salty Water - Except for Mangroves</i> Worksheet 4 a) - <i>What is a Mangrove?</i> Exercise 5 - <i>Everything is Connected</i> Exercise 6 - <i>The Ocean-Bowl Experiment</i> Input IV (2.2.1) - <i>Why do we Need Mangroves? (2.2.1)</i> Exercise 9 - <i>The Tree of Life</i>
3. mangroves in danger	Input V (2.2.2) - <i>An Ecosystem Under Threat? (2.2.2)</i> Worksheet 2 b) - <i>Something has Changed</i> Exercise 8 - <i>Waste and a Seedling</i> Exercise 10 - <i>Visualizing Threats to Mangroves</i>
4. getting involved	Input VI (3.1) - <i>Conservation and Protection (3.1)</i> Exercise 15 - <i>What Comes Next? - Steps for Reforestation</i> Input VII (3.2) - <i>Experience from San Agustin (3.2)</i> Worksheet 4 b) - <i>What Can I Do?</i> Exercise 12 - <i>What Can I Do? - Finding Solutions</i> Exercise 18 - <i>Visual Summary - Create a Poster for Class</i>
5. evaluation	<ul style="list-style-type: none"> ▪ A short test on the topic to check the students' understanding ▪ General discussion and open questions ▪ Comments from the students: What did they like? / What did they not like? ▪ Interest: Do students want to learn more about mangroves and get involved? ▪ Feedback from teachers and other persons involved

Material needed	<ul style="list-style-type: none"> ▪ worksheets 2; 3 and 4 ▪ big paper, normal paper, markers and pens, cardboard in green and in different colours, strong cardboard, scissors, tape ▪ a transparent plastic bowl or box, plastic bags, box / sand and water ▪ string straw rolls / two bottles of water, glasses and salt ▪ mangrove seedlings from a nursery and plastic bags ▪ various pictures from mangroves, their environment, benefits and threats
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* Numbers in () refer to the chapters used in the mangrove education kit.

This education kit's content and learning material has also been tested with high school students from grade 1 to 4. This documents our general impression and lessons to learn.

Our Conclusions

The high school students' feedback on the workshops has been mostly very positive. They were very excited about all kinds of activities such as the biodiversity-web (learning exercise 5). Although some language problems were mentioned, the students confirmed the overall understanding of the workshops' content.

The active involvement and experiments gained a positive feedback as well as the content of the lectures. However these inputs in front of class should be kept short and simple. If possible answers and content should be found out and discussed together with the students in a cooperative way instead of just confronting them with certain facts and figures

During the workshops most of the students played a very active role and showed a huge interest in the whole topic of mangrove forests and reforestation efforts. They enjoyed all kinds of activities and experiments - from cutting leaves and testing the danger of a plastic bag for a mangrove seedling to the ocean-bowl experiment and the biodiversity web learning exercise.

All students expressed their interest in further activities such as mangrove planting, seed collections or clean-ups. Most of them wanted to learn more about mangroves in the future.

Eventually and to draw a conclusion the overwhelming majority of students enjoyed the mangrove workshops, although the content was hard to understand for them from time to time. They had fun and worked in a very concentrated way at the same time. This is the best positive sign and it shows that it is possible to teach about mangroves in a very exciting way, keep the students' attention high and raise awareness for mangrove protection and conservation.

The teachers' feedback was also mostly positive. They liked the general system of a short input lecture before every unit and the immediate integration and involvement of the students. It helped a lot to keep their attention high.

However, the teachers' future activities remains unclear and further efforts are needed to implement mangrove education in a sustainable way without volunteers' support. Proactive teachers, locals and officials need to be integrated in a more sufficient way. The students' motivation to learn more about mangroves is overwhelmingly high.



a) Students particularly enjoy active games and experiments.



b) Visuals for lectures improve students' understanding.



c) The "biodiversity-web": one of their favourite exercises.

4.2 Fact Sheets and Worksheets for Students

Worksheets: Questions and Suggested Answers

Worksheet 1

a) *Have you ever seen mangroves?*

The students' answers may vary here. If they have seen mangroves, talk about roots, leaves, other species around and the environment they live in. If they haven't seen any, let them think about why this is the case? Do they live near the coast? If so, what is the environment like?

b) *Trees of life*

Some possible answers:

- Mangroves protect coastline from erosion and floods
- Young fish need the mangroves to grow up
- Many species get their food in mangrove forests
- Mangroves are a rich source of fishery products
- Mangroves are a source of firewood
- Mangroves protect houses from storms and flooding

Worksheet 2

a) *What does a mangrove look like and where does it grow?*

Students can draw their tree in the middle of the paper - partly under water. Explain that various mangrove species exist under different conditions. Focus attention to roots and the leaves; and discuss with the students what the ideal environment of a mangrove should be like.

b) *Something has changed...*

- (1) more houses / (2) a dike / (3) less birds /
 (4) dead mangroves / (5) less fish / (6) sea level rise

Worksheet 3

a) *One coastline - many ecosystems*

- Mangroves: prevents erosion / nursery area / pollution sink
- Sea-grass: nursery feeding area / stops sediments
- Coral Reef: habitat for many fish / buffer for shoreline

b) *What happens when...*

No mangroves = no protection from storm, erosion, floods / fish lose nursery
 No sea-grass = sediments reach coral reefs, strong waves damage mangroves
 No coral reefs = Fish lose their habitat / increased erosion

Worksheet 4

a) *What is a mangrove?*

1. Mangrove forests grow at the margins of tropical and subtropical coastlines around the world. They grow in saline coastal habitats.
2. Mangroves need slow currents, no frost and plenty of fine sediment for root attachment. They grow in brackish water.
3. Mangroves provide habitat and food for other species. They are a nursery for fish. Mangroves clean the water, prevent the coastline from erosion and human settlements from destruction.

b) *What can I do?*

- Keep the water clean! - Don't dump your waste into the sea.
- Look for the planting sites! - Keep them clean, protect them from animals.
- Watch the mangroves! - Monitor their growth and survival.
- Talk to people! - Confront them with the benefits of mangroves.
- Get involved! - Help planting and maintaining the mangroves.

MANGROVES | Worksheet # 1

a) Have you ever seen mangroves?

Mangroves are fascinating trees. They used to grow on many coastal areas in the Philippines, but only a few survived because of massive destruction in the past. Have you ever seen mangroves? Where did you see them? What do they look like? Write down your impressions here.

b) Tree of Life

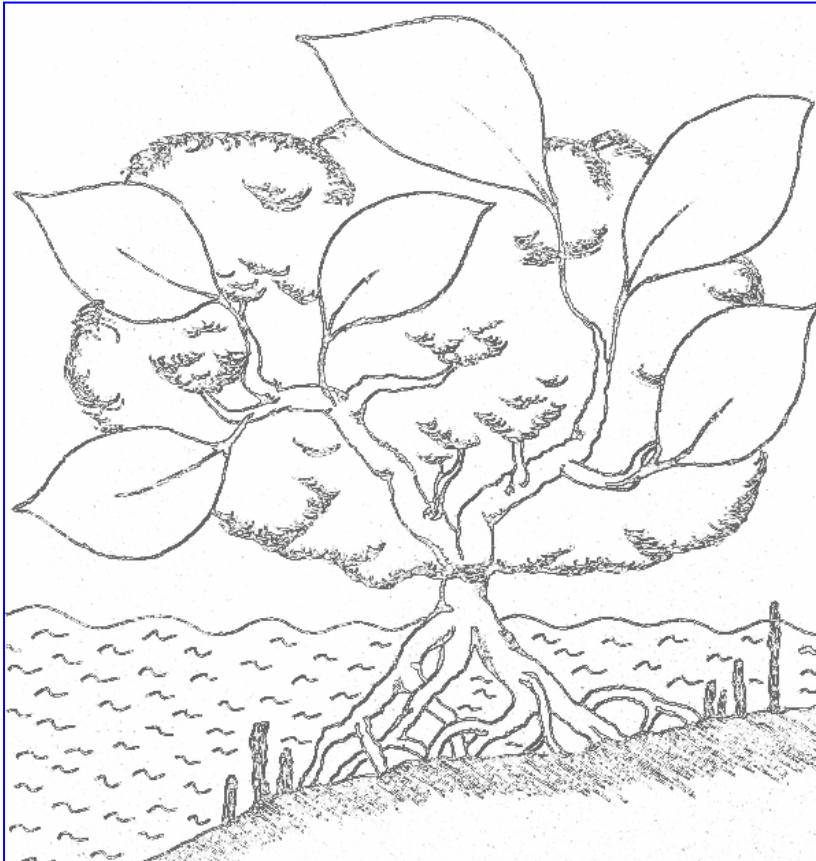
Mangroves are not only great to look at. They have several very important functions, both for the environment and for the coastal communities. Read the following short text and try to find out why they are so important. Put each answer into one of the leaves of the “tree of life”.

Mangroves are important trees for the coastal ecosystem, many fish and other animals as well as for our daily life.

When a storm or a typhoon is coming, mangroves protect the coasts from erosion and floods. Many young fish need the mangroves to grow up - they can hide there from enemies and leave when they get bigger. Many species also get their food in mangrove forests.

Mangroves are also important for the people. They are a rich source of fishery products as well as a source of firewood. They protect the houses near the coast from storms and flooding.

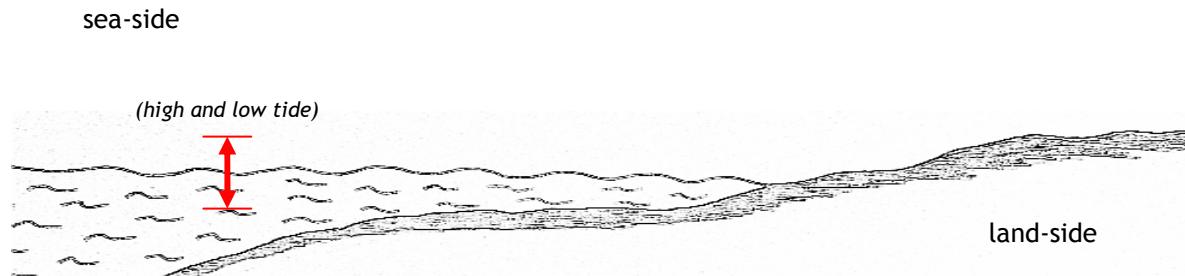
These are the reasons why we really need mangroves.



MANGROVES | Worksheet # 2

a) What does a mangrove tree look like? And where does it grow?

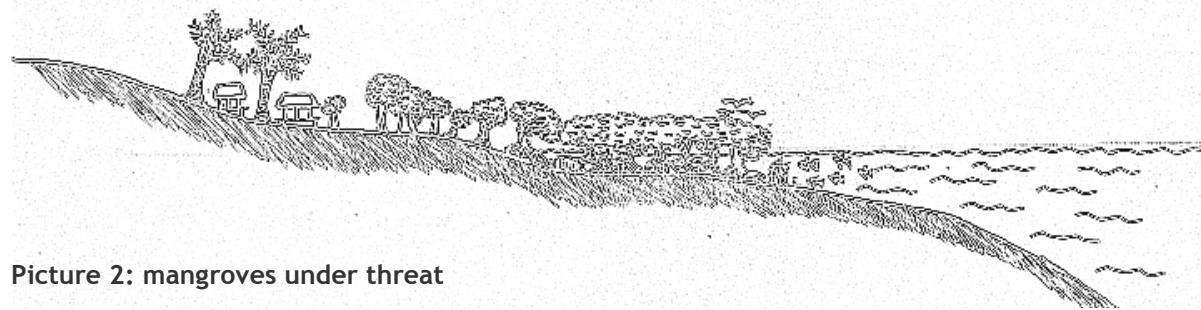
Try to draw a picture of a mangrove tree, you think it looks like. Put it somewhere on the line below, where you think it fits best.



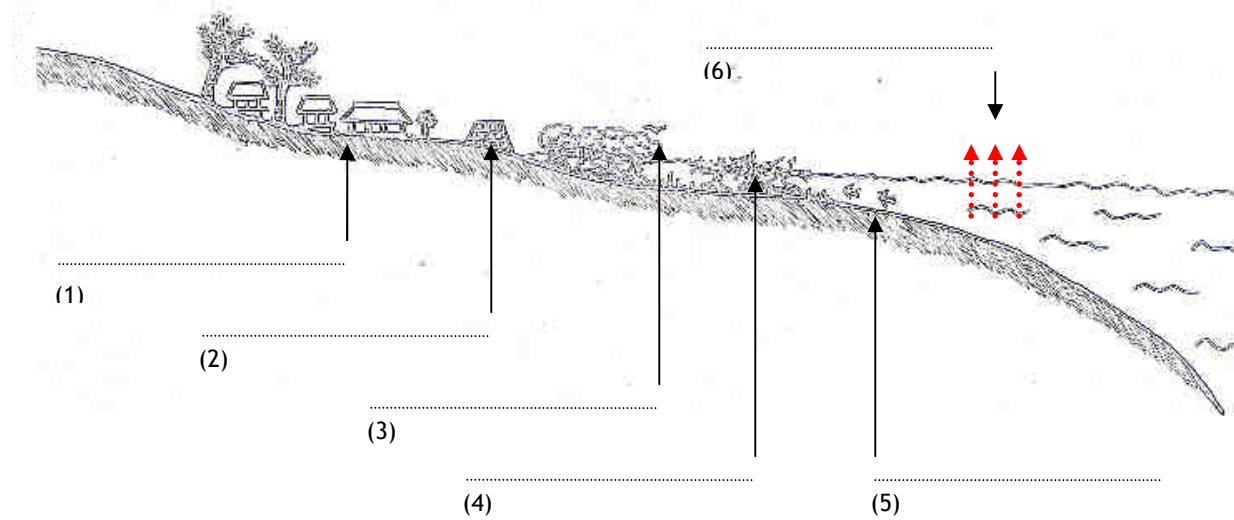
b) Something has changed...

Something looks different. Compare both pictures and describe what has changed.

Picture 1: natural environment and healthy Mangroves



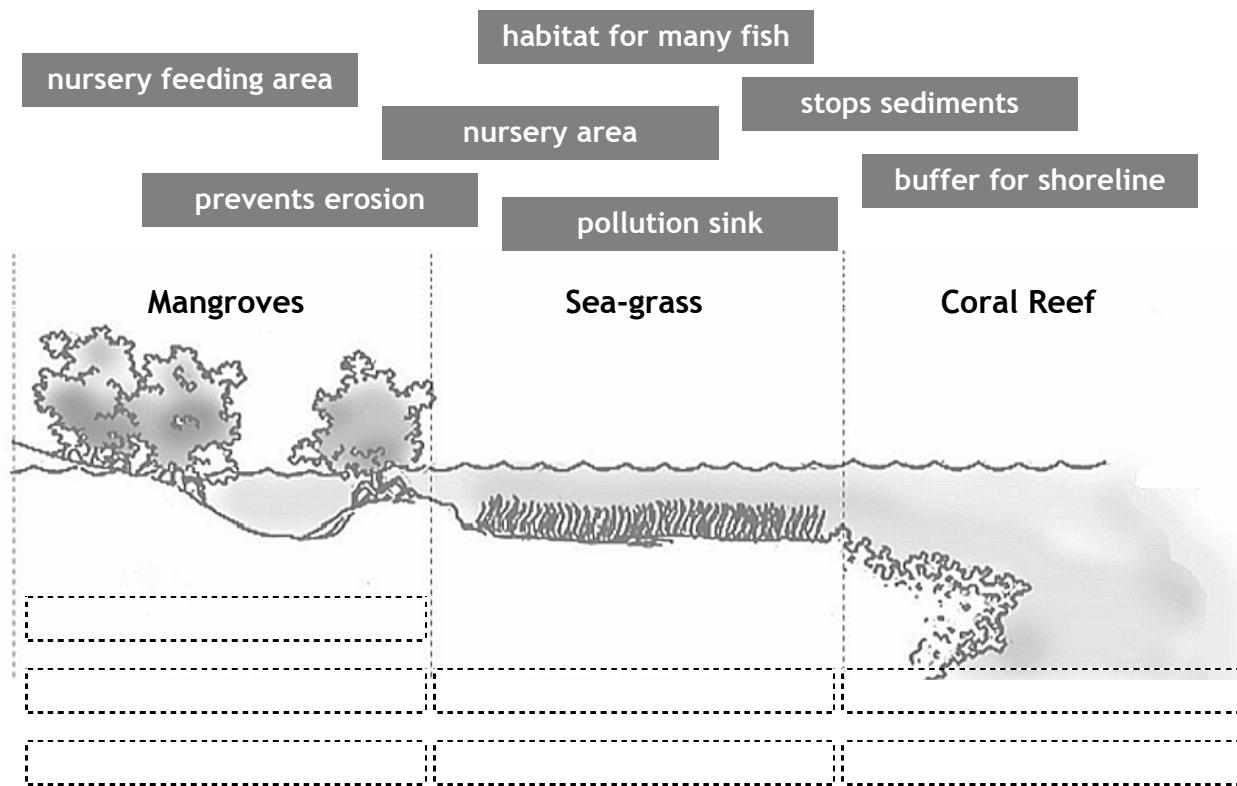
Picture 2: mangroves under threat



MANGROVES | Worksheet # 3

a) One coastline - many ecosystems

Between land and sea there is often not only beach. Areas with different plants and animals, so-called ecosystems can be found at the coastal line. They are very important for us and the environment. Have a look at the pictures and try to put the functions into the right ecosystems!



b) What happens when...

All ecosystems at the coast are very close related to each other. If something changes in one part, this will also affect other plants and animals in other parts. Try to imagine what happens when...

1. ... mangroves disappear:

2. ...the sea-grass disappears:

3. coral reefs disappear:

MANGROVES | Worksheet # 4

a) What is a mangrove?

Read the following short text and try to answer the questions below.

Mangrove forests are a unique ecosystem of marine plants growing at the margins of tropical coastlines around the world. These plants, mostly trees, are called mangroves. About 70 species of mangroves exist all over the world.

Mangroves grow in saline coastal habitats in the tropics and subtropics. They need slow currents, no frost and plenty of fine sediment for root attachment. The specialization and distribution of the species is based on the salinity and substrate gradients. The Philippines is endowed with one of the most diverse mangrove ecosystems, consisting of 35-40 mangrove species and a rich fauna with already threatened animals.

Mangroves are very salt tolerant plant and grow in brackish water - a mixture of fresh water from any source like a river and salt water from the sea. In such an environment they provide habitat and food for other species living under these conditions. Small fish for example can hide and grow up in mangrove forests. Mangroves also clean the water and prevent the coastline from erosion. And when a storm is coming, they are a natural protection for our houses and livelihood. We have to protect the mangroves, so that they can protect us.

1. *Where do mangroves usually grow?*

2. *Which conditions are important for mangroves to grow?*

3. *What are the benefits of mangroves and why do we have to protect them?*

b) What can I do?

Mangroves reforestation can be an interesting and very exciting activity. There are several ways to get involved and to help protect the mangroves. Find the pairs that belong together!

(1) Keep the water clean!

Confront them with the benefits of mangroves.

(2) Look for the planting sites!

Don't dump your waste into the sea.

(3) Watch the mangroves!

Help planting and maintaining
the mangroves.

(4) Talk to people!

Keep them clean and protect
them from animals.

(5) Get involved!

Monitor their growth and survival.

MANGROVES | Fact Sheet # 1

ECOLOGY AND ECOSYSTEMS

- **Ecology** is the scientific study of the relationship between organisms and the environment
- Ecology is a subject of various sciences such as biology, chemistry or behaviour
- Living and physical components form an interactive system, called the **ecosystem**
- Ecosystems have three fundamental characteristics: A certain structure, basic kinds of processes and they change over time
- All terrestrial and aquatic ecosystems have three basic components: **producers, consumers** and **abiotic components**
- An **ecological community** is a set of interacting species found in the same place and functioning together to make possible the persistence of life
- Every ecosystem relies on living and physical interacting components
- Often it is difficult to define the boundaries of a certain ecosystem

COASTAL AND MARINE RESOURCES IN THE PHILIPPINES

- With more than 36,000 kilometres, the Philippines has one of the longest coastlines
- The country depends heavily on its rich coastal and marine resources for the many economic, employment, and biodiversity values and services they provide.
- Philippine waters contain some of the world's richest ecosystems, characterized by extensive coral reefs, sea-grass beds, and dense mangrove forests.
- Coral reefs, mangrove forests, sea-grass beds and other coastal ecosystems are interrelated and largely depend on each other
- An ecosystem's destruction due to human impact largely affects other coastal ecosystems
 - o **Coral reefs** provide many direct and indirect benefits, including food, livelihoods, recreation, protection from erosion, and extremely high levels of biodiversity.
 - o **Mangroves** protect coasts from storms, erosion, and floods, and help purify water
 - o **Sea-grass beds** are a vital resource for underwater life. They provide the intermediate buffer necessary for coral reefs to protect coasts and mangroves

THE MANGROVE FORESTS ECOSYSTEM

- **Mangrove forests** are tree wetlands located on the coastlines in warm tropical climates
- Mangroves grow in **tropical and subtropical regions** all over the world
- 70 species of mangroves exist, covering an area of 24 million hectares
- Mangroves flourish in different environmental settings, but only under certain conditions:
 - o a moderate salinity and neutral acidity,
 - o year-round warm temperatures,
 - o regular surface-water flushing and
 - o exposure to moderate freshwater run-off
- Mangroves are a **habitat both for land and for underwater organisms**
- Mangroves live in **salt or brackish water** and have adapted to **extreme living conditions**:
 - o Remarkable tolerance to salty water
 - o Roots growing from the ground upwards and even beyond the surface of the sea
 - o Seedlings grow directly on the tree reaching a remarkable size before falling
- The mangroves seedlings are called **propagules**

MANGROVES | Fact Sheet # 2

WHY DO WE NEED MANGROVES?

- Mangroves are a *multiple-function resource*, important for environment and people
- The *ecological importance* of mangroves:
 - o Mangroves help in maintaining coastal water quality and purify water
 - o Mangroves protect coasts from storms, erosion and floods
 - o Mangroves are important feeding sites for fish species, shrimps and other species
 - o Mangroves function as a nursery for fish and are important for the food chain
- *Importance for the people*
 - o Mangroves are an abundant source of forest products such as firewood or charcoal
 - o Mangroves are a rich source of fishery products and protect human settlements

AN ECOSYSTEM UNDER THREAT

- More than 50% of all mangroves worldwide have been destroyed during the last years
- In 1918, mangroves covered 450.000 hectare of coastal line in the Philippines. In 1995 only 120.000 hectares remained. 289.000 hectares of these losses was due to a conversion of former mangrove forests into fishponds
- *Indirect threats (natural phenomena)*
 - o Pests and diseases; typhoons; global warming and climate change
- *Direct human intervention*
 - o Conversion of Mangrove forests into fishponds, shrimp farms and saltbeds
 - o Reclamation for housing projects, human settlements. other construction developments and infrastructure projects
 - o Pollution and siltation (brackish water gets saltier)
 - o Dikes and structures obstructing waterways
 - o Overexploitation / utilization
 - o Disturbance due to gleaning, fish landing etc.

CONSERVATION AND PROTECTION

- Restoration planning should first look at the potential existence of stresses such as blocked tidal inundation and plan on removing that stress before attempting restoration.
- The *objectives of mangrove reforestation* are:
 - o to compensate for the lost ecosystem services due to destruction of mangroves;
 - o to protect the coastal area against ecological disasters such as typhoons; and
 - o to restore a natural source of resources and use it in a sustainable way.
- Mangrove reforestation should be community based and support ways of cooperation between locals, organizations, local government units and academics

WHAT CAN I DO TO PROTECT THE MANGROVES?

- Keep the water clean! - Don't dump your waste into the sea.
- Look for the planting sites! - Keep them clean and protect them from animals.
- Watch the mangroves! - Monitor their growth and survival.
- Talk to people! - Confront them with the benefits of mangroves.
- Get involved! - Help planting and maintaining the mangroves.

EVALUATION | Feedback Sheet

The reason for doing workshops on mangrove education is to let you know more about this fascinating ecosystem. To improve our workshops we want to know what you liked and what not. Now it's up to you! Please give us your feedback!

1) How did you like the workshop?

The workshop consisted of different parts with various activities. Tick what expresses best your feelings and thoughts about the following components. Make only one tick in each line!

	😊😊 very much.	😊😊 only a bit.	😊😊 not really.	😊😊 not at all.
1.1) I liked the different experiments...	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1.2) I liked the activities outside the room...	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1.3) I liked the lectures and inputs...	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Look at the following statements and indicate if you agree or not.

	😊 (agree)	😊 (disagree)
1.4) I could follow the workshop easily.	<input type="checkbox"/>	<input type="checkbox"/>
1.5) I learned new facts about mangroves.	<input type="checkbox"/>	<input type="checkbox"/>
1.6) I want to learn more about mangroves.	<input type="checkbox"/>	<input type="checkbox"/>

1.7) My favourite exercise: _____

1.8) This was the worst part: _____

1.9) This was easy to understand: _____

1.10) I had problems to understand: _____

2) What do you want to learn more about?

I want to learn more about...

2.1) ...the mangrove forests ecosystem in general	<input type="checkbox"/>	_____
2.2) ...the benefits of mangroves	<input type="checkbox"/>	_____
2.3) ...the threats mangroves are exposed to	<input type="checkbox"/>	_____
2.4) ...how I can get involved to protect mangroves	<input type="checkbox"/>	_____
2.5) ...anything else about mangroves (please specify!!!)	<input type="checkbox"/>	_____

3) Any other Comments?

Is there anything you heard about in the workshop you would like to learn more about?

4.3 How to Educate? Ideas for Learning Exercises

This chapter is about methodology. It is the key part of this teaching manual. Here you will find ideas for getting the information you have just read to students, get them interested in the topic and raise awareness for the importance and need for protection of mangrove forests.

Every unit follows different objectives. The material and time needed varies from exercise to exercise. Therefore, information on the objective, material needed, time and people and a description of every learning exercise is given.

Here is a brief overview on the exercises you will find in this manual:

- *Exercise 01 Mangroves Are Cool! - Visiting Nearby Mangroves*
- *Exercise 02 With and Without Mangroves*
- *Exercise 03 Interview With Experts, Scientists and People Affected*
- *Exercise 04 Changing Environment*
- *Exercise 05 Everything is Connected*
- *Exercise 06 Erosion: The Ocean-bowl Experiment*
- *Exercise 07 Wind Versus Mangroves*
- *Exercise 08 I need protection! Waste and a Seedling*
- *Exercise 09 The Tree of Life*
- *Exercise 10 Visualizing Threats to Mangroves*
- *Exercise 11 Role Play: Fish Ponds versus Mangroves*
- *Exercise 12 What Can I Do? - Finding Solutions*
- *Exercise 13 Untrue Statements*
- *Exercise 14 Mangroves in the News*
- *Exercise 15 What Comes Next? - Steps for Reforestation*
- *Exercise 16 Visualizing the Topic with the Help of Pictures*
- *Exercise 17 No One Likes Salty Water - Except for Mangroves*
- *Exercise 18 Visual Summary - Create a Poster for Class*
- *Exercise 19 Mangrove PowerPoint Presentation*

Exercise 01***Mangroves Are Cool! - Visiting Nearby Mangroves*****Objectives**

This exercise is more an excursion, than a learning exercise in class. It is a great way to raise awareness, as the students virtually see, what they are talking about. At the mangrove site, information on the nature and environment of mangroves, their benefits and threats should be given.

This trip can be combined with a clean-up of the mangrove site, the planting of new mangrove seedlings or other activities.

How many people and what material do you need?

- For the whole class, group of students
- Experts, scientists and officials can be invited to join the trip
- Combined with a clean-up trip: plastic bags to remove waste
- Combined with a mangrove planting trip: Seedlings and gloves for protection

Description

Find out, if there are mangroves growing in your area or if there is even a sanctuary nearby. This is also a good way to introduce the issue of mangrove reforestation to your students. When at the mangrove site, you can first ask questions to your students, such as:

- What is your first impression?
- What looks strange / different / funny?
- What does the environment look like?



Afterwards, the students' impressions can be structured by giving information on various visual aspects:

- Explain why mangroves are very special trees
- Explain why they grow in that area (brackish water, tide etc.)

Talk about their appearance (roots, leaves, size) and explain, why they look the way they look.

Picture: Clean-up at the Carmen Marine Sanctuary, San Agustin.

Relevance and learning effect

This exercise brings the students to the object they are learning about. It is a good way to let the students see and feel the mangroves as well as to get an impression of their natural environment. At the end, the students should know, why mangroves look the way they look and what they need to grow and survive.

Good for teaching

- 2.2 *The Mangrove Forests Ecosystem*
- 3.1 *Conservation and Protection*

Exercise 02***With and Without Mangroves*****Objectives**

By showing pictures of former mangrove forests and destroyed coastal areas, students should discuss what the difference is and learn about the importance of mangroves.

How many people and what material do you need?

- For small groups of students,
- Pairs of contrasting pictures - with and without mangroves (number according to the number of groups)
- Big Paper, markers and pens in different colour, tape to fix the students' presentations

Description

Print pairs of pictures showing healthy mangroves, a mangrove forest, young fish among mangrove roots etc. on the one hand and dead trees, fish ponds in coastal areas and underwater deserts on the other hand. These contrasts will illustrate the changing environment and the various threats to mangrove forests.

Divide your class into small groups and give each of them a pair of pictures. Then let them discuss the following questions:

- What do you see and what has changed?
- What might be the results for humans and the environment?

Afterwards they can put their thoughts on paper and present it in front of class. The whole class can discuss the findings after every presentation. At the end they should find out and know about several benefits of mangroves and what puts them in danger.

Example

Students get a picture of a natural mangrove forest and fish pond.

What has changed? - No trees anymore at the coast

What might be results? - no coastal protection, animals lose habitats

→ Benefits: Protection from typhoons, habitat for many species

→ Threat: Large fish ponds along the coastal line

Relevance and learning effect

The students get a visual impression of what mangrove deforestation actually means. By thinking about reasons and results they will find out about threats to mangroves and their importance.

Good for teaching

- 1.1 Ecology - We and Our Environment
- 1.2 Talking about Ecosystems
- 2.1 Coastal and Marine Resources in the Philippines
- 2.2 The Mangrove Forests Ecosystem

Exercise 03***Interview With Experts and People Affected*****Objectives**

This is a good way to introduce the topic to the students. By inviting an expert from an organization or a local fisherman, farmer etc. who directly depends on the mangrove ecosystem, the class will get a vital impression of what the importance of mangroves actually is.

How many people and what material do you need?

- For the whole class
- Invite different people to come to class (officials from the agricultural bureau, scientists, mangrove experts fishermen, farmers etc.)

Description

Invite an official from the local agricultural office, a person involved with coastal resource management or a fisherman to let him talk about his experience with mangroves.

Think of possible questions together with the students before the actual interview. While the personal experience of a fisherman should be very interesting for the students (as fish is about their everyday life), you can focus on the meaning of mangroves for coastal communities and reforestation efforts when talking to any other person involved in mangrove protection and reforestation and coastal resource management.

Relevance and learning effect

Especially when talking to fishermen and farmers, this exercise will show the interrelation between human activity and the mangrove forests, its importance, benefits and threats.

Good for teaching

- *2.1 Coastal and Marine Resources in the Philippines*
- *2.2 The Mangrove Forests Ecosystem*
- *3.1 Conservation and Protection*

Exercise 04***Changing Environment*****Objectives**

This exercise illustrates various threats mangroves are exposed to. Students actively see the change and discuss the effects for humans and environment with the teacher with the help of self-designed visuals.

How many people and what material do you need?

- Discussion and activity in class
- Cardboard in different colours for self-designed visuals, as followed:
 - Fish and other species living in mangrove forests
 - Living mangroves
 - Dead mangroves
 - Houses
 - Dike(s)
- Water and land can be drawn on the blackboard
- Marker and big paper, scissors
- Tape to fix the visuals on paper, a wall or the blackboard

Description

This exercise involves the students' active participation. Involve as many of them as possible. Let them first make the self-designed visuals as described above. Then create a natural mangrove environment on a big paper or on the blackboard by using these visuals. Place one house, three living mangroves and some fish on the paper and let the students describe what the natural environment of mangroves looks like.

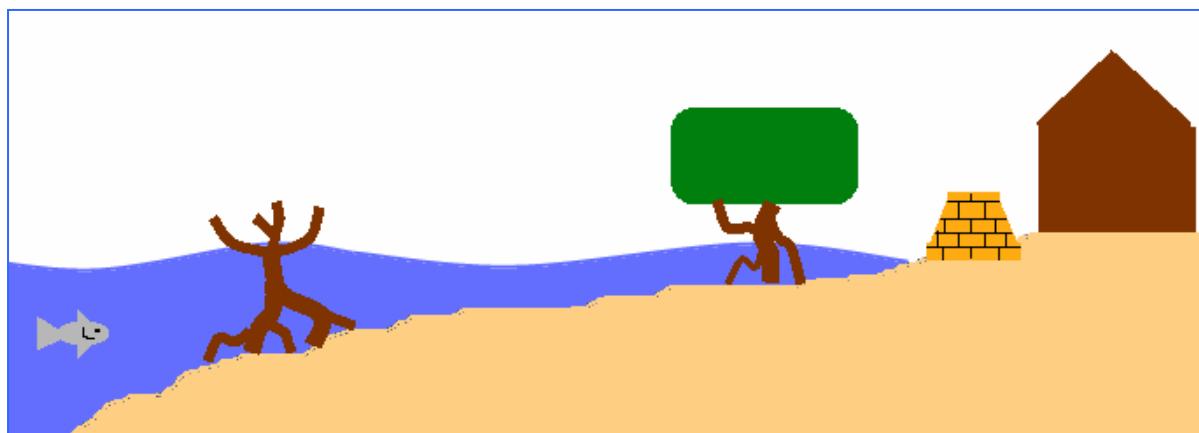
Now change the setting: let some mangroves turn into dead ones because of sea-level rise, take fish away and put the dike as well as new houses on the paper. What has changed? Let the students describe!

Relevance and learning effect

By actually comparing the natural setting of mangrove forests with the changed one the students visualize the change due to several threats. Explain with the help of the visuals what that change means for coastal communities and the environment

Good for teaching

- 2.2 *The Mangrove Forests Ecosystem*



Exercise 05***Everything is Connected*****Objectives**

This game is used to raise awareness for the interconnectivity between and within ecosystems. It shows how easy the ecological balance can be disturbed by destroying only one organism. Every species plays an important role in the web of life and change affects others drastically.

How many people and what material do you need?

- For at least a small group of participants and open space
- String straw rolls (depending on the number of participants)
- Paper, pens, scotch tape, pins

Description

Instruct the students to create big circle using themselves and give them an individual name that connects them to the mangrove ecosystem, e.g.:

- air, brackish water, sun, fresh water
- insects, birds such (kingfisher, woodpecker...), mudskipper, land animals
- mangrove trees and other plants, sea grass
- various species of fish, shellfish, crabs, octopus, shrimps, lobster, star fish

It is important to have at least one mangrove tree within the group of students! The teacher will give the string to anyone within the circle. She/he will start the game and pass the string to the part of the environment which she/he knows is needed by this organism (which is the second student) or the second organism needs him/her as well. The second person will then choose an organism inside the cycle of life which she/he believes that he/she needs too to survive. The string needs to be hold tightly at any time. Assist here as a facilitator. This is a sign of a balanced ecosystem. Forwarding the string is a continuing process.

The string may also go to any organism more than once. When all organisms hold the string together, the destroyer of the environment will appear. Her/his task is to create an imbalanced ecosystem by cutting down mangrove trees. For this the facilitator taps the back of a "mangrove" that is a part of the circle. You should make a story, telling, what happens to the mangrove. This organism will then lose the string in his/her hands as a sign that she/he is no longer part of the web of life. Whoever is connected with his/her string will die or collapse, until the rest who are connected with the web of life will also be diminished.

Make sure to explain "ecosystem" and "biodiversity" before playing this game.

Source: Palawan Conservation Corps: "Ang Magkakaugna"
(in: Berger / Otto / Wichern / Ziegfeld / Magpayo 2008)

**Relevance and learning effect**

The students will see that extreme changes in an ecosystem affects more than only one organism and that all live depends on each other.

Good for teaching

- 2.1 Coastal and Marine Resources in the Philippines
- 2.2 The Mangrove Forests Ecosystem

Exercise 06***Erosion: The Ocean-bowl Experiment*****Objectives**

This experiment illustrates why mangrove forests are important to stop erosion and protect the shoreline. By using different cardboards with

How many people and what material do you need?

- One person explains and shows the experiment to the class / audience
- Transparent plastic bowl or a small aquarium if possible
- Sand and water
- Strong cardboard or plastic, scissors

Description

Fill a transparent bowl with sand and water as a coastal area - see the picture below. Place some houses on the shoreline and use a strong cardboard as a border between land and sea, symbolizing the mangroves. Now move the bowl back and forth, imitating waves. Some sand will move to the water-side.

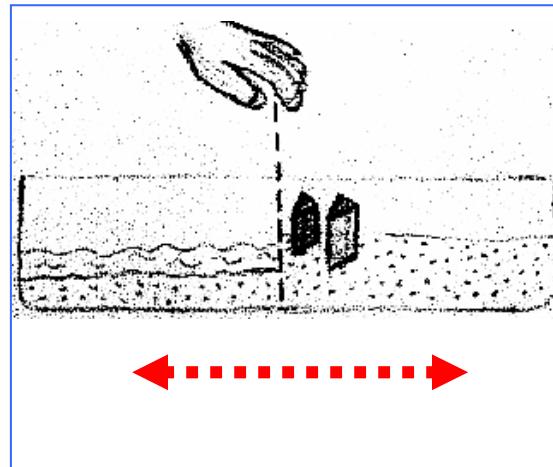
Change the cardboard and see what happens: The smaller the cardboard (mangroves) is, the more sand will move to the sea-side (erosion). Eventually even the houses will be damaged. Let the students try the bowl-experiment!

Relevance and learning effect

This exercise shows how important mangroves are to protect the shoreline from erosion and flooding. Mangroves are a direct protection for the livelihood of coastal communities.

Good for teaching

- 2.2 *The Mangrove Forests Ecosystem*
- 3.1 *Conservation and Protection*



Exercise 07**Wind Versus Mangroves****Objectives**

This exercise translates the importance of mangroves to protect the shoreline and human livelihood into an activity game. The students will play “wind” and “mangroves”, trying to reach or to protect a house. The students will learn, that the more mangroves exist, the harder it is for the wind to reach and damage the house.

How many people and what material do you need?

- Designed for groups of at least 10 students
- Open space
- Cardboard and tape to create name-tags for “wind”, “mangroves” and “house” (Or use green (mangroves), blue (wind) and red (houses) cardboard, if possible).

Description

In this game, students will act as “wind” or “mangroves” either to reach, or to protect a house behind the mangroves. Divide the class into two groups - with half of them acting as wind and the others as mangroves. Choose one to be the house. The mangroves position between wind and house. The wind-group will then run towards the house to reach it. They stop when caught by a mangrove. When they reach the house, they remain there. Count, how many made it through the mangroves and repeat the game - but now with more wind and less mangroves. Repeat this until only very few mangroves are left. At the end, more and more “wind” students will reach the house.

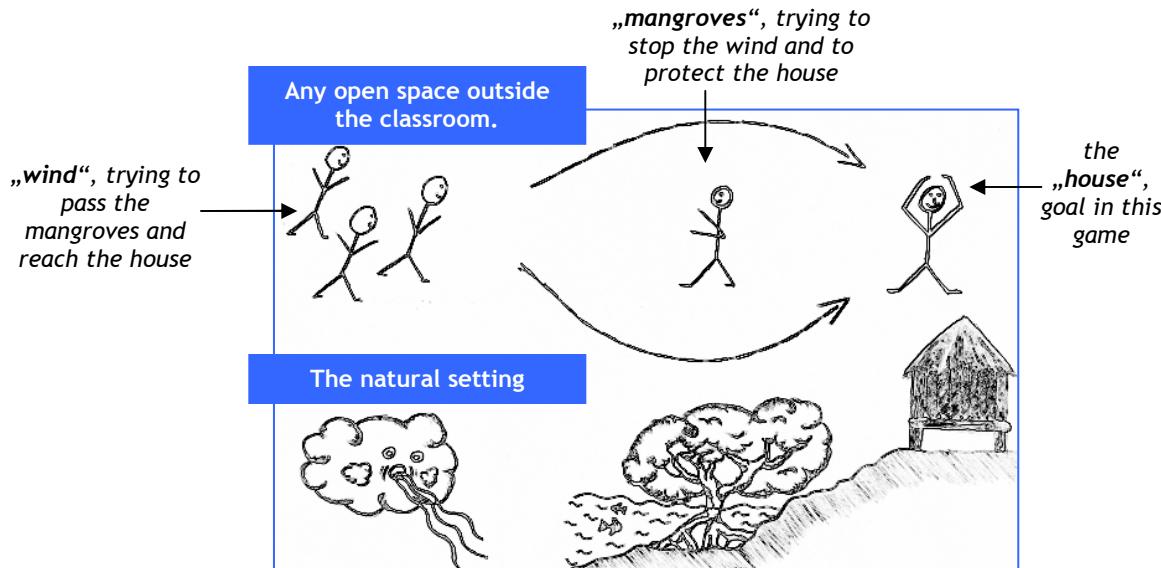
Explain and visualize the experiment for the students before going out!

Relevance and learning effect

This exercise is good to illustrate the importance of mangroves with regard to shoreline protection and to show how they prevent houses from being damaged or even destroyed by heavy storms. This is relevant, as it connects the mangroves to the students’ daily livelihood.

Good for teaching

- 2.2 The Mangrove Forests Ecosystem
- 3.1 Conservation and Protection



Exercise 08***I need protection! Waste and a Seedling*****Objectives**

This exercise is to let the students see the effect of waste on mangrove seedlings. To show the negative impact, a living mangrove seedling is best for presentation.

How many people and what material do you need?

- Presentation in front of class
- A few living mangrove seedlings, different in size (from a nursery)
- Plastic bags and other waste

Description

Waste and especially plastic bags are a big problem for young mangrove seedlings. Due to current and waves they stick to the mangroves and actually pull or even break them.

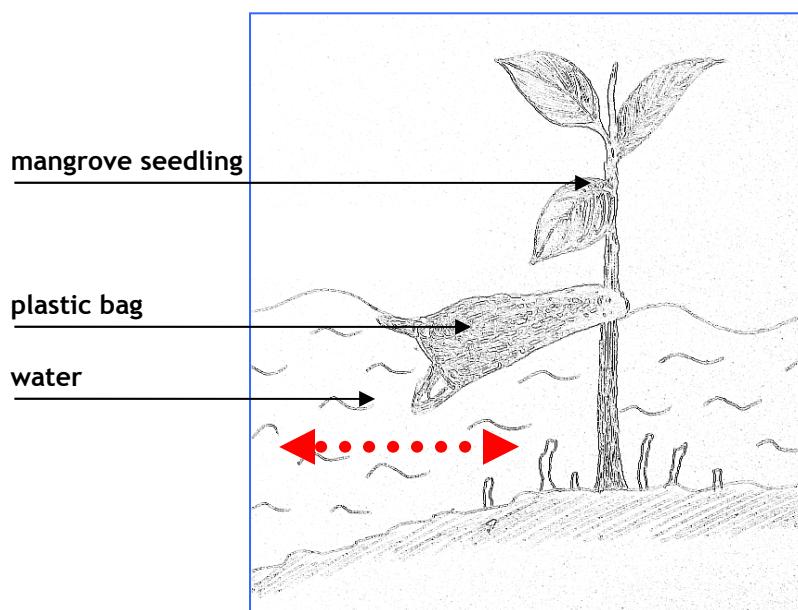
While showing the students the effect of usual plastic bags on young mangroves you can explain this to the audience. Tell them, how dangerous huge plastic bags can be to mangrove seedlings because of the change of low and high tide.

Relevance and learning effect

Students get a vital impression of the dimensions of a small mangrove seedling and a big plastic bag and why waste is dangerous especially for young mangrove trees. This can be combined with a clean-up at a near mangrove site.

Good for teaching

- 2.2 *The Mangrove Forests Ecosystem*
- 3.1 *Conservation and Protection*



Exercise 09***The Tree of Life*****Objectives**

This exercise is to visualize the benefits of mangroves by putting together a “tree of life”. The students actively learn about the importance of mangroves.

How many people and what material do you need?

- Group activity - Putting leaves on the tree together on the blackboard
- Big paper and marker in different colours
- Green cardboard and scissors for the leaves

Description

First, inform the students about the benefits of mangroves. Let the students draw the roots, trunk and branches of a mangrove tree on a big paper afterwards. Divide them into groups and provide green cardboard. The students should now put the benefits of mangroves they remember on the cardboard and cut leaves.

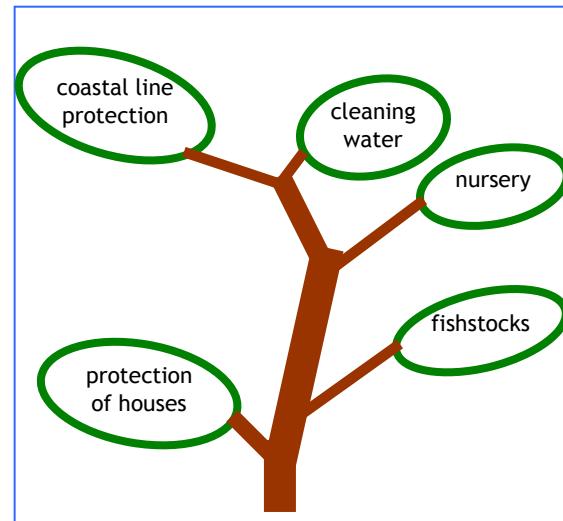
Let the students present their results! Ask them to come to the front to put their leaves onto the tree of life on the blackboard.

Relevance and learning effect

The students repeat the benefits of mangroves in an active way. They memorize the importance of these trees and get the chance to present their results.

Good for teaching

- 2.2 *The Mangrove Forests Ecosystem*
- 3.1 *Conservation and Protection*



Exercise 10***Depicting and Visualizing Threats to Mangroves*****Objectives**

The students will summarize what they have just heard about threats to mangroves and visualize it in an active and creative way.

How many people and what material do you need?

- Activity for small groups in class
- Cardboard in different colours and pens
- Big paper and tape
- (Scissors, crayons, glue)

Description

After having learned about the various threats to mangrove forests, the students should become creative in small groups. They can depict one of the threats (see below) and draw, write, perform or make something else showing their ideas and knowledge about this issue.

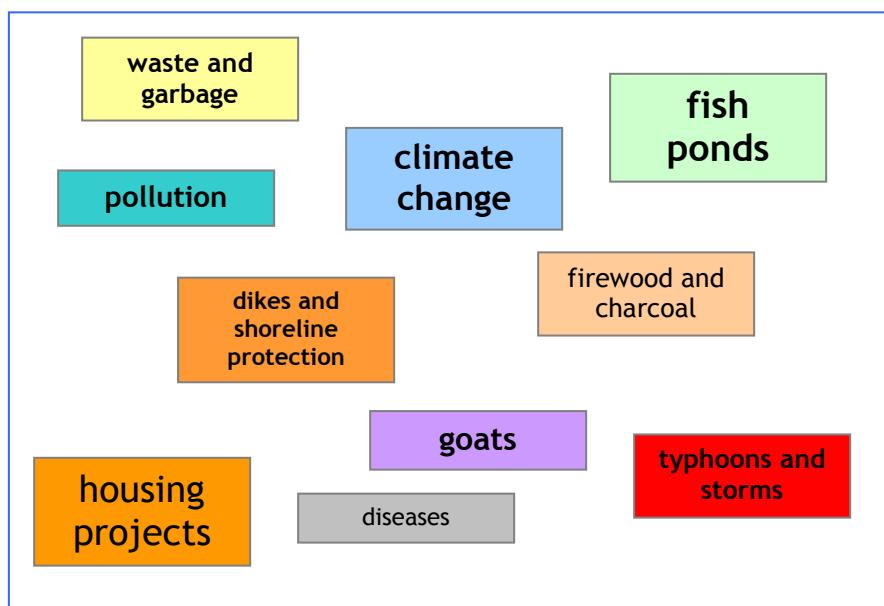
Let them present their ideas in front of class and collect them on a big paper.

Relevance and learning effect

This exercise is good for memorizing information, the students have just heard. They repeat the threats in a creative way.

Good for teaching

- 2.2 *The Mangrove Forests Ecosystem*



Exercise 11***Role Play: Fish Ponds versus Mangroves*****Objectives**

In this exercise students should find the pros and cons of fishponds by themselves. They will see, that short-term profits are the only advantage of fishponds, while destroying mangroves has more and stronger negative impacts on coastal communities and the environment.

How many people and what material do you need?

- Activity for pairs or small groups of students
- Dress or significant items for both the fishpond owner and the fisherman who wants to protect the mangroves

Description

Most of the mangrove loss in the Philippines is due to the conversion of mangrove forests into brackish water fishponds. Let the students think why this happened and what the effects might be. They should find arguments both for fishponds and the conservation of mangroves before presenting their findings in front of class. Two students will argue against each other. One will represent a fishpond owner, the other one a traditional fisherman who is interested in the protection of the mangroves

Advantages of fishponds	Why we need mangroves
<ul style="list-style-type: none"> ▪ creation of jobs within the coastal communities ▪ Increasing of the local income situation ▪ Less pressure on natural fish sources ▪ Guaranteed source of food and income 	<ul style="list-style-type: none"> ▪ local workers often won't get the specialized jobs ▪ loss of sustainable forms of fishing ▪ fish ponds only productive for a few years; useless afterwards ▪ mangroves are vital for natural fish stocks (food and nursery) ▪ fish ponds pollute coastal areas with medicaments and chemicals

Relevance and learning effect

The students should understand that there are only short-term advantages of fishponds whereas the destruction of mangroves has dramatic long-term consequences both for the environment and the coastal communities. Conservation and protection of mangroves is the only real alternative!

Good for teaching

- 2.2 The Mangrove Forests Ecosystem
- 3.1 Conservation and Protection



Exercise 12***What Can I Do? - Finding Solutions*****Objectives**

This exercise helps the students to think themselves about what they could do to protect mangroves and get involved in mangroves reforestation rather than giving solutions to the class.

How many people and what material do you need?

- pens or marker
- big paper

Description

After giving information on the threats to mangroves and discussion the issue of mangrove reforestation with students, this exercise fits best. Let the students think about solutions for the problems they have just heard. They can do it individually or in together small groups.

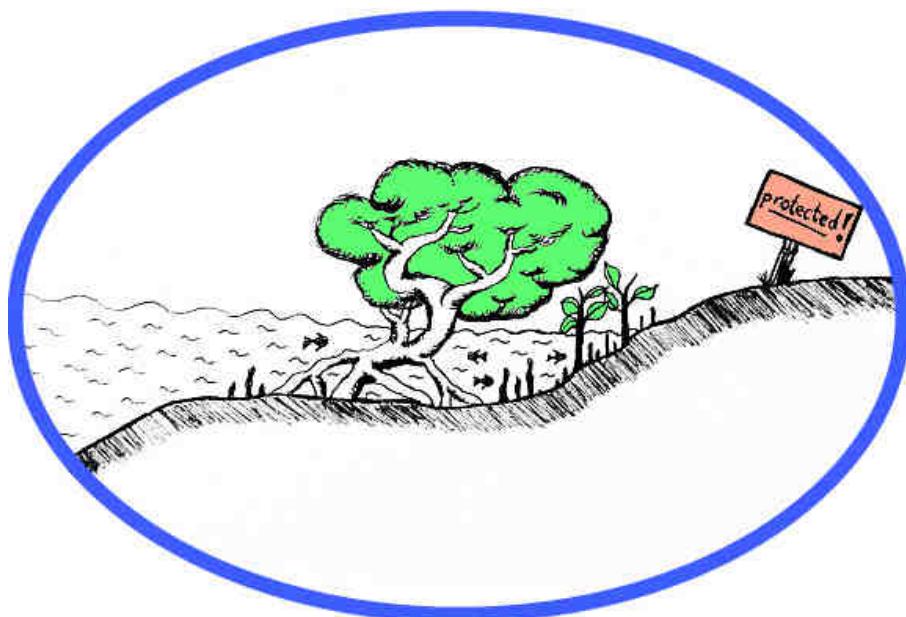
The students can then be creative and write or draw their solutions or what they think they personally can do before presenting them in front of class. Help the students and tell them additional solutions when important ones are missing.

Relevance and learning effect

Solutions do exist! Although mangroves are endangered all over the world and especially in the Philippines, this exercise, that solving the problem and a successful reforestation is possible! By finding these solutions themselves, the students will also experience that each and everyone can help to protect the mangroves.

Good for teaching

- 2.2 *The Mangrove Forests Ecosystem*
- 3.1 *Conservation and Protection*
- 3.2 *Experiences from Around San Agustin*



Exercise 13***Untrue Statements*****Objectives**

This exercise confronts the students with untrue statements about mangroves. It helps to clarify misunderstandings and to memorize the “truth” about certain mangrove related issues.

How many people and what material do you need?

- Group Activity
- Paper and pens with “untrue statements”

Description

Confront the students with untrue statements about the mangrove ecosystem. They can be from the news, from yourself or even from the students themselves. Give each group of students one of the statements or the paper with all the wrong statements and let them find out what is wrong. Each group should discuss its statements and present their outcome afterwards in front of class.

Relevance and learning effect

This activity will clarify misunderstandings and wrong perceptions of the mangrove ecosystem. You can choose the issue area of the wrong statements according to your students’ knowledge. Interesting ones might be the interconnectivity of coastal ecosystems or mangrove reforestation efforts.

Good for teaching

- *1.1 Ecology - We and Our Environment*
- *1.2 Talking about Ecosystems*
- *2.1 Coastal and Marine Resources in the Philippines*
- *2.2 The Mangrove Forests Ecosystem*
- *3.1 Conservation and Protection*

Exercise 14***Mangroves in the News*****Objectives**

An article on an extreme weather event, fish ponds, fish stock depletion or any other issue that can be related to mangrove forests, its benefits and its destruction is a good way to introduce the topic of mangroves and mangrove forests protection to the students.

How many people and what material do you need?

- Article on mangrove related event from a newspaper
- Pictures and further information on the event
- For group activity: Several different articles

Description

This exercise will help to introduce mangroves and mangrove protection to students. Confront the students with the article and let them read and discuss it in small groups. Let one of them (or one of each group) read the article aloud in front of class. He or she as a reporter can explain the situation or event with the help of pictures and further information.

Relevance and learning effect

This exercise confronts the topic to the students in a way, they realize that they are all effected by mangrove destruction or the benefits of mangroves - especially in coastal communities. It is a good way to introduce the issue to the students.

Good for teaching

- *1.1 Ecology - We and Our Environment*
- *1.2 Talking about Ecosystems*
- *2.1 Coastal and Marine Resources in the Philippines*
- *2.2 The Mangrove Forests Ecosystem*
- *3.1 Conservation and Protection*

Exercise 15***What Comes Next? - Steps for Reforestation*****Objectives**

This exercise shows the complex process of mangrove forests reforestation and visualizes that much more steps than just planting mangroves are needed for a successful reforestation.

How many people and what material do you need?

- Entire class activity
- Cardboard, markers and tape

Description

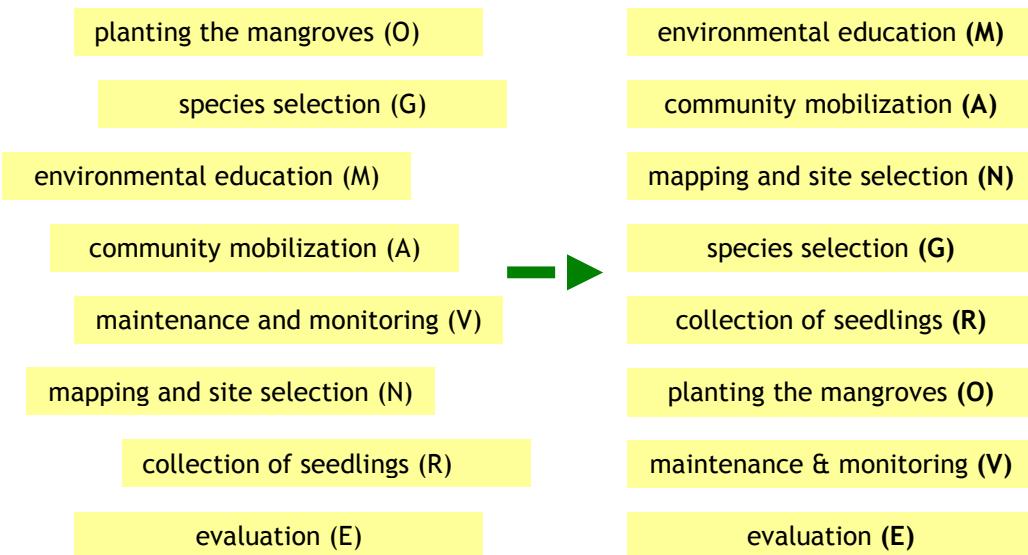
Mangrove reforestation projects should be well-planned. They often fail because of bad management and because several steps were not considered. After telling the students about the complex process of reforestation, prepare cardboard Put each of the following eight steps on different cardboard cards: "environmental education", "community mobilization", "mapping and site selection", "species selection", "collection of seedlings", "planting the mangroves", "maintenance and monitoring" and "evaluation". You can put an additional letter on each of the cards to have a word at the end, such as M-A-N-G-R-O-V-E (see the graphic below). Let the students put the steps into the right order and let them find out the word.

Relevance and learning effect

This exercise is a good way to memorize the just heard information - not only about mangrove reforestation. The students will learn, how many steps have to be considered for a successful reforestation project.

Good for teaching

- 3.1 Conservation and Protection



Exercise 16***Visualizing the Topic with the Help of Pictures*****Objectives**

Showing pictures is a great way to introduce mangrove forests to your students. Photos of mangrove trees, roots, potential threats etc. will raise the pupils' attention and help to visualize major facts about mangroves.

How many people and what material do you need?

- Various pictures on mangroves (forests, leaves, roots), their environment, threats (e.g. goats), benefits and reforestation efforts
- whole class activity

Description

Print out various pictures of mangroves and their environment. Focus the students' attention on certain issues the workshop will be about (e.g. goats for threats or a clean-up for reforestation efforts etc.) to give a preview and gain the students interest. Pictures taken from the area the students come from will even increase their attention. Discuss certain issues briefly!

Relevance and learning effect

This exercise is helpful to start the workshop with. The students will focus their attention on very specific issues. They will get interested in the workshop's various topics to come.

Good for teaching

- *All major parts of the workshop.*



Most of these pictures were taken around San Agustin and were used for the workshops.

Exercise 17***No One Likes Salty Water - Except for Mangroves*****Objectives**

Plants in general need fresh water to survive. High concentration of salt can easily kill almost any plant. Mangroves however DO survive in salty water. That is what makes them very special and unique. This exercise lets the students “feel” and literally experience, what the mangroves’ environment must be like - by tasting fresh and salty water.

How many people and what material do you need?

- A bottle of fresh water and one with salty water
- Two glasses
- Experiment for a few students in front of class

Description

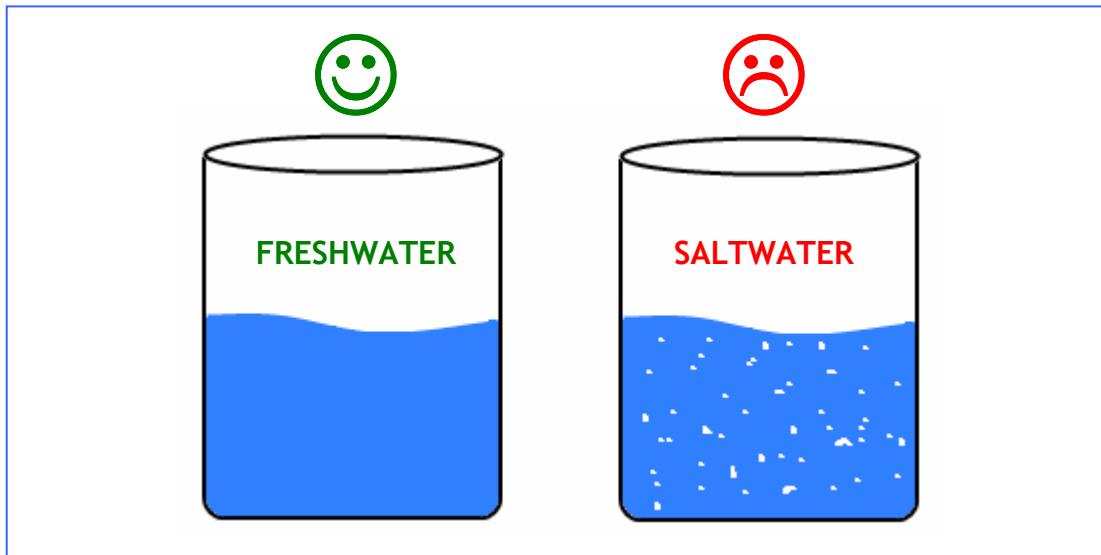
Show the two bottles of water to the class - at the first glance they both look the same. Fill two glasses with water, one with fresh, the other with salty water. Ask at least two students to come in front and let them try. Which one do they like better? Which one tastes disgusting?

Relevance and learning effect

The students will easily find out, that salty water is not good for drinking at all! They will refuse it and understand why mangroves live under very special and unique conditions. They should also learn about the mangroves’ various ways how they adapt to this environment.

Good for teaching

- 2.2 *The Mangrove Forests Ecosystem*



Exercise 18***Visual Summary - Create a Poster for Class*****Objectives**

This exercise provides a good summary of the mangroves' benefits, threats and ways to protect them. It is also something to keep for the students and to put it somewhere in the classroom.

How many people and what material do you need?

- Class activity
- Cardboard in different colours including green, blue, red and yellow
- Scissors and glue

Description

In this exercise the students will repeat the facts they have just learned and create a visual for their class at the same time. You can do this either as a final exercise at the end of your mangrove education term or you can develop it right from the start, so that it is finished at the end.

Give the students cardboard in different colours and scissors and let them cut leaves (green) to put benefits of mangroves on them, clouds (red) for threats, houses (yellow) for how to get involved and fish (blue) for the various kinds of species living with mangroves. Let the students work together in small groups and let them present their answers in front of class to put the visual together.

Relevance and learning effect

This is a general summary of the workshop or lesson. It will show the students' general understanding of the four major parts of this manual (what are mangroves, why do we need them, what are the threats for them and how the community can take care of mangrove forests). This exercise will also reveal where more efforts have to be made to improve the students' understanding.

Good for teaching

- *A summary for all the content provided in this education kit*



Exercise 19**Mangrove PowerPoint Presentation****Objectives**

This exercise is a good introduction into the topic and helps to visualize certain relevant aspects. It will raise the students' interest and confront them with the broad issues around mangroves. Keep the presentation as simple and short as possible -based on pictures and other visuals. CERV and Meaningful Volunteer provide a presentation on their websites.

How many people and what material do you need?

- Presentation in front of class
- Make sure to have a white wall in the room
- Projector and laptop

Description

Before running the presentation make sure to have power supply and a white wall in the classroom. Set up laptop and projector well in advance not to lose too much time with technical matters. Concentrate on certain issues and key aspects and involve the students with questions to keep their attention high during presentation.

Relevance and learning effect

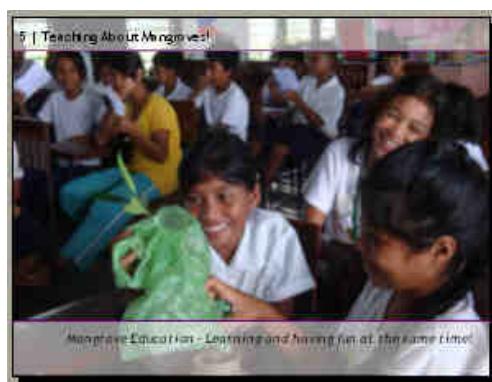
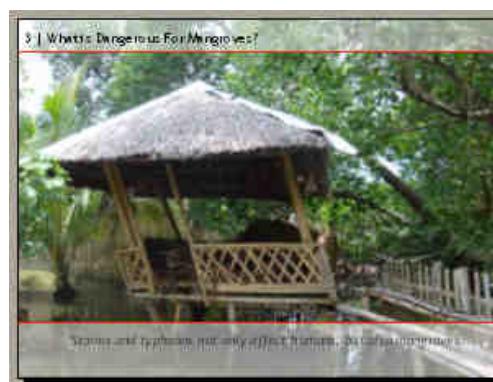
This exercise gives a visual impression of what you are talking about. Pictures rather than information and simple language should be used.

Good for teaching

- *All parts of this manual*



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②	Why do We Need Them?
③	What is Dangerous For Mangroves?
④	How Can We All Protect Them?
⑤	Teaching About Mangroves!



This presentation can be downloaded under www.meaningfulvolunteer.org

Chapter 5 | Further Information

This manual was created to provide you with fundamental information on the mangrove forests ecosystem and to give incentives for the implementation in schools to raise awareness for the importance of mangrove forests among students. Though, this manual is not covering every single aspect in depth. This chapter contains a list of resources for any further reading and additional information. It also provides references for figures and pictures used in the manual, as well as a help for lessons in Romblomanon, the language spoken in San Agustin.

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Drawings and pictures in chapter 4 were made by the authors.

5.2 Literature and Internet Resources

LITERATURE

BERGER, C /EWERS, D. /OTTO, A. /WICHERN, J. /ZIEGFELD R. /MAGPAYO, E. 2008: CoLlective InforMation about ATMosphere and Earth (CLIMATE). A guide to facilitate issue on Global Warming through CLIMATE. Palawan Conserveation Corps / Carpus e.V.

BOTKIN, D. B. / KELLER, E. A. 2005: Environmental Science. Earth as a Living Planet., John Wiley and Sons, Inc. Hoboken, USA.

BROWN, W.H. AND A.F. FISCHER 1918: Philippine mangrove swamps. Department of Agriculture. Bur. Fish. Bulletin No.7.

CHRISTIE, P., WHITE, A.T., / DEGUIT, E. 2002: Starting point or solution? Community-based marine protected areas in the Philippines. Journal of Environmental Management 66: 441-454.

DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES 2001: Philippine Coastal Management Guidebook Series. Coastal Resource Management Project of the Department of Environment and Natural Resources. Cebu City, Philippines, Volumes 1-8.

5 | FURTHER INFORMATION

- FIELD, C.D. 1996: Restoration of mangrove ecosystems. International Society for Mangrove Ecosystems, Okinawa.
- FOOD AND AGRICULTURAL ORGANIZATION OF THE UNITED NATIONS (FAO) 2007: The World's Mangroves 1980 - 2005. FAO Forestry Paper 153, Rome.
- FORTES, M.D. / SANTOS K.F. 2004: Sea-grass ecosystem of the Philippines: Status, problems and management directions. In: In turbulent seas: The status of Philippine marine fisheries. Coastal Resource Management Project, Cebu City, Philippines.
- HUTCHINGS, P. & SAENGER, P. 1987. The ecology of mangroves. Queensland University Press, Brisbane. Field, C.D. (Ed.) 1996. Restoration of mangrove ecosystems. International Society for Mangrove Ecosystems, Okinawa.
- LEWIS, R.R. / STREEVER, B. 2000: "Restoration of mangrove habitat," WRP Technical Notes Collection. Vicksburg, MS.
- LUGO, A.E. / SNEDAKER, S.C. 1974: The Ecology of Mangroves. Ann. Rev. Ecol. Sys. Volume 5.
- MASTALLER, M. 1996: Destruction of mangrove wetlands - causes and consequences. Natural resources and development (Institute for Scientific Co-operation, Tübingen) 43/44: 37-57.
- PRIMAVERA, J.H. 2005: Mangroves, Fishponds, and the Quest for Sustainability. Science, Vol 310, Issue 5745..
- PRIMAVERA, J.H. 1995: Mangroves and brackish water pond culture in the Philippines. Hydrobiologia 295, 303-309.
- SALMO III, SEVERINO G. / JUINIO-MENEZ, MARIE ANTONETTE 2001: Mangrove Reforestation. Coastal Resources Management Tools. Marine Environment Resources Foundation, Inc. The Marine Science Institute, University of the Philippines, Quezon City.
- SAMSON, M.S., ROLLON, R.N. 2008: Growth Performance of Planted Mangroves in the Philippines: Revisiting Forest Management Strategies. Ambio. 37, 234-240.
- SMITH, ROBERT LEO / SMITH, THOMAS M. 2002: Elements of Ecology. 4th edition, Pearson Education Asia, Singapore.
- SPALDING, M.D., BLASCO, F. & FIELD, C.D. 1997: World Mangrove Atlas. International Society of Mangrove Ecosystems, Okinawa.
- TOMLINSON, P.B. 1986: The botany of mangroves. Cambridge University Press, Cambridge.
- Uthoff, D. 1996: From traditional use to total destruction - forms and extent of economic utilization in the southeast Asian mangroves. Natural resources and development 43/44, Institute for Scientific Co-operation, Tübingen), 58-94.
- WHITE, A.T., / CRUZ-TRINIDAD, A. 1998: The values of Philippine coastal resources: Why protection and management are critical. Coastal Resource Management Project, Cebu City, Philippines.
- WORLD BANK 2005: Philippines Environment Monitor 2005. Coastal and Marine Resource Management.
- ZAMORA, P.M. 1990: Philippine mangroves: Their depletion, conversion and decreasing productivity. Wallaceana 58.

INTERNET RESOURCES

- Coastal Conservation and Education Foundation, Inc: www.coast.ph
- Department of Environment and Natural Resources (DENR): www.denr.gov.ph
- Local Marine Managed Areas Network: www.LMMAnetwork.org
- Partnerships in Environmental Management for the Seas of East Asia: www.pemsea.org
- Philippine Council for Aquatic and Marine Research and Development: www.pcamrd.dost.gov.ph
- Mangrove and Estuary Research Section, Ecosystems Research and Development Bureau: www.lgn.pworld.net.ph
- UN Food & Agriculture Organization (FAO) Mangrove Atlas: www.fao.org/forestry/site/mangrove-atlas/en
- International Society for Mangrove Ecosystems: www.mangrove.or.jp
- GLOMIS: Global Mangrove Database and Information System: www.glomis.com
- Mangrove Reforestation: www.mangroverestoration.com
- Wikipedia: <http://en.wikipedia.org/wiki/Mangroves>
- Technical University Berlin: www2.tu-berlin.de/~kehl/project/lv-twk/23-trop-wet5-twk.htm
- Traditional Tree Initiative - Species Profiles for Pacific Island Agroforestry: www.traditionaltree.org

5.3 Mangrove Forests and Workshops in Pictures



A *Rhizophora* mangrove tree in Queensland, Australia (wikipedia.org).



New mangrove Seedlings in Kerala, India (wikipedia.org).



Mangroves: Ecosystems both on land as well as below the surface (wikipedia.org).



A mangrove tree with its typical roots in Malacca, Malaysia (wikipedia.org).



Sonneratia sp. in the Philippines (FAO 2007, page 3).



Rocky mangroves in Costa Rica (FAO 2007, page 3).

5 | FURTHER INFORMATION

Teaching Manual

Mangroves in the Philippines

The following pictures were all taken in the municipality of San Agustin, Romblon.



Hundreds of mangrove seedlings grow in a nursery before planted.



Newly planted mangrove seedlings, protected by already existing ones.



Waste is a major threat to mangroves - especially to young seedlings.



Goats can be also very dangerous to mangroves. They can destroy seedlings and damage the bark of mature trees.



New seeds constantly grow on existing mangrove trees.



Some communities live very close to the coastline - protected by mangrove forests.

The following pictures are some impression from the workshops conducted for this education kit.



Students particularly enjoy activities and games. At the same time they learn about mangroves, their benefits, threats and protection.



Tree of Life and a mudskipper. Every kind of visualization supports the students' understanding of the complex topic.



A high school student is writing down one of the many benefits of mangrove forests.



Elementary school students try to answer one of the worksheets.



Everything is connected! This game illustrated biodiversity and the complexity of the mangrove ecosystem. Each student acts as a species.



Elementary school students enjoy the ocean-bowl experiment and simulate erosion - with and without mangroves.

5.4 English - Romblomanon

This translation should help the students to understand important terms in the manual.

Ecosystem Mangroves			Threats to Mangroves		
	bird brackish water environment food freshwater habitat purification salt / salty soil shellfish species	pis-pis alat tabang palibot pagkaon tubig pamayay paglimpyo asin / ma-asin duta kayog klasi		damage destroy diseases firewood fishpond plastic bags pollute (v) threat waste goats	guba (n) / distrosa (v) sira-on sakit kahoy palaisdaan plastik bag higko hadlok basura kambing
The Weather			Fishing		
	climate rain (v/n) storm typhoon weather wind	klima uyan bagyo bagyo panahon hangon		boat (paddle) boat (motor) dynamite fishing bouy fish (n) / (v) fishcage fishnet overfishing	baroto motor pag gamit ng dilameta buya isda / bunit likom pukot sobrang parging isda
The Mangrove Tree			Raising Awareness		
	leaf / leaves mangrove plant (n/v) root seed seedling	dahon bakawan tanum gamot busoy tubo-an		awareness education educate maintain monitoring	pag-aman educasyon tudloan mintenar pag aubay-bay
Conservation and Protection			In the Sea		
	conservation nursery protect (v) reforestation sanctuary	pag-plaga punlaan protektahan pagtanom sanktuaryo		coral reef low tide high tide surface waves	koral hunas taob ibabaw humback
Coastal Communities			Human Activities		
	building coast community construct dike erosion house	bilding baybayon komunidad human diki panas bayay		farm (n) fishing plant (v) swimming	uma pagbunit tanum langoy

Personal Notes and Comments

5 | FURTHER INFORMATION



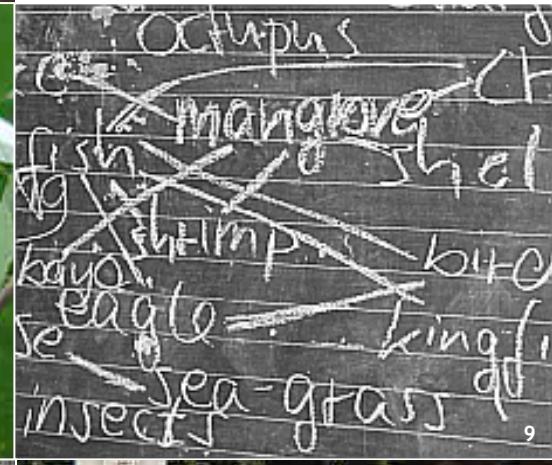
What all these pictures are about

- 01 - Students collect seeds in Carmen, San Agustin
- 02 - Mangroves area near San Agustin at low tide
- 03 - Visuals with the benefits of mangroves
- 04 - Rizophora root system in Kalibo, Panay
- 05 - Elementary school students work on mangrove benefits
- 06 - High school students during a workshop
- 07 - Mudskipper on mangrove roots
- 08 - Seeds (propagules) on a mature mangrove tree
- 09 - Species living in, from and with mangroves
- 10 - Students simulate erosion in a bowl experiment
- 11 - A mangrove seed trying to attach to the ground
- 12 - Students playing "wind versus mangroves"



*When planning for a year,
plant corn.
When planning for a decade,
plant trees
When planning for life,
train and educate people.*

Chinese proverb



Thank you! - To all the
students, teachers
and everyone involved
making this
education kit possible!

Protecting Mangroves

Benefits for People and the Environment + Reforestation Efforts and Experience from San Agustin
- An Education Kit -

This manual is dedicated to communities in the Philippines to support their efforts in raising awareness for the importance of the mangrove ecosystem and the need for its protection. Feel free to use or reproduce any parts of this manual for the purpose of disseminating information to schools and other interested people!



Thank You! / Salamat!

This manual would not have been possible without the help and support of the students, teachers and communities of San Agustin on Tablas Island, Romblon. Their ideas, experience and creativeness inspired this brochure.

For further and up-to-date information on the ongoing mangrove reforestation project visit www.volunteerphilippines.com or www.meaningfulvolunteer.org.