ENVIRONMENTAL SCIENCE

GRADES 7 AND 8

TEACHER'S MANUAL FOR THE REPUBLIC OF THE MARSHALL ISLANDS

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The following are resource materials used to complement this manual.

Alice Leney, Philip Pupuka, Rubbish, No more !, 1999

Jenny Wood, Coral Reef, Two-Can Publishing Ltd, 1991

Dr. Ken Rubin, Assistant Professor Department of Geology and Geophysics University of Hawaii, Honolulu, HI 96822

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Ministry of Education, Science: All around us, level F grade 6, 1995

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Table of contents

Activity list

Foreword

The objective of this manual is to provide teachers with appropriate material to help students understand their environment and how they, as part of the community, interact with it.

Our final goal is that students and communities in general understand their responsibility, while also providing practical actions on how they can conserve the environment.

We, as community members, are all major actors for the conservation of the environment. It is fundamental to be involved in this conservation effort for the sustainability of our island and future generations.

Most of the chapters in this manual are based on field experimentation. One of the best ways for students to understand their environment and feel involved in its conservation is for them to see, to feel and use all their senses to experience the world around them.

Each chapter contains scientific information and activities. These activities are designed to use minimum of materials and are well described for the teachers to feel easily confident in conducting them. Once the activity has been done with a group of students, then the process can be repeated by the students themselves. The teachers can choose to evaluate the students' participation during the field work, or give a written test to evaluate if the chapter has been properly understood.

Acknowledgements

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Aude Chenet
Coordinator

UNIT 1
Ecosystems

CHAPTER 1
Ecosystems

OBJECTIVES:

Students are able to describe the different environments around them

Students are able to explain how living and non-living things are interconnected in an ecosystem

VOCABULARY:

Environment, reproduction, metabolism, ecosystem, spider web.

BACKGROUND INFORMATION

Living organisms inhabit many ecosystems on Earth. To make sense of the number and variety of interactions of living beings and their environment, it is useful to divide the world up into separate units called ecosystems. An ecosystem consists of all the living beings and non-living things in a given area that interact with one another.

These are all interconnected, like a giant spider web.

The threads of an ecosystem's web are the relationships among its plants, animals, soil, water, light, etc.

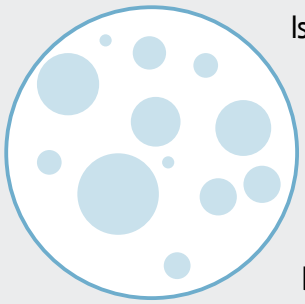
Ecosystems are separate from each other but are interconnected at a higher level, they can affect one another. Damage in one ecosystem can cause damage in other ecosystems.

The deep sea and an island are only two of many different ecosystems found on Earth.

Organisms obtain the air, food, water and other resources they need to live and grow from their environment. Fish get oxygen from the water (ocean) through their gills. They eat algae, smaller live animals or parts from dead animals including other fish for food.

Fish can live in the ocean because this ecosystem contains everything they need to survive.

Living things?



Is water a living thing? Is sand a living thing? Is smoke alive? Are volcanoes alive? Is the sun alive? Are crystals living things? Is wind a living thing?

None of these things are living. As science defines it, a living being means it is capable of metabolism, growth, and reproduction. Reproduction means being able to have offspring or otherwise duplicate oneself (like cell splitting) and metabolism means to be able to extract energy from chemicals in order to sustain oneself. Using this definition, you should be able to say why none of the seven items above are living.

Activity 1: Living needs

OBJECTIVE

Distinguish between what people need to survive that are essential or non-essential for living.

MATERIAL

Paper and pencil

PROCEDURE

This can be done in groups of students or with the whole class. Students can make cards of objects or activities that are part of an atoll ecosystem. The cards can be drawn, named and explained by the students. Cards can be matched with one another, using the question :"Who/what am I?"

All ideas are welcome first and afterwards students have to classify whether the items they identified are essential or not essential for living. For example, these cards may include "coconut tree, fish, church, people. . .".

CHAPTER 2

Populations

OBJECTIVES

Students can define population and give examples of different organisms that would be part of a population.

Students can observe different kinds of areas and the populations living in them.

VOCABULARY

Migration, birth, death, species, population

BACKGROUND INFORMATION

A population is a group of organisms of the same type, or species, living together in the same environment. For example, all of the squid species living in the lagoon are a population. All the coconut trees on an island are a population. But we cannot say that all the fish in the ocean are a population, as fish is a general term, including many different species.

CONNECTING WITH THE RMI

A census keeps track of a population. It can note the increases or decreases in the population of people in a country.

Activity 2: The fallen log

PURPOSE

Students able to describe the interactions between rotting logs and nearby plant and animal populations.

ORGANIZATION

Small groups of students

MATERIAL

Rotting log, paper and pencil

PROCEDURE

The activity site has to be located on the island. Students gather around the log, observing plants and animals present around and in the log. Describe the plants and animals, and record the numbers found.

After examining the log, consider the following:

- It there bark on the log?
- Evidence of plant growth on the log. For example, fungi (mushrooms), algae, moss, weeds, young bushes and trees.
- Evidence of animal activity on and around the log - look for insect holes, ants, and animals' dens.
- Activity inside the log - presence of plants or animals.
- Sawdust around the base of the log is an indication of its breakdown by insects and small mammals - or that it was cut down.

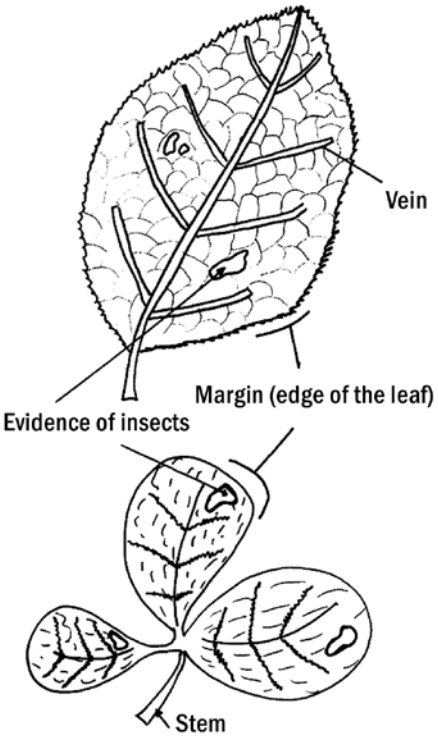
Discuss with the students the interaction between rotting logs and the plant and animal populations. For, example, nutrients returning to the soil and used for plants growth.

The log is providing homes for mammals, insects, worms, spiders, etc.

Ask the students to compare the population in rotting logs and the population of animals or plants in a place with healthy trees.

Discuss the differences.

Activity 3: Large leaves



PURPOSE

Students will be able to describe how insects and leaves can interact and discover the concept of interrelationships between two populations.

ORGANIZATION

Small groups of students

MATERIAL

Boxes or jars, leaves, insects

PROCEDURE

Students are divided into small groups. Each group is assigned an area near the school with many plants.

Each group collects three kinds of leaves that are placed in the boxes. Students can also collect leaves that have been eaten or nibbled by insects.

Discuss the differences and similarities between the leaves collected. See if any insects or moulds are attached on the leaves.

Introduce the idea of interrelationship between plants and insects. Discuss how leaves can be a food source.

CHAPTER 3

Communities

OBJECTIVES

Students provide examples of how members in any community interact.

Students explain the relationship between plants and animals in a community.

VOCABULARY

Interaction, diversity

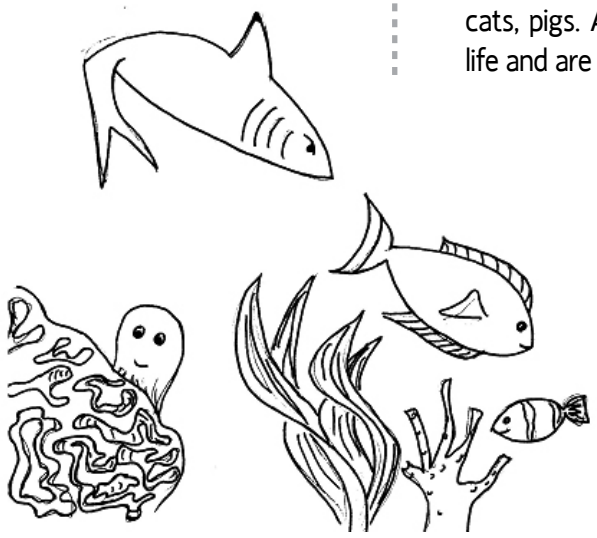
BACKGROUND INFORMATION

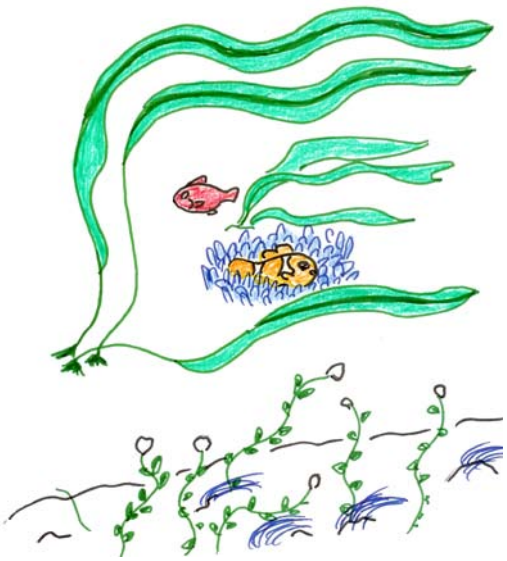
All living things on Earth belong to an ecological community. Every community contains many different kinds of living beings: people, cats, dogs, pigs, birds, grass, insects, trees.

Each living being makes up the population in the community. They are part of an ecosystem. All the different populations that live together in that area are called a community. The community of an ocean might include coral, squid, fish, and algae. The members of a community interact with each other in several ways and also share the same environment, food and shelter. Coral reefs provide a place for squid to hide. Small fish eat algae. The same applies to an island environment, but with different components.

MOTIVATING THE LESSON

Students can connect to all populations interacting together including humans. Think about people and other populations existing on an island: dog, cats, pigs. All these populations are interacting with each other in everyday life and are therefore part of the same community.





Activity 4: School yard diversity

PURPOSE

Observe communities and make general statement about the relationship of plant diversity to animal diversity.

ORGANIZATION

Two groups of students

MATERIAL

Eight sticks, rope or string (1 metre rope), paper and pencils.

PROCEDURE

Divide students into two groups. Ask them to throw an object in a safe direction in or near the schoolyard, and mark an area of one metre by one metre near it. Do this again in a different-looking area. Ask the students to record all the animals, plants, seeds and other evidence of living things they find in both plots. They can draw a picture of each item they see in the plot along the left hand side of a large sheet of paper. Next to each of the drawings, they can record the number of each item observed.

Ask the students to create a display of all the data for the two plots. Students may discuss:

- Which plot has the greatest number of plants?
- Which plot has the greatest number of the same plants and animals?
- What are the factors that cause these two areas to be different?
- How can you create an area with a wide variety of animals and plants using this information?
- Does a wide variety of plant species present also mean that a wide variety of animal species will be present? What areas can you think of that can prove or disprove it?

EVALUATION IDEA

Students draw a web based on their findings and see if they can link the items through interaction with one another. The web can be based on different types of environments, trees, sea, reef, people's houses.

CHAPTER 3

Habitat

OBJECTIVES

Students recognize that a habitat is the place in an ecosystem where a population of organisms lives and grows.

Students observe similarities and differences in habitats and how the needs of different organisms can contrast.

Students understand the relationship between animals and their habitat.

VOCABULARY

Place, resource, live, survive, requirement, needs, habitat

BACKGROUND INFORMATION

Where do you look if you want to find a coconut crab, a fish, a turtle? Do you always look in the same place? NO!

Each of these populations lives in a different place. This place is called a habitat. A habitat provides food, shelter and other resources the organisms need to survive. Different organisms live in different habitats because they have different requirements for survival. The requirements are: water, light, temperature, food availability, company, etc. The size of the habitat depends on the organism's needs and habits. The habitat of a whale is the ocean, whereas the habitat for a mite might be the ear of a moth.

MOTIVATING THE LESSON

Ask the students to compare similarities and differences between Majuro and the outer islands. Talk about what happens to islands that become more industrialized and populated. Have the students think of ways to protect animals and habitats from destruction.

PURPOSE

Students will be able to portray and discuss inter-relationships between trees and the animals that inhabit them.

MATERIAL

Paper and pencils, magnifying glasses

ORGANIZATION

Small groups of students

PROCEDURE

After dividing the students into groups of 5-10 students, have them adopt a different tree.

Ask the students to look at evidence of animal inhabitants (insects, birds, small mammals), which live or visit their tree. Then ask them to draw all the livings things on the adopted tree. Post the pictures on a bulletin board. Ask the students to record the kinds of animals found and the number of each animal recorded.

Ask the students to find out the role of their tree in the animals' life. Students can also record some more information such as temperature, weather conditions, and the time of the day.

After a few days or months, the same activity can be repeated to compare the results obtained. The tree can be observed at different times of the day to see the differences in activities of the animals.

Then you can discuss:

- The changes in the animal population
- The reasons why animals are using this tree
- The effects of the animals on the habitat
- The preference for different kind of animals regarding the habitat: do they prefer dead or live trees?
- What is the difference between a dead and a live tree? What are the similarities?

EVALUATION / KEY QUESTIONS

- What about people? How do you meet your own needs in your habitat?
- How do the changes in habitats around you affect the populations of plants and animals?
- Find and compare the needs of two different species in the same habitat.
- Compare the needs of different organisms.
- How do humans affect the organisms' habitats?
- How can we protect the habitats of plants and animals?

UNIT 2
Water

CHAPTER 1
Water cycle

OBJECTIVES

- Students understand how water is recycled into the atmosphere.
- Students understand how heat causes water to evaporate.
- Students understand where water comes from.

VOCABULARY

Cycle, freshwater, salt water, evaporation, condensation, precipitation, heat energy, release, atmosphere, infiltration, transpiration

BACKGROUND INFORMATION

Water moves in a cycle. This cycle is the movement of water from the oceans and freshwater sources into the air, and back again into the land and surface waters such as lakes and oceans.

Three main steps make up the water cycle. The first step involves heat energy from the sun. Heat energy causes water on the surface of the earth to change to vapour (the gas phase of water). This process is called evaporation. Water can evaporate from the oceans and from freshwater sources. Water also evaporates from the soil. Animal and plants can also release some vapour from their skin into the air. This process is called transpiration.

The second step of the water cycle involves condensation. It is a process by which water vapour changes back into a liquid. For this to occur, the air containing the water vapour must be cooled. Warm air close to the Earth's surface rises and moves into the upper atmosphere, where it is cooler. Vapour in this air can then condense into water droplets, forming clouds.

The third step of the cycle is called precipitation. It occurs when the water droplets in clouds become too numerous and heavy to remain hanging in the air. The water then falls as rain, or in colder climates as snow, sleet or hail.

After water falls on the Earth's surface, some of it returns to the atmosphere again through evaporation. Some of enters the soil by infiltration. This water then becomes part of the groundwater that may later return to streams, lakes or the sea.

MOTIVATING THE LESSON: WATER AND LIFE

Humans, plants and animals need water to stay alive and grow. People also need water to grow plants and raise animals.

Water is also necessary to clean such as food, clothes and dishes.

The human body also needs water. Water makes up 75% of a person's total volume of the body. Body fluids such as respiration, saliva, and digestive juices and blood are also made up mostly of water. The human body could not function without water.

CONNECTION WITH THE RMI

Puddles form from rain, which then disappears a moment later. Where does the water go? You hang out clothes to dry. Where does the water go? It rains, where does the water come from?

Activity 5: Condensation

PURPOSE

Students understand the concept of condensation

ORGANIZATION

Whole class

MATERIAL

Jar of water, ice cubes

PROCEDURE

Take a jar with water and ice and observe what happens to the outside of the jar? What causes the water droplets to form on the outside of the jar?

Activity 6: Effect of heat on water

PURPOSE

For students: demonstrate what happens to water when it is heated; understand concepts of evaporation.

ORGANIZATION

The whole class

MATERIAL

Jar of water that will be heated, hotplates.

PROCEDURE

Measure the water level in a jar, boil the water for 10 minutes, let cool and measure the water level again.

Why is the level of water decreasing? Where does the water go?

CHAPTER 2

Weather

OBJECTIVES

- Students able to define precipitation and how it is part of the water cycle
- Students can explain the process of cloud formation and identify the four major types of clouds used to predict the weather

VOCABULARY

Precipitation, rain gauge, cloud types (stratus, nimbus, cumulus, cirrus)

BACKGROUND INFORMATION

Water enters the atmosphere in a process called evaporation. As the air containing the vapour rises, it cools, increasing the relative humidity and causing condensation. Clouds are a result of this condensation.

They are often used to predict the weather. Different kinds of clouds show what kind of weather way be moving towards you.

Some clouds look like piles of cotton, and are called cumulus. When they are present in the sky, the day will be fair and there will be little moisture in the air.

Dark grey clouds are called nimbus clouds. When they are present, rain is likely to fall.

Stratus clouds are in thin layers. They are usually low and flat. When present, then there is generally a lot of moisture in the air and rain may come soon.

Cirrus clouds are wispy clouds that form high in the sky. They may appear shortly before a change of weather.

Precipitation is water that falls to the Earth, droplets in the clouds must increase in size for this to happen. Clouds droplets increase in size by combining with other droplets. At some point, the droplets become too heavy to remain hanging in the cloud. They fall to the earth as rain.

When there are stratus or nimbus clouds, the rain is usually continuous-light to moderate and the raindrops are small. Clouds that are very tall, such as cumulus, have strong upward motion in them so that the raindrops must be very large and heavy before they can fall to the ground. Since the clouds are very tall, it might rain hard for a short while, but it is soon over.

There are several types of rainfall on the island: from light showers to heavy showers, light rain to heavy rain. In colder climates, rain drops can come down as hail, sleet or snow.

MOTIVATING THE LESSON/ CONNECTIONS WITH THE RMI

Students can refer in this part to traditional knowledge of various clouds used in predicting of weather patterns or navigational skills and methods.

Connect to other regions around the world and the different kinds of precipitation.

What is water used for in the RMI?

Activity 7: Cloud record

PURPOSE

Students identify clouds and keep track of them to predict weather

ORGANIZATION

Whole class

MATERIAL

Large poster paper designed like a calendar, pencils and paper

PROCEDURE

1. Make a calendar for one week. Each day, monitor the clouds and record which clouds they have seen.
2. Predict the weather for the next day. Then on the next day, record how accurate their prediction was.
3. At the end of the month, students will report their findings, such as which clouds appeared most often. Ask them how accurately the clouds predicted weather.

WEEK DAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	SUNDAY
DAY 1							
PREDICTION							
DAY 2							
OBSERVATION							

Activity 8: Rain gauge

PURPOSE

Students measure rainfall after building a rain gauge and measuring the water.

Organization: class divided into groups of students, depending on the material available.

MATERIAL

Rain gauge, jar (vertical), wooden box/ stand, ruler, strip of paper, a marker

PROCEDURE

Pour 1cm of water into the jar. (This is the base for the water level).

One centimetre is equivalent to 10 millimetres.

Mark the water level on the jar.

Mark off each centimetre from base to top of the jar.

Place the jar in a clear area, away from trees. Read rainfall in millimetres.

CHAPTER 3

Freshwater conservation

OBJECTIVES

- Students understand the extent to which living beings need water.
- Students recognize ways that water is polluted.
- Students recognize ways that water is wasted.
- Students care about water conservation and learn how to conserve water.
- Students know how to prevent water pollution.

VOCABULARY

Freshwater lens, conserve, waste minimization, recycling

BACKGROUND INFORMATION

In RMI, we do not have any permanent rivers or lakes as sources of freshwater in our small island country. However, we have a small amount of water called ground water (freshwater lens), but very little during the dry season. This situation is quite dangerous for our growing population living in a restricted area.

Therefore, people need to know how to manage their water resources so that everybody has access to water.

Our attitudes and practices have to change to ensure that we conserve water. This step is very important for the well being of our families.

Pollution of water resources in the RMI is mainly due to sewage from households and effluent from small industry. This pollution is affecting ground water resources as well as coastal water. There are two major ways to reduce water pollution: waste minimization and recycling.

MOTIVATING THE LESSON: DID YOU KNOW?

There is about the same amount of water on Earth now as there was millions of years ago. Nearly 97 percent of all the world's water is salty or otherwise undrinkable. Another 2 percent is locked in ice caps and glaciers. That leaves only 1 percent for all our needs! Water regulates the Earth's temperature. It also regulates the temperature of the human body and is necessary for metabolism.

Activity 9: How much water do you use?

PURPOSE

Estimate and calculate how much water students use during day, week and year.

ORGANISATION

Groups of students or whole class

MATERIAL

Containers (gallon, litre, cups), paper and pencils to collect data.

PROCEDURE

As a class, make a list of how water is used at school. Then form groups, each of which will be responsible for gathering data and calculating for one kind of water use.

Decide how the group will be calculating the amount of water. What type of container will they use? A gallon, a cup, or a bucket?

Draw a chart for data gathering: What types of activities require what amount of water per day, per week, per year

First estimate the amount of water needed for each activity as well as the frequency for the activity.

Then measure the amout of water required for that activity.

ACTIVITY	ESTIMATED		MEASURED	
	AMOUNT PER ACTIVITY	TIMES USED	AMOUNT PER ACTIVITY	TIMES USED

Activity 10: How can you conserve water?

PURPOSE

Identify and understand how we can save water in our everyday lives.

ORGANISATION

Groups of students or whole class

MATERIALS

Paper and pencils to collect data

PROCEDURE

As a class, make a list of how water is used at school and at home for the previous activity.

Then ask each of the groups to find out what water is wasted and how we could reduce the amount we use. Students can be asked to think about three key questions for this purpose:

- How can we reduce the amount of water we use everyday?
- How does the weather affect the amount of water used during the year in the RMI?
- What activities did you discover used the most water? The least?

As a conclusion: **You Can Help Conserve Our Water Resources**

At school and at home, you can help protect our water resources.

- Turn off the tap in your bathroom while you brush your teeth.
- Take shorter showers (use a timer to record how long you spend in the shower)
- Don't let the water run while you're washing or rinsing dishes.
- Fill a pitcher with tap water and put it in the fridge, rather than running the tap every time you want a cold drink
- Clean sidewalks and driveways with a broom-not water!
- Repair dripping faucets.
- Place a layer of mulch around trees and plants to retain water.
- Let us save our oceans!

You can also conserve and save water in another way. Look around you on each side of the island. What do you see? Seawater?

We need to care for the ocean for food. The ocean is home animals and plants that we eat. We would not eat fish if they were lying in dirt and gasoline as we might get sick from them. However a lot of people throw their garbage into the ocean, including baby nappies (diapers), plastic bags and metal parts. If we want to eat clean food from the ocean, then we need to keep the ocean clean. The same applies if we want to keep on swimming in a clean ocean - we have to keep it clean!

One way to keep the ocean clean is to talk with people and make them understand how important it is to conserve the ocean and keep the beach clean. Select a part of the island and organise a clean-up with your friends. Pick up all the trash, bags, papers, cans, etc. Put them all in big red trash bins on the side of the road: if people see what you are doing and if you tell them why you are doing it, they will remember to keep rubbish out of the water.

UNIT 3

Coral Atolls, Marine Resources

CHAPTER 1

What is coral?

OBJECTIVES

- Students understand biological features of coral.
- Students become interested in coral.

VOCABULARY

Polyp, zooxanthellae, symbiosis, limestone

BACKGROUND INFORMATION

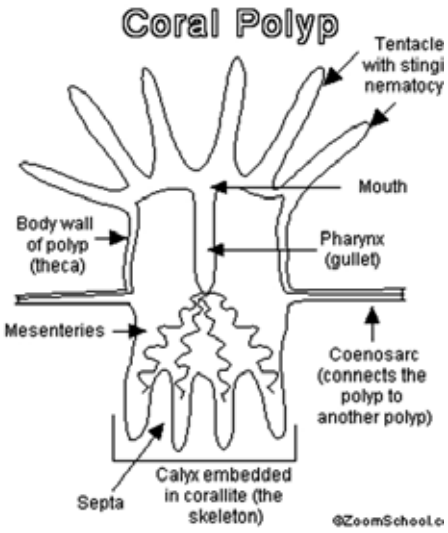
Corals are found in seas around the world. Large colonies are found in some warm, shallow waters, where colonies of millions of coral polyps form vast coral reefs. Reefs are slow-growing; they only grow about one inch per year. Average water temperatures typically do not fall below 20 degree Celsius (up to 30 degree Celsius) and it is generally no deeper than 100 metres. These conditions are met in tropical waters near the equator, on the eastern sides of continents and around oceanic islands such as the Marshalls.

Primitive coral reefs existed about half a billion years ago, long before there was any life on land. About 230 million years ago modern types of reef building corals appeared. Coral reefs are the oldest structures in existence created by living creatures, with some approaching 6,000 years in age.

The reef's massive structure is formed from coral polyps, tiny animals that live in colonies There are two types of corals, hard and soft. Hard corals have an internal, rock-like, chalky skeleton that remains when they die. Huge colonies of hard corals form coral reefs. Soft corals do not have a hard skeleton.

The polyp is a small invertebrate, very similar to an anemone. Its size ranges from 3—56 mm in diameter or height. The individual polyp has a tubular body with tentacles surrounding the mouth at the upper end

Corals are carnivores that eat zooplankton (like copepods and tiny marine larvae). Tentacles, have poisonous stingers that are used to sting prey and move it into the mouth



The polyp of hard corals makes a hard, protective limestone shell. This shell is called the exoskeleton. The polyp extracts the calcium from seawater to make it. These limestone cases form a 'house' for the coral polyp, consisting of a floor, outer walls and a number of internal partitions. Each polyp makes its own type of lime, this results in many different types corals.

Coral reproduction can be both sexual and asexual.

Many coral species mass spawn. Within a 24 hour period, all the corals from one species and often within a genus release their eggs and sperm at the same time. They float to the surface where they separate and fertilization takes place. The egg develops into larvae called planula which attaches itself to a suitable substrate and grows into a new colony.

Two types of asexual reproduction take place, the budding, in which an identical polyp sprouts out of the polyp's side, and the fragmentation in which broken pieces of corals that land on a suitable substrate may begin growing and produce a new colony

Each polyp has special algae called zooxanthellae. These one-celled plants use sunlight and carbon dioxide to conduct photosynthesis, a process that produces oxygen and other nutrients needed by polyps. In return, the algae get protection and constant supply of carbon dioxide and other raw materials they need for photosynthesis. Such a mutually beneficial relationship is called symbiosis.

Most corals feed at night because that is when the zooplankton travel into the water column and become available for capture. Keeping the tentacles retracted during the day also help corals avoid predation, protect themselves from the sun, and avoid shading their zooxanthellae which provide them with 90% of their food!

Corals have some natural predators but the most significant is a *Acanthaster planci*, also known as the Crown-of-Thorn. It is a large starfish that feeds on corals by extruding its stomach out onto the coral to digest the living tissue layer. These predators have had serious effects on the coral populations in many regions of the Pacific.

Crown-of-Thorn starfish (picture by M.Juncker)

A FINE BALANCE

While corals are the chief architects of reef structure, they are not the only builders. Algae such as Halimeda are stony algae, made up of limestone. They are very common on the reef, and add a huge amount of calcareous sediment, or small particles, to the reef, especially the sparkling white sand on reefs and coral islands. Other algae such as coralline encrusting algae serve to cement together some of the rubble from reef decay, and form a solid base. Parrot fish and other grazers are also important in the cycle of growth and decay, they break off pieces of coral to feed on the polyps and algae growing around their base. The coral is either broken off in chunks, or chewed down to sand. This physical breakdown of the reef is a process of erosion and growth. The calcareous framework of the reef is broken down into finer sediment and consolidated (concreted) by coralline algae. This new substrate provides a solid base for new growth of corals and other plants and animals on the reef.

Erosion is just as an important process for the reef, as growth, to provide a solid platform for expansion of the reef. Firstly bioeroders such as some grazing fish, boring sponges and bivalves, and algae contribute to the physical break down of the reef by biting bits of coral off or boring into the coral colonies, weakening them and eventually causing them to collapse or dissolve. Large storms and cyclones occasionally cause great damage to patches of the reef, turning large areas of reef into piles of coral rubble. These areas are soon colonised by algae, but gradually corals start to grow there again and the cycle of reef growth is renewed. This recovery can take many years, usually anywhere from 10 to 25 years, depending on what state the reef has to recover to. These processes are natural ones, and have been occurring on reefs during most of their evolution. There has been a certain balance between the processes of growth and erosion over the millennia, and coral reefs have so far managed to thrive in the face of these disturbances.

CONNECTING TO THE RMI, MOTIVATING THE LESSON

Coral lives in warm, shallow and clear water; therefore the Marshall Islands are geographically well suited for them to live.

Activity 11: Beach walk

MATERIAL

Paper and pencils

OBJECTIVES

For students to discover what the reef is made of.

For students to discuss the different between their results and understand the difference between several environments.

ORGANIZATION AND PROCEDURE

Check the tide table and weather before going out. Take students to the beach at low tide.

Students should wear shoes or sandals to avoid injuries.

Students can be organized in small groups of five people. They can spread over the beach to check out the reef.

students to draw what they find on the reef.

This can lead to a group discussion to compare the results obtained.

Activity 12: Observation of coral exoskeleton (in the classroom)

OBJECTIVE

For students to learn how to use a magnifying glass and be able to describe precisely what they see

MATERIALS

Magnifying glass, try to get four of them, to see small holes where polyps used to be.

ORGANIZATION

Students are divided into groups of five.

PROCEDURE

Regroup after the groups have had a look at the structure of several types of corals with a magnifying glass. They will be encouraged to draw what they can observe.

There is no need to give students too much information about coral structure. The overall goal is for them to use a magnifying glass and observe that the coral has a very complex structure, which makes it alive and more important.

Remember that the aim of this guide is for students to reach a global understanding of the environment that surrounds them.

CHAPTER 2

Atoll formation

OBJECTIVES

For students to understand how atolls form.

For students to understand how their islands are changing.

For students to understand the natural earth moving phenomenon.

For students to understand their lifestyle and atoll related problems.

VOCABULARY

Erosion, mangroves, theory, erupt, drown, colonize

BACKGROUND INFORMATION

Fringing reefs grow in a narrow band or fringe along the shore. They develop near shore throughout the tropics, wherever there is some kind of hard surface for the settlement of the coral larvae. Depending on the place, the shore may be steep and rocky or have mangroves or a beach. They are the most common type of reef.

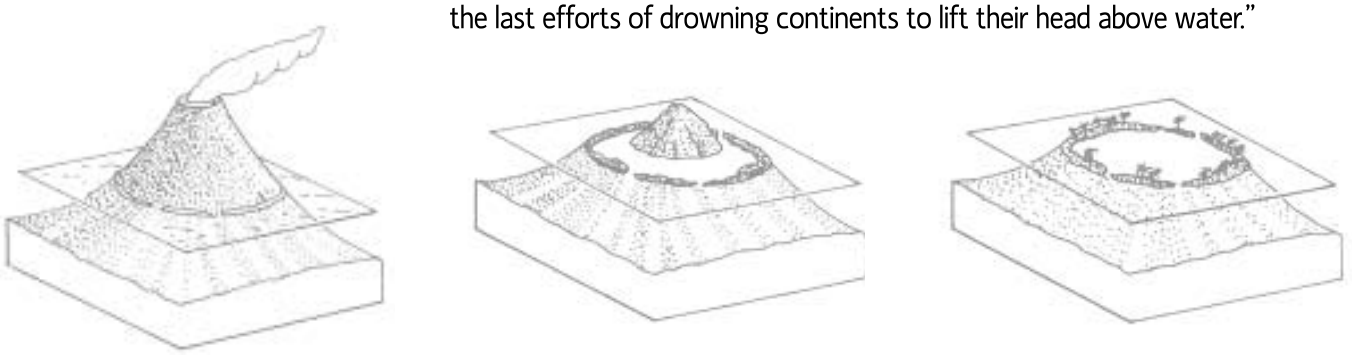
Barrier reefs: Like fringing reefs, barrier reefs lie along the coast, but barrier reefs occur considerably farther from shore, occasionally as far as 100km or more. Barrier reefs are separated from the shore by a channel or a lagoon. The largest and most famous barrier reef is the Great Barrier Reef. It runs more than 2,000km along the northeastern coast of Australia, varying in width between about 15 and 350 km and covering an area of over 22,5000km^2.

Atoll: An atoll is a ring of reef, and often islands or sand cays that surround a central lagoon. Unlike fringing and barrier reefs, atolls can be found far from land, rising up from depths of thousands of meters or more. Bathed in pure blue ocean water, atolls display spectacular coral growth and breathtaking water clarity. Atolls range in size from small rings less than a mile across to systems well over 30km in diameter.

DARWIN'S THEORY

Atoll formation process: In the middle of nineteenth century Charles Darwin solved a puzzle of atoll formation. Darwin is the most famous scientist for proposing the theory of evolution by natural selection, but his theory of atoll formation is also an important contribution to science. In the 1950s the United States Geological Survey drilled several deep holes on Enewetak atoll in the Marshall Islands. These cores revealed what Darwin predicted: the atoll formation process involves the gradual sinking of an oceanic volcano over

thousands of years. The fringing reef around the original island actively grows as the island slowly sinks. Eventually a lagoon forms between the sinking island and the growing fringing reef becomes a barrier reef. This eventually leaves a circular reef surrounding a central lagoon, the atoll. "Coral islands are the last efforts of drowning continents to lift their head above water."



MOTIVATING THE LESSON

The Marshallese people are living in unique shaped islands called atolls. Therefore we should know what our living environment is. Atolls have been created by natural phenomenon for long time. Our life-styles rely on this land shape.

Activity 13: Group discussion

Pros and cons of living on an atoll.

OBJECTIVES

Allow students to discuss their own environment

MATERIAL

Paper and pencils

ORGANIZATION

Form groups of students (five or six students per group)

PROCEDURE

Ask all the group to discuss the pros and cons of living on an atoll for 5—10 minutes.

ADVANTAGES

Easy to get food from sea: all people live in the coastal zone in the Marshall Islands. Accessibility to sea is very good.

Cheap transportations: people use taxis. The cost of gasoline is getting higher and higher but still we can manage it, because the length of the trips are very short.

Beautiful and scenic: we have a beautiful ocean and nature around us. Healthy and beautiful coral attract not only fish but also divers.

Close human relationship: we are living in a small land area. Therefore the members of the community are living close to each other, which makes it easier for us to help each other if needed.

DISADVANTAGES

Far from other countries: The Marshalls are geographically far from other countries. We need to import most of our goods from other countries.

Water shortage: We do not have a very limited natural fresh water supply (freshwater lenses and rain water. We do not have freshwater rivers, streams or lakes. We don't have much space to store rainwater. During the dry season, we sometimes have a shortage of water — especially during an El Nino event.

No industry: We have very little industry to participate in trade with other countries.

High price level: Because of high dependence of importation, the prices are very high.

Hard to cultivate plants: the soil is mostly coral with very low nutrients.

Activity 14: RMI environmental issues and explanations

MATERIAL, ORGANIZATION AND PROCEDURE:

Place students in groups of four. Each group will be given one issue to consider, analyze and afterwards explain to the whole class.

Examples of environmental problems in the Marshall Islands:

- Trash
- Shortage of water supply
- Water pollution
- Erosion
- Sanitation
- Destruction of nature

CHAPTER 3

Importance of coral

OBJECTIVES

- For students to understand the relationship between humans, nature and coral.
- For students to understand the importance of coral.

VOCABULARY

Aggregate

BACKGROUND INFORMATION

The coral provides shelter for many animals in this complex habitat, including sponges, nudibranchs, fish (like Blacktip Reef Sharks, groupers, clown fish, eels, parrotfish, snapper, and scorpion fish), jellyfish, anemones, sea stars (including the destructive Crown of Thorns), crustaceans (like crabs, shrimp, and lobsters), turtles, sea snakes, snails, and mollusks (like octopuses, nautilus, and clams). Birds also feast on coral reef animals.

Coral reefs are often compared to underwater cities, where the reefs are the buildings, each polyp limestone shell, a flat. All the different people and animals would represent the wide variety of marine organisms linked to the reefs and we could even see green spaces and trees as the algae.

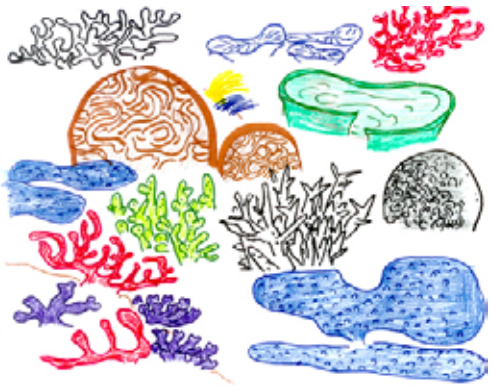
Coral reefs are the most species-diverse areas of all marine habitats, approaching tropical rainforests in their species richness. Up to one quarter of all marine species and one fifth (4,500) of known marine fish species live in the coral reef ecosystem. In one area of the Great Barrier Reef, about 2,000 different species have been recorded. Covering less than one percent of the ocean floor, they support an estimated twenty-five percent of all marine life.

The main services returned by corals reefs are:

- Fish breeding grounds: Reefs are fish nurseries, providing essential shelter for juvenile fish, including many important commercial species.
- Natural wave breakers: Reefs protect vulnerable beaches and shorelines from wave action, storms and floods.
- Sources of food and income: Coral reefs are a significant source of food for hundreds of millions of people. Reefs also provide income and employment through tourism, marine recreation and fishing. Between 20-25% of the fish catch in developing countries is taken from the coral reef ecosystem.

Over 15 million people are trained as recreational scuba divers, making it probably the world's most popular adventure sport. Millions more have learned to snorkel. Quite apart from the pleasure and educational value of visiting coral reefs, these visitors are bringing jobs and money to coral reef areas around the world.

- Medical breakthroughs: Corals not only provide life, they can save lives too. Already scientists have found chemicals used for HIV and cancer treatments in coral reef organisms-and there are many untapped compounds that could prove valuable to medical research.
- Cultural value: Coral reefs are directly linked with the traditional, spiritual and cultural values of many people who live in reef areas. Marshellese use shells to make their handicraft.



Activity 15: The role of coral – brainstorming

OBJECTIVE

For students to understand the role of coral and reefs

MATERIAL

Pen and paper

ORGANIZATION

Divide students into groups and discuss the roles of coral reefs. How do they affect our lives and nature?

PROCEDURE

Get students to discuss what will happen if all coral reefs disappear. This discussion will lead to the next chapter.

Activity 16: Card game

OBJECTIVE

For students to create models of marine ecosystems

MATERIAL

- Dead body of branch and block like corals
- Sand
- Handicraft
- Marine creature cards — Annex 2 (coral fish, turtle, shark, human, crab, snail shell, coral, plankton, seaweed etc)

ORGANIZATION

Students are in groups of five.

PROCEDURE

Each group will use the marine creature cards. The main point is to get students to make simple models of marine ecosystems. They will link all the cards together depending on the type of interaction they have with each other.

Activity 17: Field trip

ORGANIZATION/PROCEDURE

Take students to the shoreline on the ocean side. Show them the point where the waves are breaking. This place is where coral reefs acts as a natural sea wall.

Then take students to a sand dredging site. Explain the role of coral to students.

Show some dead corals and sand to explain process of sand and land formation.

CHAPTER 4

Corals are in danger

OBJECTIVES

- For students to realize that some human activities can affect coral reefs
- For students to gain awareness of those issues

VOCABULARY

Pollution, oil slicks, fertilizers, sedimentation, sewage, pesticides, tourism

BACKGROUND INFORMATION

Coral reefs have been coping with the rigours of nature throughout their entire evolution, and have managed to thrive so far. The real threat to coral reef ecosystems today is people.

HUMAN DEVELOPMENT

WATER POLLUTION

Pollution takes on many forms including oil slicks, sedimentation, fertilizers, pesticides, heavy metals, garbage and other chemicals. Oils come primarily from urban run-off (eg. oils from cars and petrol stations), with a smaller percentage of oil spills from shipping and discharge from industry. Oil can kill marine life that gets coated in it, and in the past the damage increases when people tried to clean up oil spills with chemicals or high-pressure sprays and hot water. Chemicals such as some pesticides and herbicides are particularly dangerous because they are highly toxic to marine plants and animals and can persist in the environment for decades or more before being broken down. Litter often ends up on the most remote beaches and reefs, and apart from being ugly, can kill and injure marine animals when they eat it or get it caught around their necks and bodies.

EUTROPHICATION

Eutrophication is a process that occurs when the natural amount of nutrients in the water is increased. Elevated nutrients in the water come from increased land run-off. In urban areas this comes from sewage, stormwater and things like people washing their cars and clothes with high nitrate content detergents. Land that is paved or concreted in urban areas prevents water being absorbed into the land. Excess water falling on paved surfaces is channelled out to sea as run-off, taking all the nasties in its path with it. A significant source of excess nutrients in coastal waters can be traced to the increased use of fertilisers in agriculture.

When fertilisers are used, the growth rate of plants increases. Fertilisers have the same effect in the sea, where high levels of nutrients can cause harmful overgrowth of algae, essentially choking reefs to death. Heavy growth of algae outcompetes other reef plants and animals, and prevents recolonisation of the substrate by the larvae of corals and other invertebrates by monopolising the available substrate.

There is technology available to clean up our sewage, but in lots of places (including the Marshall Islands) we do not use it.

SILTATION

Siltation is a process that describes the addition of an amount of silt or extremely fine particles to water. The sediments settling out on reefs mainly come from land run-off. This can result from the mass clearing of land for grazing or crop fields. Coral reefs are especially vulnerable to suffocation from siltation. Tiny coral polyps and other creatures are covered in the fine silt and literally cannot feed or breathe. The presence of silt also decreases the amount of light that penetrates the water, decreasing photosynthesis in plants and corals.

CONSTRUCTION

The construction of wharves, breakwaters and causeways as well as landfills are likely to interfere with water currents, the formation of beaches and the natural movements of fish. The construction of a causeway between islets in Kiribati, for example, has blocked the spawning migration of some fish species.

Construction work may involve blasting channels in reefs and removing sand from beaches. The negative effects of these actions often include reducing the coastline's ability to withstand storms and reducing the environment's capacity to support marine species. Many coastal construction affects fringing reefs because they are located right next to the shore. It is commonly thought that barrier reefs are more important because the corals look better but actually fringing reef is critical for fish life cycle as it serves as nurseries for young fish.

FISHING

Destructive fishing

Fishing with a simple hook and line is usually not harmful to coral reefs, but blasting with dynamite, setting traps and using poisons such as cyanide or bleach can cause irreparable damage. Besides the obvious physical destruction of the coral, underwater explosions stir up sediment that prevents sunlight from penetrating to the polyps.

Destructive fishing is not only blasting reefs of using poison, it is also using tools or techniques that are putting the fish resource at risk for the future generations. For example, using a net with very small mesh size is a destructive fishing practice, by catching the juveniles, we prevent them from reproducing and this will mean fewer fish in the future.

Recreational fishermen also cause damage by running aground on coral, or breaking corals with anchors.

Overfishing

As the population increases, so does the harvest of resources from the sea. Due to overfishing, reef fish populations have been greatly decreased in some areas of the world. The removal of large numbers of reef fish has caused the coral reef ecosystems to become unbalanced and allowed more competitive organisms, such as algae, which were once controlled by large fish populations, to become dominant on reefs in many regions. If we take the example of the parrot fish, it is a hervivore that eats algae. By doing this, parrot fish, along with other herbivore species, maintain a good balance between coral and algae population. If people catch too many parrot fish there will not be enough of them to graze the algae that will overgrow and smother the corals.

Dynamite fishing

TOURISM

Often, when people vacation in tropical locations surrounded by beautiful reefs they want to take coral souvenirs home. In order to do this, they either collect pieces of coral themselves or buy pieces from a "curios" shop. These shops receive their corals from commercial collectors who select well-developed colonies, which will make them the most money. This is very damaging because a large amount of the healthiest corals are selected.

GLOBAL WARMING

For unknown reasons, when the water is warming up above 30°C, the polyps expel their zooxanthellae. As previously mentioned in chapter 1, zooxanthellae give their colour to the corals, by expelling them, corals turn to a bright white color, that's the reason why the phenomenon is called bleaching.

A bleached coral is a sick coral, not dead. The polyp can take new zooxanthellae and will get its colour back. If it does not, it will die as it cannot get enough food supply by itself.

Bleaching has affected many reefs over the world and is occurring more frequently leaving less and less time for new corals to grow.

OCEAN ACIDIFICATION

The gases such as carbon dioxide that contribute to global warming are also dissolving in the ocean. This makes the sea water more and more acid. As highlighted in chapter 1, corals are made of limestone and limestone is dissolved under the action of acid. This means that if the ocean is still getting more acid in the future, coral reefs will not be able to cope and will disappear. It is a very slow phenomenon but when it begins, it is hard to reverse it.

MOTIVATING

Various human activities cause damage to coral reefs. Students learned importance of coral in this unit. Students will realize that our daily activities hurt corals. Students should have awareness of the issues in addition to knowledge.

Using the comparison with the cities, ask the kids to think what would happen if we remove people from the city, if no one is there to cut the grass and clean the buildings. The vegetation is going to invade the buildings like the algae are growing over the corals if too many fihes are taken and they won't be able to graze enough algae anymore.

To illustrate ocean acidification, take a piece of dead coral and put it in vinegar or lime juice, the kids will observe the dissolution.

Ask the students to think about the threats they can think about in their village, do they know about fishing practices, are they destructive? Have they ever seen bleached corals? Do they know where their home sewage is going, maybe they can ask their parents. Do they see many algae on the reef?

Activity 18: Legends of the Marshall Islands

MATERIAL

Demonstration kit

OBJECTIVE

For students to imagine the process of water pollution.

MATERIAL

Demonstration kit: glass tank, a cup of oil, fish line, trash, sand, soap etc.

Pictures: waste water draining, garbage dumping site, power station, construction site, coral bleaching etc.

ORGANIZATION/ PROCEDURE

Create a story like "Marshall Islands are very beautiful and a great country. People can catch food, collect materials to make handicrafts from the ocean, and we lived happily. But one day, a fisherman left a fishing line after fishing...".

Choose five students. Give them roles of Fisherman, Construction worker, Local resident, Sailor, etc, respectively.

Fill a suitable amount of water into glass tank. This tank will be a model of the ocean.

Read the story, which you made. And call a student who has the Fisherman role.

Get that student to drop a fishing line into the glass tank.

Continue to highlight different things that will be left behind. Arrange the last sentence of the story. Read your story every time.

Conclusion of this demonstration: water in the tank will be very dirty after this demonstration. Explain that this tank is our ocean and we are doing this. The ocean is bigger than this tank, but the same things are happening in the water.

UNIT 4

Waste Management

INTRODUCTION

The aim of this unit is to provide students with the minimum information on the main types of trash that are disposed of in the environment. They will be able to identify their rubbish and understand the way they can deal with it so that they can stop poisoning their environment.

The RMI is made of small, low-lying atolls, one of the most fragile environments on Earth. Traditionally waste used to be thrown away on the ground or in the lagoon, because it easily rotted or was eaten by animals. Nowadays, imported goods that don't break down quickly have increased in volume: piles of rubbish cause environmental and visual pollution because they simply cannot rot or be eaten by animals.

As part of the community, we have to be responsible for our environment, as we must stop poisoning our land and water. Plastic, glass and cans collect water and breed mosquitoes that carry dengue fever and malaria. It is most important for the health and well-being of our people. If we stop creating so much rubbish, pollution will reduce and benefit our communities.

Students are among the first to face this new approach to waste management: they can act as a link with the communities, and will transfer the information to allow the message to be widely spread.

This scientific background and most of this unit content is from "Rubbish no more, A waste Handbook for the Pacific Islands" Coconut free press, 2nd edition, Alice Leney. See also SPREP's recent publication "Rubbish is a Resource!" on DVD with printed handbook.

CHAPTER 1

What is rubbish?

This chapter is based on an activity consisting of several key questions to be discussed. This activity needs to be repeated every time we deal with rubbish, and for this reason it constitutes a major one for the waste management unit.

OBJECTIVES

Students understand what questions to ask when talking about rubbish.

This means students ask key questions to better identify the different types of rubbish and can determine the best way to deal with any type of rubbish created by communities.

Students decrease the amount of pollution they create themselves or within the communities.

VOCABULARY

Pulped, rubbish, re-use, recycle, poison.

BACKGROUND INFORMATION / INTRODUCTION

What is rubbish? Usually we mean something that has served its useful purpose and is no longer needed or is now spoilt.

As we all make rubbish, we have to know what the different types of rubbish are.

To learn this, we can ask ourselves several questions each time we throw things away:

What sort of rubbish is it?

Look at it closely (be careful not to get yourself dirty or get cut by sharp objects)

What is it made from?

For example: paper, leaves, plastic, glass..., or a combination of things?

Because it is now rubbish, and we are concerned about the pollution it might create, we must ask ourselves:

What will happen to it when I throw it away?

Can I use it for something else? Meaning — can I reuse it?

Can it be recycled, i.e. used as raw material for new products?

The best way for students to understand this chapter is to give examples:

PAPER RUBBISH

Say students have a packet of biscuits, in a cardboard box or a newspaper wrapping.

What sort of rubbish is this?

This can include cardboard boxes big and small, loose pieces of cardboard, egg boxes, newspapers, magazines, paper bags, and all types of writing papers. Paper products are soft and flexible, easy to squash when they are wet.

What is it made from?

Nearly all of it is made from trees of some sort. Wood is mashed-or pulped to produce paper.

Cardboard is really just low quality, thick paper. Huge forests are being cut down to make paper, although some of it may be recycled, which means using old materials to create new.

What will happen when I throw it away?

Paper and cardboard will rot quite quickly if left outside in the rain. But when buried deep in a rubbish heap, it may take years break down. Throwing it away is a waste of all the trees.

Can it be reused?

Clean paper is useful for wrapping things. Odd scraps are useful for lighting a fire, especially in wet weather. Paper can also be used in the compost heap if torn into pieces.

Can it be recycled?

In some countries, paper is easy to recycle, and it is used to make new paper. In our islands, it is usually best to compost old paper and cardboard in a "banana circle" or compost heap.

It is important to keep, look and buy things made from recycled paper as this encourages the paper recycling industry, and is a means to cut down less trees.

Activity 19: Identifying our rubbish – group discussion

OBJECTIVES

This activity is based on the analysis of the several types of rubbish.

Several questions are important to ask when buying something so that later on we can deal with it and decrease the rubbish it can create.

MATERIAL

Aluminium cans, plastic bags, plastic items and glass bottles, tin cans, paper, cardboard, batteries (car battery if possible); paper and pencils

ORGANIZATION/ PROCEDURE

Students work in groups. You need to set up three teams of students.

Write all the types of rubbish on pieces of paper. Each group will be given one type of rubbish (written on a piece of paper). They will then start going through all the questions to fully understand the group and how to deal with the rubbish.

The activity will be repeated twice, so that students feel comfortable using this process and will be able to use it in several situations. The game is quick, no more than 15 minutes for each team to work out the rubbish.

Questions they have to ask their team:

- What sort of rubbish is it?
- What is it made from?
- What happens to it when I throw it away?
- Can it be reused?
- Can it be recycled?

Make sure every team picks a paper of a different type of rubbish. For this to be sure, just write down one element of each group of rubbish.

There are seven groups of rubbish:

Glass, batteries, scrap metal, oil and fuel, tin cans, aluminium and paper.

See Annex 1 for more information about the different types of rubbish.

CHAPTER 2

Reducing rubbish for the future

OBJECTIVES

- Students understand what packaging means, its aim and how it can affect our life and environment.
- Students understand the need to reduce rubbish in their daily life.

VOCABULARY

Packaging, effect

BACKGROUND INFORMATION

The fact is that before we throw away things in the environment, it comes into our hands. Now that we understand what the different types of rubbish are, and knowing what will shortly become rubbish (packaging for example), we can try to avoid having too much of it.

Some packets can keep food edible for a long time, but by far the best food is fresh food. What we gain in storage life, we may lose in nutritional value. Most of the things we buy today are packaged in ways to catch our attention: bright colours, clear plastic bubbles to show what we are buying, pictures of delicious food etc.

But we pay for the packaging! Therefore if we reduce the amount of packaging we get, we also save money. Also, recycling can be a business and support jobs. Check with the recycling operations to see which materials they need and some, like aluminium cans, they may even pay you for.

There are several questions we can ask ourselves when shopping if we do buy bags, wrappers, or boxes that goods come in.

To reduce rubbish, we can again ask ourselves several questions:

- Can we buy it without a packet?
- Can we buy this with less packaging somewhere else? And where?
- If we do buy a package, what material is the package made of? Can we reuse it?
- Can the packaging be recycled? (You may need to check with the recycling organisations nearest you)

We can greatly reduce the amount of rubbish we create by asking these questions before we buy anything.

MOTIVATING THE LESSON

The RMI is a country made of small islands with a fragile environment. Every piece of rubbish thrown away will somehow have an effect on this environment and we, as part of the community will be affected in return. If the water and the soil are polluted, then we may not have any more drinkable water, or we may not be able to grow anything in the soil, or possibly not catch any fish. We ourselves are the ones suffering from the pollution, therefore we have to deal with it and be more responsible for the rubbish we create.

Recycling some materials may result in cash - you can earn money while improving the environment!

Activity 20: Reduce your rubbish – brainstorming

OBJECTIVES

Students ask themselves the key questions mentioned earlier during the class.

Students start understanding the content of the chapter and applying it to a few real situations and what is expected of them.

MATERIAL

Items wrapped in packaging. It's best to choose things students usually buy without considering the packaging. You could organize the activity after a class break when students buy food and drinks. Being applied to a realistic situation, the activity will therefore be more interesting.

ORGANIZATION

Groups of students (average of five students).

Students are sitting around table with goods in middle.

PROCEDURE:

Each group will pick one of the items.

Groups have a few minutes to answer several key questions. Once they are finished, one person per group will present the group answers.

This activity will lead to a class discussion about recycling and rubbish reduction.

There is no absolutely right or totally wrong answer, every idea has to be discussed.

CHAPTER 3

Composting? Why? How?

OBJECTIVES

- Students understand organic waste and how to deal with it.
- Students understand what compost is, and how to make it.
- Students spread the information within their families and in their communities to build compost heaps and therefore reduce organic waste.

VOCABULARY

Fertilizer, compost, carbon, nitrogen, humus, manure

BACKGROUND INFORMATION

Most of our rubbish is organic. It means that it comes from organisms meaning plants and animals (meat, vegetables: what we are eating plus our garden waste).

When we throw organic waste away, it rots away into natural components. By using this process, when we put all our food and plants in one place, we can create compost for our garden as a natural fertilizer (giving nutrients to the soil to grow better). Compost also keeps the water in the soil longer and can make plants healthier to resist disease and insects.

The compost heap is the place where we make this compost.

For the compost to break down efficiently, there need to be bugs within the heap. Those bugs will feed on the organic wastes and help to make the heap work quickly.

They need some ingredients and a good balance of energy food containing carbon and nitrogen. The carbon comes from paper, weeds, dead leaves, plant stalks. The nitrogen comes from grass and green leaves, and also food containing nitrogen such as fish and meat, and manure and other animal products. The smell of food scraps can encourage dogs and pigs to dig up your heap; so sometimes it can be better to feed scraps to the pigs and then use their wastes instead. The different ingredients for the compost are put into several layers.

There are four important rules for the compost to be in the best conditions:

- A compost heap needs lots of air, for the bugs to breathe and work harder to make compost. If you build it in a hole in the ground, top it off with branches to increase the flow of air and allow moisture to drain away. If you build it on the ground, any bugs and insects living in the soil will easily get into your heap which is what you want.
- Compost needs to be kept damp. The heap will work best when moist, but not too wet. It may be necessary to add a bucket of water (can be dirty dishwater) over the heap every now and then, and keep it covered from the sun. During the rainy season, just check that you did not build the heap on a place where the water accumulates.
- A compost heap needs to be warm. It is not a problem here in the Marshalls. Bugs need an average blood temperature to be efficient. To keep the temperature high, it is good to cover the heap with a thick layer of grass or a sheet of plastic.
- A compost heap needs to stand a while. Depending on the weather and how well the compost is working, compost can require six months or so before being ready. You can speed the process up by mixing the pile up every two weeks. This spreads the bugs around and gets air into the system. Rather than putting new waste onto an existing heap all the time, make a new heap so that the first heap can break down fully before you use its compost.

A very clever way of making a compost heap is the "banana circle". This involves planting five or six banana plants 1.5 metres apart in a circle. Put all your garden waste and the waste water from your kitchen or washing in the middle. As the compost heap breaks down, the nutrients are absorbed by the banana plants and you get bigger and better bananas as a reward without doing any work. Better still, you get fresh fruit that tastes good and makes you stronger.

Activity 21: Building a banana circle

OBJECTIVES

Students learn how to build a banana circle

Students start recycling their organic waste, and the whole community learns the benefits they can get from composting.

MATERIAL

Organic waste, leaves (green and dead), manure, grass, branches, palms, paper and cardboard, six banana plants

PROCEDURE

Groups of students of three or four.

Find a place that is good for growing bananas. It will need to be about 3 metres by 3 metres, and not too sloped. You will need a spade to plant the bananas and a bucket to give them some water to get established.

Each group will be responsible for bringing one layer of the compost heap from the school grounds. They have 20 minutes or so to bring it. Then each one of the groups will put its layer on top of the other layer.

The idea is that the entire school is involved in the continuation of the compost heap, therefore ensuring that organic waste at school is recycled into fertilizer.

After six months or so, the banana plants will be growing and beginning to fruit. Depending on how much garden waste the school creates, you may need another banana circle.

Activity 22: Compost heap – group discussion

Where can we build a compost heap according to where we are living?

OBJECTIVES

For students to understand how they can apply the content of the class' curriculum into their daily life and environment.

ORGANIZATION/ PROCEDURE

Discuss with the entire class the several types of locations where the students are living, and find out how each one can build the compost heap where he/ she lives. This discussion will include communities in town and communities in the "countryside".

Try to get as many different answers as possible so that each of the students can feel included and involved in the discussion.

Depending on the students' home location, you can set up several groups: Rairok, Ajeltake, and so on.

CHAPTER 4

Where does our rubbish go?

OBJECTIVES

Students gain an awareness of waste management in the RMI.

Student learn about recycling as a form of waste management.

Students are involved in this waste management.

VOCABULARY

Landfill, leachate, organic

BACKGROUND INFORMATION

In towns and cities of other countries, rubbish dumps are run by local governments. Modern rubbish dumps or landfills are complicated pieces of engineering. In the RMI, there are many local dumps where rubbish is thrown on top of each other. Year after year, as we make more rubbish, many different things rot together and can react to create damaging chemicals that can be gas or liquid washed out from the bottom of the landfill. This is called leachate which can pollute our wells but also sea water located nearby. This means that we may no longer use the water from the well and all the marine life located close by may die from the pollution.

Also, RMI doesn't have much land. Rubbish is taking up space that we need for people or food or animals.

There are two ways to avoid pollution into fresh and marine waters:

- Decrease the amount of rubbish we create in the first place.
- Decrease the amount of toxic rubbish we create through more care.

Dumping rubbish starts at home. Because it is our rubbish and we made it, we have the responsibility to make sure it causes as little pollution as possible.

The first thing to do when we have rubbish is to check that it contains no food.

Rubbish would not be smelly and full of flies if we were removing food or organic wastes from it in the first place.

Rubbish can be separated at home in three different ways:

1. Put organic and food scraps in a bucket for the compost heap, or to feed pigs.
2. Use plastic bags for the things that can be reused or recycled (again they have to be cleaned). This includes cans, plastic bottles etc.
3. Use another bag for the remaining rubbish. If possible, squash it so that we can fit more into the same space.

If you do all this, you should reduce your volume of rubbish by half!

Activity 23: Set up rubbish collection points

OBJECTIVES

Students start separation of the several types of rubbish at school. Then it can be done at home or by a group of houses that agree to use rubbish collection points.

Students reduce the rubbish created by their school, learn how to create a rubbish collection point, and start a community project.

MATERIAL

Buckets for the food and organic rubbish. Students have to decide on the number and size, quantity and the best place for the buckets to be used appropriately, before emptying them into the banana circle.

Use metal wire to build the recycled and non recycled rubbish holding pens. These points will consist of two 1.5m high, 1m long and 1m wide boxes for people to throw rubbish inside.

For the sign: plywood or laminated paper, paint, paint brushes. Students can decide on the content as well as the background of the signs.

One class can be allocated for the design, and later on, another class can cover the construction.

Glossary

Aggregate: (as in Construction) materials used in construction.

Algae: are groups of aquatic organisms that capture light energy through photosynthesis, using it to convert inorganic substances into organic matter.

Atmosphere: gaseous mass surrounding Earth.

Carbon: non-metallic chemical element.

Colonize: establishment of a group of living organisms in an area.

Compost: mixed manure particularly of organic origin.

Condensation: process by which water vapour changes into water; usually the result of cooling water vapour (e.g clouds)

Cycle: repeating sequence of events.

Diversity: different kind, variety.

Environment: surroundings and external conditions affecting the growth and development of a living organism.

Erosion: wearing away by the action of water and wind.

Erupt: break out suddenly or dramatically.

Evaporation: process by which liquid water changes to water vapour (gas) usually the result of adding heat to liquid water.

Fertilizer: chemical or natural substance added to soil to make it more fertile.

Freshwater: water found usually in lakes, rivers, ground water, and rain. Does not contain salt and is drinkable.

Humus: organic constituent of soil.

Infiltration: act of gaining entrance or access.

Interaction: reciprocal action or influence among living things.

Landfill: place where rubbish is disposed.

Leachate: liquid created when garbage is compacted and sits in landfills for many years.

Manure: animal dung used for fertilizing land.

Pulped: paper shredded into small pieces (usually for making paper).

Mangroves: specialised coastal tree that lives halfway between coast and sea.

Metabolism: is the complete set of chemical reactions that occur in living cells.

Migration: act of moving from one place to another.

Nitrogen: gaseous chemical element.

Packaging: wrapping or container for goods.

Pesticide: substance used for destroying insects or other organisms harmful to cultivated plants or to animals.

Pollution: contamination.

Precipitation: results when clouds become heavy with condensed water; the water droplets fall from the clouds as rain.

Rain gauge: a weather instrument used to measure the amount of rainfall.

Range: an area included into limits.

Reproduction: is the biological process by which new individual organisms are produced.

Resource: the means available to fulfil a function.

Saltwater: water containing dissolved salts.

Sedimentation: action of the matter that settles to the bottom of a liquid.

Sewage: waste matter.

Shelter: something used as a shield for protection from danger.

Skeleton: hard internal or external framework that contains the body of a living organism.

Species: class of things having common characteristics.

Survive: continue to exist or live.

Theory: system of ideas explaining an idea or topic.

Transpiration: emission of vapour.

Tourism: the organization and operation of holidays.

Annex 1 Types of Rubbish

GLASS	
1. What sort of rubbish is that?	Hard material that will not bend (unless very hot) but will crack and shatter if hit hard.
2. What is it made of?	Melting silica, sand.
3. What will happen to it when I throw it away?	Does not pollute as it is a fairly natural material. Broken glass can injure people and animals by cutting their feet.Bottles and jars collect water and breed disease-causing mosquitoes.
4.Can it be reused?	Can be refilled. Good for keeping food also as well as drinks.
5.Can it be recycled ?	Green, brown and clear glass are all recyclable. It is melted down and used to make new bottles. This saves energy but costs money.
BATTERIES	
1. What sort of rubbish is that?	There are two main types: the small ones for torches and radios, and
big ones like car or boat batteries.	
2. What is it made of?	Contains lead and mercury, heavy metals and acids which are toxic or poisonous. Acids are strong chemicals that can quickly burn clothes, materials and people.
3. What will happen to it when I throw it away?	Small batteries are not really a problem but the acid and lead in the bigger batteries can inure people and animals. Never throw batteries in the sea or in creeks, as they could poison the water.
4. Can it be reused?	Torch batteries cannot be reused, unless you buy rechargeable Batteries which can be recharged hundreds of times. They cost more to buy in the first place but they are cheaper in long run. Car batteries are rechargeable but will die in the end.
5. Can it be recycled	Car batteries can be recycled at the scrap metal dealer for the lead. Shops that sell car type batteries may also take them for recycling. Small batteries are not recycled in the Pacific the best is to use rechargeable ones with a charger.
SCRAP METAL	
1. What sort of rubbish is that?	Old cars, trucks, washing machines, stoves, engines, bicycles, old pieces of metal frames, pipes, wheels.
2. What is it made of?	Metal comes from the ground through mining which can be a destructive business and requires a lot of energy. Therefore, it is better not to waste metal but to recycle as much as possible.
3. What will happen to it when I throw it away?	Metal is a thick material so it takes long time to rust. Often the pollution is not caused by the rotting metal but from old paint, oils and chemicals inside machinery, especially if thrown into the sea.
4. Can it be reused?	Can be useful to people who make and repair things. Parts of the machinery can be re-used and is sometimes worth money, it is always worth asking people if they want them. For people living in the bush, it is worth putting all the dead machinery from the community in one place so it can be taken away.

5. Can it be recycled ?	Iron and steel (very common), which most large things are made of and is easy to tell because it goes red brown colour with rust and is not so valuable. Copper, which is a soft, gold brown colour, used for small pipes and wire, is very valuable. Aluminium, light soft silvery metal is very valuable. Brass and bronze, heavy gold colour metals, is harder than copper and more valuable, commonly used to make boat fittings.
OIL AND FUEL	
1. What sort of rubbish is it?	Old engine oil, kerosene, petrol, diesel
2. What is it made of?	Made from crude oil refined after being pumped out of oil wells.
3. What will happen to it when I throw it away?	As a liquid, a small quantity can pollute a large area. Oil will be slowly broken down through a natural process which can take a while. If we just tip it onto the ground, it can easily end up in our water supply. Fuels such as petrol or kerosene (but not diesel) will evaporate.
4. Can it be reused?	When the fuels are contaminated with dirt and water, let it stand for few days undisturbed. The water and dirt will sink to the bottom. Then slowly pour off the clean fuel without shaking the dirt. Using a transparent jar helps to see when the water and dirt come back into the fuel again. Dirt can destroy your engine so, if in doubt that the fuel is clean, don't re-use. The little fuel left in the container can be left to evaporate until only water and dirt are left, and then they can go into the rubbish. Used oil can be used to stop termites eating timber or the underside of cars from rusting.
5. Can it be recycled ?	Oil is recycled by some oil companies, and it is becoming more and more common in the Pacific.
TIN CANS	
1. What sort of rubbish is it?	Tins of meat, vegetables, milk powder, coffee
2. What is it made of?	Steel coat and thin coat of tin plate to stop the rust.
3. What will happen to it when I throw it away?	Tin will slowly rot, and the metal returns to the earth. The nearer the sea, the quicker they rust. They can cut feet and breed mosquitoes.
4. Can it be reused?	Can be used as containers for odds and ends. With holes inside, they can be used for plants seedlings.
5. Can it be recycled ?	Wash them, squash them flat, and the local scrap metal merchant may take them. The best way is to grow trees seedlings in them. If each student does that, your school will become a real forest!
ALUMINIUM	
1. What sort of rubbish is it?	Soft drink and beer cans. Light and easy to squash.
2. What is it made of?	Aluminium, a metal dug from mines which takes a large amount of electricity to produce it. It is expensive to make and creates a large amount of pollution.
3. What will happen to it when I throw it away?	Slow to rust and way too valuable to be thrown away!
4. Can it be reused?	Kids sometimes use it to make toys.
5. Can it be recycled ?	Yes, most of countries already recycle them. Squash them and store them somewhere. You will be paid per kilo collected!

Annex 2