GRADE 10

SOCIAL SCIENCE

UNIT 2

Topic 1: Environmental Change-Past, Present and Future

- **Types of Changes in Papua New Guinea**
- **Global Warming**
- **El Nino and La Nina**
- **Case Study: El Nino in Papua New Guinea**

Topic 2: The Ways in which People Change and Influence their Environment

- **Over Population and Land Use**
- **Introduction of New Plants and Animals**
- **Endangered and Threatened Species**
- **Deforestation**

Topic 3: Local Environmental Issues

- **Pollution of River Systems**
- **Marine Pollution**
- **Industrial Pollution**

Topic 4: Conservation and the Preservation of the Environment

- **Conservation of the Environment**
- **The Green Revolution**
- **Conservation in Papua New Guinea**
- **Environmental Repair and Protection**
- **Case Study: Conservation in Papua New Guinea**

Acknowledgements

We acknowledge the contributions of all Secondary school teachers and subject consultants who in one way or another helped to develop this course.

Special thank you is offered to the Staff of the Social Science Department of FODE who played active role in coordinating writing workshops, outsourcing of lesson writing and editing processes, involving selected teachers of National Capital District.

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Principal

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SECRETARY'S MESSAGE

Achieving a better future by individual students and their families, communities or the nation as a whole, depends on the kind of curriculum and the way it is delivered.

This course is part and parcel of the new reformed curriculum. The learning outcomes are student-centred with demonstrations and activities that can be assessed.

It maintains the rationale, goals, aims and principles of the national curriculum and identifies the knowledge, skills, attitudes and values that students should achieve.

This is a provision by Flexible, Open and Distance Education as an alternative pathway of formal education.

The course promotes Papua New Guinea values and beliefs which are found in our Constitution and Government Policies. It is developed in line with the National Education Plans and addresses an increase in the number of school leavers as a result of lack of access to secondary and higher educational institutions.

Flexible, Open and Distance Education curriculum is guided by the Department of Education's Mission which is fivefold:

- To facilitate and promote the integral development of every individual
- To develop and encourage an education system that satisfies the requirements of Papua New Guinea and its people
- To establish, preserve and improve standards of education throughout Papua New Guinea
- To make the benefits of such education available as widely as possible to all of the people
- To make the education accessible to the poor and physically, mentally and socially handicapped as well as to those who are educationally disadvantaged.

The college is enhanced through this course to provide alternative and comparable pathways for students and adults to complete their education through a one system, two pathways and same outcomes.
It is our vision that Papua New Guineans' harness all appropriate and affordable technologies to pursue this program.

I commend all the teachers, curriculum writers and instructional designers who have contributed towards the development of this course.

UNIT 2: INTRODUCTION

Dear Student,
Welcome to Unit 2 of the Grade 10 Social Science course. This unit is about Environmental Change, Pollution and Solutions.

Learning Outcomes:

- Demonstrate understanding of issues relating to sustainable, ethical allocation and management of resources
- Explain the relationships between the natural and built in environments in Papua New Guinea and the world
- Communicate ideas and information in a variety of ways
- Demonstrate understanding of personal responsibilities in relation to a sustainable society and environment.

In this Unit you will learn about:

- Environmental Change: Past, Present and Future
- The Ways in which People Change their Environment
- Local Environmental Issues
- Conservation and Preservation of the Environment

In this unit you will learn that Papua New Guinea, as part of a global community, has been, is being and will continue to be affected by environmental change. You will observe, identify and critically analyse peoples' impact on the environment and examine environmental changes from the past to the present and use this knowledge to predict, plan and act for changes in the future.

Students will undertake an extension once they have completed the core unit.

Each Topic has lessons with Practice Exercises and Answers. You must read each lesson and work through the Practice Exercises. You will have to correct your own answers. The answers to the Practice Exercises are given at the end of each topic. When you complete a topic, you will then complete the Topic Test in the Assignment Booklet. You will repeat the same process until you complete the Unit.

We hope you enjoy this Unit!

STUDY GUIDE

Follow the steps given below and work through the lessons.

Step 1 Start with Topic 1 and work through it in order.

Step 2 When you complete Lesson 1, you must do Practice Exercise 1.

Step 3 After you have completed the exercise, you must correct your work. The answers are given at the end of each Topic.

Step 4 Then, revise well and correct your mistakes, if any.

Step 5 When you have completed all these steps, tick the check-box for Lesson 1, on the content page, like this:

☑ Lesson 1: Types of Changes in Papua New Guinea

Then go on to the next lesson. You are to repeat the same procedure until you complete all the lessons in a topic.

As you complete each lesson, tick the box for that lesson on the content page, like this ☑ . This will help you check your progress.

Assignment: Topic Test
When you have completed all the lessons in a Topic, do the Topic Test for that Topic, in your Assignment Booklet. The Unit book tells you when to do this.

Marking:
The Topic Tests in each **Assignment** will be marked by your **Distance Teacher**. The marks you score in each Assignment will count towards the final result. If you score less than 50%, you will have to repeat that Assignment.
Remember, if you score less than 50% in three (3) Assignments, your enrolment will be cancelled. So, you are encouraged to do your work carefully and make sure that you pass all Assignments.

Here is a sample Study Timetable to use as a guide. Refer to it as a reminder of your study times. A timetable will help you to remember when you should be doing some of your FODE studies each day.

Time	Monday	Tuesday	Wednesday	Thursday	Friday
8:00-10:00	**FODE STUDY TIME**				
10:00-11:00					
1:00-2:00					
2:00-4:00					
6:00-7:00					
7:00-9:00	Listen to or watch current affairs programmes. Write your diary, read a book.				

COURSE MATERIALS

Here is a list of resource materials that you will need for this course.

- Grade 10 Social Science Unit 2 Course
- Assignment 2 Booklet

Other materials to help you in your learning:

- Ruler
- Pair of dividers
- Blank sheets of paper
- Piece of cotton or string
- Pencil, eraser
- Exercise book

Other References

- Papua New Guinea School Atlas
- World Jacaranda Atlas

TOPIC 1: EVIRONMENTAL CHANGE-PAST, PRESENT AND FUTURE

In This Topic, You Will Learn About:

- **Types of Changes in Papua New Guinea**
- **Global Warming**
- **El Niño and La Niña**
- **Case Study: El Niño in Papua New Guinea**

TOPIC 1: INTRODUCTION

Welcome to Topic 1! In Topic 1, you will learn about environmental change in the past, present and future.

Learning Outcome: Students will be achieving this outcome when they, for example:

- 10.2.1 identify, describe and explain the causes and effects of environmental change

In this topic, you will look at what change is and the types of changes in the past, present and the future. The changes that occur in the environment are natural and man-made. Natural changes are sometimes referred to as physical changes, and man-made as human changes.

Although change includes both natural and man-made occurrences and activities in the environment, in the course of this topic however the main discussions of content will be on natural causes of change. Such natural causes include global warming, El Niño and La Niña, and particularly effects of El Nino in Papua New Guinea.

The effects of El Nino will be discussed as case studies.

Lesson 1: Types of Changes in Papua New Guinea

Welcome to Lesson 1. This is the first lesson of Grade 10 Unit 2. In this lesson, you will define change and discuss the types of changes in Papua New Guinea.

Your Aims:

- define change
- identify types of change: physical and human
- identify people who observe and analyse change
- identify and explain the effect of these changes
- identify and explain who makes predictions for future changes

What is change?

Change is something altered and is new at a particular time. When something changes it becomes different to what it was before. Many things around us today are very different from what they were many years ago. Change often comes with time. The world we live in is divided into two types of environment: physical and human.

The **physical** environment is made up of things that are found in nature which occur naturally. Features such as forests, mountains, rivers, oceans are all part of the physical environment. You can include some more physical features. The human environment is made up of man-made features such as buildings, roads, sports- fields, recreational parks, schools, airstrips and many more you can think of. Examples of physical and human environments are shown in Illustration 10.2.1a-b.

Illustration 10.2.1a: Natural feature of the physical environment. The Hundred Islands National Park in the Philippines.

Illustration 10.2.1b: An example of human environment, and impact of man on physical environment.

Types of environmental changes

The Earth has gone through many processes of change since it was first formed about 4500 million years ago. Many aspects of the **physical** environment such as the shape of the land, the level of the sea, the climate, the plants and animals on earth have all gone through many processes of change since the world began. The physical environment goes through very slow processes of change. Processes such as weathering, erosion and deposition are so slow that sometimes we do not notice their occurrence. Other changes in the physical environment such as volcanic eruptions, earthquakes, cyclones, tsunamis, landslides and floods occur so quickly that their impact on the environment is severe and affects life and property. These are known as natural hazards and disasters. Natural hazards are natural events that are **destructive** in nature and can cause damage to the environment and loss of human lives.

You can see below pictures of natural processes and hazards.

Illustration 10.2.1c: Shaping of rock by physical weathering in the Grand Canyon, Colorado, USA

Illustration 10.2.1d: Residents gather amongst the devastation in the aftermath of Typhoon Haiyan on November 13, 2013, in the Philippines.

The **human** environment on the other hand goes through fast change. The construction of roads, schools, hospitals, towns and cities, electricity and telecommunication networks is all part of changes in the human environment. Many of these changes have altered the way we live and how we interact with one another. Figures 10.2.1c-d, show pictures of the human environment. These are known as **social** changes that are a result of economic changes such as living in a town or city and working for a salary or wage. **Economic** changes are those changes that bring about development to a place. Social changes deal with people's behaviour, attitude and mindset, and how they interact with one another.

Illustration 10.2.1e: (left) Wanigela urban village built on water at Koki, Port Moresby.

Illustration 10.2.1f: (right) Panguna mine after its closure in 1989.

Papua New Guinea changing through time

1. Physical processes occurring rapidly resulting in natural disasters

Papua New Guinea has gone through many stages of change in both its physical as well as human environment. Here are examples of physical processes of change that have occurred rapidly in the recent past that included natural disasters in the most recent past to more than a hundred years ago.

i) El Nino in 2015 had led to reduced cloud cover and faster cooling of the land overnight resulting in frost in the highlands and food crops being severely affected.

ii) April 27th-29th, 2013, heavy and prolonged rainfall resulted in heavy flooding and landslides in Wapenamanda, Enga Province.

iii) July 28th 1998, Aitape tsunami in the Sandaun Province.

iv) 1994 volcanic eruption on Mt. Tavurvur in East New Britain Province.

v) 1997 El Nino occurred in Papua New Guinea (see Lesson 3 of this topic).

vi) According to climatic records major drought had occurred in parts of PNG in 1896, 1902, 1914, 1941, 1972, 1982, 1997, and 2015.

2. Human processes occurring rapidly resulting in change

a. Examples of economic changes

i) Building of the Highlands highway since 1953 by hand tools and labour.

ii) The production of the Bougainville copper mine in 1972 under the management of Bougainville Copper Limited (BCL) with the PNG government as a 20% shareholder. It ceased production in 1989 due to the Bougainville crisis.

iii) Construction of the Liquified Natural Gas (LNG) project in 2010.

iv) Construction of electricity and telecommunication and mobile network.

v) Business investments in trade, timber, supermarket, banks and finance companies.

vi) **Bilateral** aid as in JICA, AusAid, European Union

b. Examples of social change

i) South Pacific Games in 1963, 1991 and 2015

ii) Introduction of education at all levels: elementary, primary, secondary, technical, college, university

iii) Building of hospital, sporting complex and stadium

iv) Cultural show, Festival of arts, fairs

Illustration 10.2.1g: 2015 Commonwealth games gold medalists Dika Toua and Steven Kari.

A sporting activity is an example of social change. One's involvement in sports broadens one's view of life. Successful sportsmen and women earn income thus improving and changing their social status in life.

Many people and events affect us and change our lives. Some changes can be personal while others are broader and affect our society. Some changes bring benefit, others create problems and conflicts. Often one change produces a series of related changes.

We cannot always control the causes and effects of change in our lives; however, by careful planning, positive action and resolving of conflicts, we can influence the processes of change around us and learn new ways of responding to change.

Change does not occur only by chance. It can also be planned and made by choice. People respond to change in both positive and negative ways. Change is an on-going process. One change will often result in other changes. The rate of change varies in different places and at different times. The things people do worldwide are basically the same. What is changing is the way in which people do those things. Some of those include:

- families care for each other
- children are educated
- goods and services are bought to satisfy people's needs
- a belief system guides people's lives
- rules and punishments are put in place to control people and society
- leisure activities provide relaxation for people
- more resources are extracted from the environment

Now do Activity.

Activity

1. The following is a list of changes in Papua New Guinea. Identify and write **P** if the change is a physical change and **H** if the change is a human change.

   a. The construction of the Goilala Highway in Central province. _____

   b. The damage caused by tropical cyclone Guba in 2008. _____

   c. The relocation of the Cataret Islanders to Tinputz in Bougainville. _____

d. The sinking of the Rabaul Queen in 2012. _____

e. The destruction and death caused by the Aitape tsunami in 1998. _____

2. What are the processes that cause the physical environment to change slowly?

_____

_____

_____

_____

3. What are the processes that cause the physical environment to change rapidly?

_____

_____

_____

Check your answers after the summary.

Scientists who observe change

Knowledge and evidence about the changes that occur in the physical environment is made possible for us through the careful study, observation and predictions by scientists. By careful observation, collection of data and information, and by analysing and processing information are able to present to the population at large, the changes that have occurred in the past, from simple microscopic organisms to very complex forms of life that exist today.

Table 1.1 shows the different scientists and the role each play in the study of the environment.

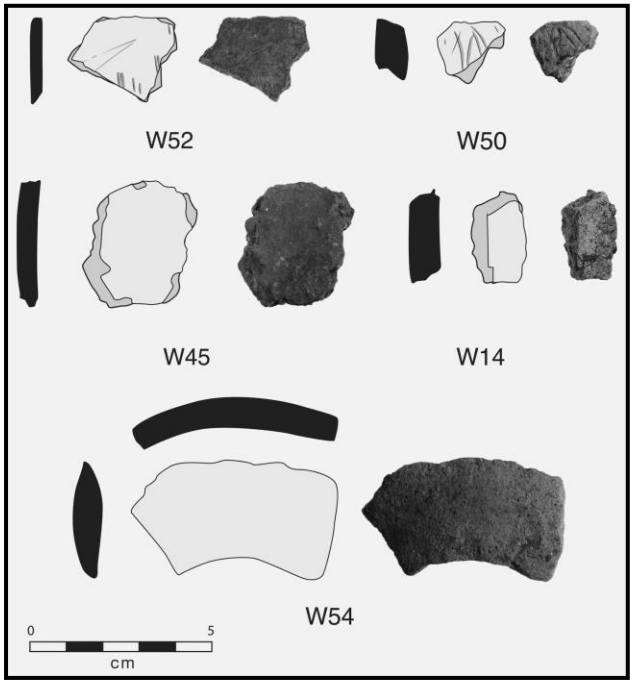
Type of scientist	Role
Geologist	Study the rocks of the earth.
Paleontologist	Study the fossil remains of dead plants and animals
Archaeologist	Study the historical artifacts; ancient cultures and civilisations
Seismologist	Study the occurrences of earthquakes
Volcanologist	Study the volcanic eruptions
Meteorologist	Study the weather patterns and climate change

You will see in Illus. 10.2.5h-i, the work of archaeologists in China that uncovered the remains of a very old city, and Wanelek pottery being discovered in the Madang Province.

Illustration 10.2.5h: In the 1930's, the remains of a 500-year-old city was discovered at Sanxingdui in southwest China.

Now archaeologists working at the site have discovered the foundations of a building they believe could help unlock the secrets of the lost city.

During the early days before modern man came into existence there were no written records and scientists can only predict through archaeological evidence how these early people had lived.



Effects of change

Change affects all parts of and forms of life. Adaptation versus extinction refers to plants and animals that were not able to **adapt** to change. They eventually died out and became **extinct**. Those that were able to adapt survived, lived on and reproduce their own kind. Some of them had to develop very complex features and characteristics in order to survive very harsh climatic and environmental conditions.

People's continuous actions on the environment for the extraction of natural resources and for development purposes such as: logging, mining, construction of roads and bridges, fishing, and agriculture have resulted in many of the global environmental problems that we face today. The main problem that Papua New Guinea and the world face today is the effect of global warming. Figure 10.2.5j shows the different aspects of global warming.

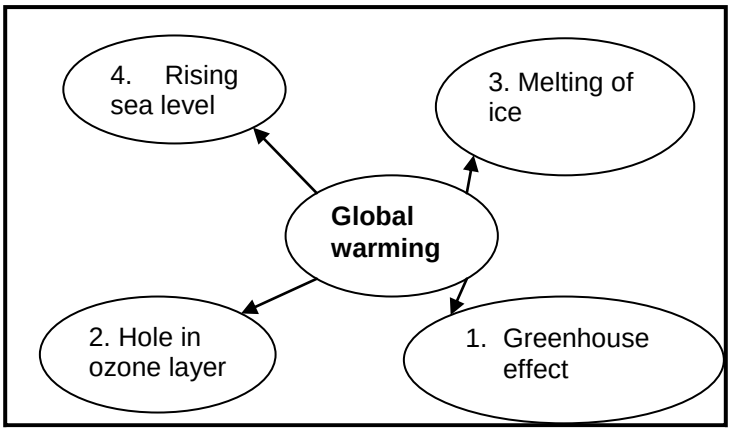


Figure 10.2.5j: Effects of global warming

Future Changes

Change as we know by now is a continuous process. By understanding the changes that occurred in the past and knowing the processes of change that are taking place today, we are able to make **predictions** about what the future will be like.

It is important that scientists continue to investigate the world we live in. The more we know about the processes of change that take place today, the more we are able to make accurate predictions about the future. When we are not careful, our actions can cause a lot of harm and damage to the environment. It is very important that we know the impact of our actions on the environment so that we can learn to preserve and protect it from bad effects of future changes.

Now read summary.

Summary

You have come to the end of Lesson 1. In this Lesson, you have learnt that:

- the Earth has gone through stages of change since it was first formed 4.5 billion years ago.
- changes in the physical environment usually occur slowly while changes in the human environment usually occur rapidly.
- by careful observation we are able to measure and understand these changes and the processes that cause them.
- natural disasters such as earthquakes, volcanoes, tsunamis, cyclones, floods, landslides sometimes cause the environment to change rapidly.
- the human environment has changed very rapidly and this is having a big effect on the environment.
- the work of archaeologists, historians, geologists, paleontologists, and other scientists enables us to understand past and present changes and to make predictions for future changes.
- people must take positive action towards their activities in order to protect and preserve the environment for the future generation.

Answers to Activity

1.
(a) H (b) P (c) H (d) H (e) P

2. Processes causing the physical environment to change slowly are:
   Weathering, erosion, deposition or sedimentation

3. Processes causing the physical environment to change rapidly are:
   Earthquake, volcano, tsunamis, cyclone, landslide, flood

NOW DO PRACTICE EXERCISE 1 ON THE NEXT PAGE

Practice Exercise 1

Read your notes and answer questions.

1. Define these words:

   i) Physical environment

   _____

   _____

   ii) Human environment

   _____

   _____

   iii) Economic change

   _____

   _____

   iv) Social change

   _____

   _____

   v) Natural hazard

   _____

   _____

2. What is the difference between archaeologists and palaeontologists?

   _____

   _____

   _____

   _____

   _____

   _____

3. Explain the phrase “Adaptation versus Extinction?”

_____

_____

_____

_____

4. State 4 aspects of global warming.

_____

_____

_____

_____

CHECK YOUR ANSWERS AT THE END OF TOPIC 1

Lesson 2: Global Warming

In Lesson 1, you learnt about types of change in the physical and human environment in Papua New Guinea. You were also introduced briefly to the different aspects of climate change including global warming. In this lesson you will learn about global warming, its causes and effects on our environment.

Your Aims:

- define greenhouse effect and global warming
- discuss the causes of greenhouse effect and global warming
- identify the effects of global warming
- suggest ways in which we can reduce global warming locally

Global warming

Burning fossil fuels increase the amount of carbon dioxide in the atmosphere. The action of carbon dioxide and other greenhouse gases in trapping infrared radiation is called the greenhouse effect. It increases the overall average temperature of the earth which could have disastrous outcomes.

Light rays from the sun passes through carbon dioxide in the atmosphere and heat up the surface of the earth. The air is heated by the warmth coming from the earth's surface. The carbon dioxide in the air prevents most of the heat from escaping back into outer space. If it were not for greenhouse gases trapping heat in the atmosphere, the earth would be a very cold place. Greenhouse gases keep the earth warm through a process called the **greenhouse effect**. The more carbon dioxide there is in the air, the less heat is released back into outer space causing the earth's atmosphere to become warmer. This is why carbon dioxide is called a greenhouse gas. Examples of natural greenhouse gases are carbon dioxide, methane, ozone, and also including manmade gases such as nitrogen oxide and fluorinated gases. These make up only one percent of the earth's atmosphere, but they are almost entirely responsible for all of its heat trapping capacity.

See Figure 10.2.2a on greenhouse effect on the following page.

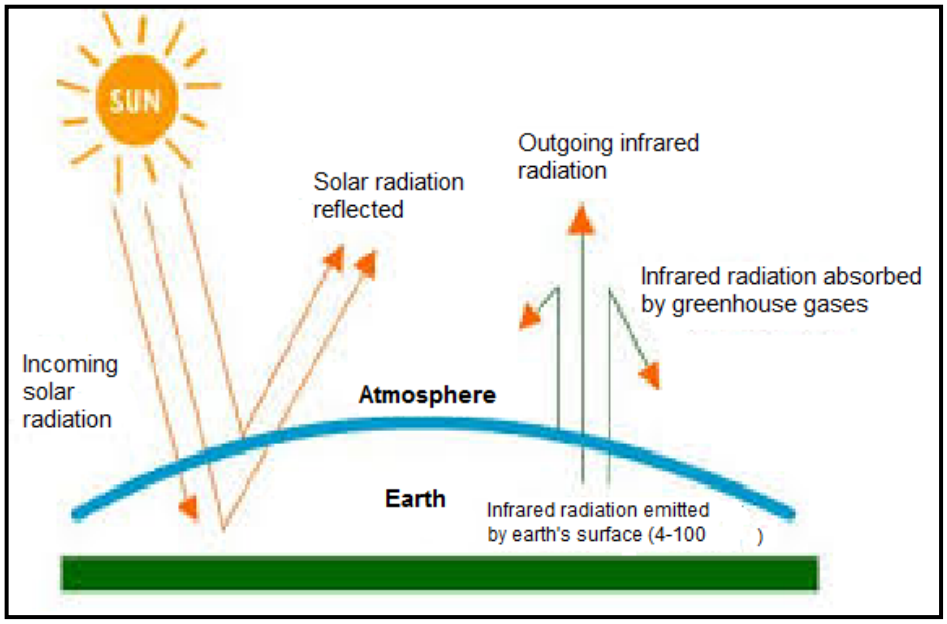


Figure 10.2.2a: Diagram illustrating greenhouse effect

Causes

Global warming is an increase in the world's temperatures, believed to be caused in part by the greenhouse effect. So, what really is global warming? It is mainly a problem of too much carbon dioxide (CO_2) in the atmosphere - which acts as a blanket, trapping more heat and warming the planet. As we burn fossil fuels like coal, oil and natural gas for energy carbon is released and it accumulates in the atmosphere. The main human activities that contribute to global warming are waste management and agricultural practices. Through these activities more greenhouse gases such as methane and nitrous oxide are released into the atmosphere. Some of the examples are stated below.

- The increase in population makes the problem worse as we breathe out carbon dioxide.
- More people mean more food which means more methane because there will be more burning of fossil fuels, and more agriculture. Carbon levels have increased in the atmosphere as a direct result of burning large volumes of fossil fuels.
- Another problem with the increasing population is transportation. More people mean more cars which mean more pollution.
- Methane leaks from natural gas wells and coal mines. Mining coal and oil allows methane to escape. Methane is found naturally in the ground. When coal or oil is mined huge amount of the earth is dug up. When you dig up the fossil fuels methane is released as well.
- Methane also escapes from large landfill rubbish dump, as well as from volcanic eruptions.
- Methane is also created anytime organic matter decays under oxygen-starved conditions. This occurs in rice **paddies**, and inside the stomach of **herbivorous** animals. As humans clear forests to make farms and increase the number of animals

to raise, these also increased the amount of methane released into the atmosphere. Another source of methane is manure. Because more food is needed we have to raise food. These animals are a source of food which means more manure and methane.

- The ice and snow in the Arctic **tundra** is also melting, and releasing large volumes of methane and carbon dioxide.
- We have cut down millions of acres of forest and every tree contains carbon, and as a tree is burnt or decomposes, carbon is released into the atmosphere. We are not replanting the trees (an important part of our ecosystem), so we are constantly taking advantage of our natural resources and giving nothing back in return. Deforestation is another major contributor to global warming.
- By destroying the reefs that absorb some of the carbon dioxide through bad fishing methods or erosion from clearing the land.

People are now producing more artificial nitrogen for use as fertiliser, then all of the natural nitrogen fixing process of all of the plants on earth. In nature nitrogen is pulled from plants out of the atmosphere in a process called nitrogen fixation. But when this artificial nitrogen is applied to farmland, some of it is released into the atmosphere as nitrogen oxide, a powerful greenhouse gas that is several hundred times more **potent** than either carbon dioxide or methane.

Another set of highly potent gases are fluorinated gases. These are accumulating in our atmosphere. Fluorinated gases are a set of chemicals used inside refrigerators, for insulation, and for other industrial purposes.

Effects

As carbon dioxide increases in the atmosphere, world temperatures will begin to rise. The earth's temperature is increasing very fast. Scientists believe that even a small increase in the global temperature would lead to significant climate and weather changes, affecting cloud cover, precipitation, wind patterns, the frequency and strength of storms, and the duration of seasons. Increasing temperatures would result in ice bergs melting and this will lead to a rise in sea levels.

The effects of global warming are outlined below.

- *Drought and flooding*
  When the weather gets warmer, evaporation from both land and sea increases. This can cause drought in areas of the world where there is increased evaporation and no rainfall.
  In some regions of the world this will result in crop failure and famine especially in areas where temperatures will fall. Increased flooding in other places in the world will occur also.

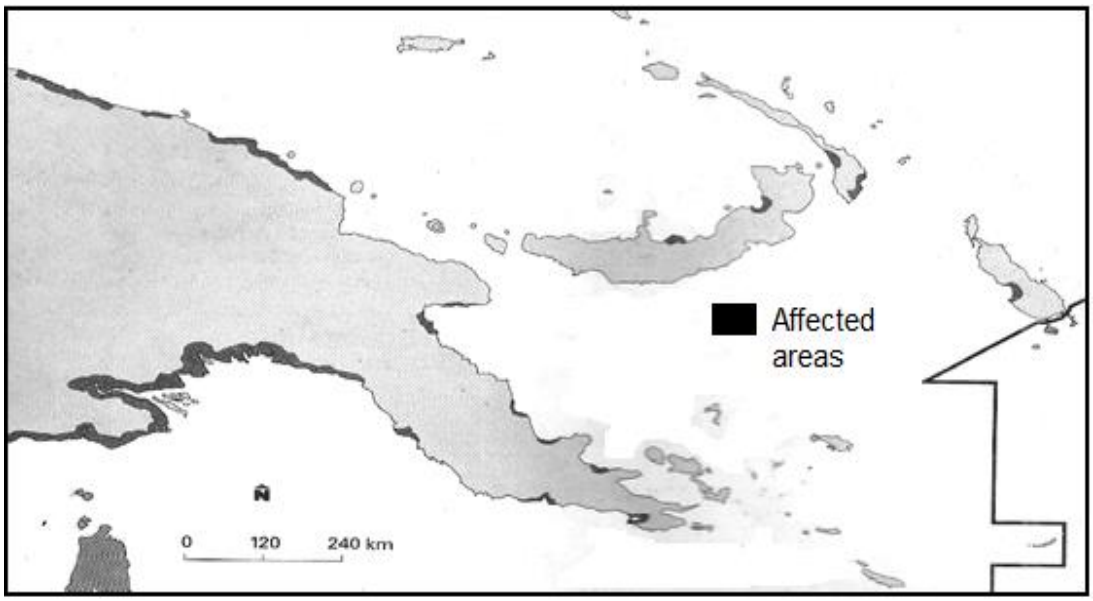
- *Less ice and snow*
  At present glaciers are rapidly shrinking rapidly. Ice is melting faster than previously estimated. In areas that are dependent on melt water from mountain area, this can cause drought and lack of domestic water supply.

- *More extreme weather incidents*
  The warmer climates will probably experience more heat waves, more violent rainfall and also an increase in the number and severity of storms.

- *Rising sea level*
  Sea level rises because of melting ice and the thermal expansion of the sea (water expands when warmed). Areas that are just above sea level now may go under water. For example, some Pacific Island nations are expected to be partially or completely under water by the end of the century. Coastal and shallow marine plants and animals will be affected, for example, mangroves and coral reefs.

  In countries with large areas of coastal lowland there will be a dual risk of river floods and coastal flooding, which will reduce the area for living and working. Coastal defenses will need to be strengthened, and river **levees** will need to be developed. The increase in static pools of water may breed more insects like mosquitoes and diseases that are spread by insects.

Map 10.2.2b shows effects of global warming and rising sea levels in Papua New Guinea that may become flooded if sea-level rises by only 1 metre. Western and Gulf Provinces would be most severely affected with more than 90 per cent of their coastal areas flooded. Altogether, more than 25 per cent of Papua New Guinea's coastal areas would be affected. Many of the world's endangered species would become extinct as rising temperatures changes their habitat. Millions of people would be affected, especially poor people who live in unsafe locations or depend on the land for a subsistence living.



Map 10.2.2b: Areas in Papua New Guinea that are already being affected by rising sea levels

You will now read a passage on the Cataret islanders in Bougainville who have been affected by the rising sea level.

First Official Climate Change Refugees Evacuate Their Island Homes for Good

The day has finally come, and a critical landmark in the saga of global climate change is occurring as we speak—and hardly anyone has noticed. The Carteret Islanders of Papua New Guinea have become the world's first entire community to be displaced by climate change. They are the first official refugees of global warming–and they are packing up their lives to move out of the way of ever-rising waters that threaten to overtake their homes and crops.

The island they call home will be completely underwater by 2015. This story first broke a couple years ago, when it was first suggested that these islanders could become climate change refugees. But now that it's actually happening–seems no one's paying attention. And though the picture isn't as worst as some might imagine, life for the islanders has indeed all but become impossible on the Cartarets: On the Carterets, king tides have washed away their crops and rising sea levels poisoned those that remain with salt. The people have been forced to move.
That report comes from 'The Ecologist', one of only a handful of media outlets to cover the story, and the only one to have a reporter on hand to witness the **evacuation**. This is what he saw when he arrived on the scene:

The men climbed silently from the boat and into the shallows. They splashed towards us, carrying almost nothing. From beside me, others who had come to meet them walked out quietly in welcome. The air was still, both sad and happy, which seemed to suit the moment. That single boat carrying these five men is the first wave in what is, as far as I can tell, the world's first official evacuation of an entire people because of climate change.

Illustration 10.2.2a: Cataret islands affected by rising sea levels

By Brian Merchant/Tree Hugger

Thus begins an unfortunate exodus, however small, of a people whose lives have been directly threatened by climate change. And though the entire community appears only to be comprised of 40 large families (around 2,000 people), the loss of their homes and way of life is still a tragic occurrence. The displaced villagers are already at work building new homes near a village on another larger island, on higher ground.

And this is certain to be just the first such community to be forced into such action—with sea levels continuing their steady rise, and a distinct lack of meaningful action from governments of rich, polluting nations, more helpless communities are sure to be displaced.

Greenhouse Effect

Carbon dioxide in the atmosphere acts like the glass of a greenhouse. In temperate regions, many vegetables such as tomatoes, cucumbers and lettuces that are badly affected by cold, dry weather are grown in a greenhouse. A greenhouse is usually made of glass and becomes very warm and humid inside when the sun shines on it, even though it is very cold outside. Light rays from the sun (infra-red radiation) pass easily through the glass of a greenhouse. Inside the greenhouse, the light rays heat up the floor, the leaves of the plants and the benches. This heat radiates from the plants and the ground and warms the air inside the greenhouse. However, the glass does not allow the heat radiation to pass back through it. This means that the heat is trapped inside the greenhouse. Even on dull,

cloudy days, the air inside a greenhouse can be much warmer than the air outside. Sometimes the air inside a greenhouse becomes too hot. When this happens, louvres in the glass are opened to allow the extra heat to escape until the temperature is back to the correct level.

Now, read this important point about why it is called the greenhouse effect.

The greenhouse effect above refers to the actual greenhouses used here on earth to grow vegetables in very cold climatic regions. In terms of global warming this same idea is used to describe the earth as a greenhouse and the gases act as a glass or form of blanket that traps the sun's heat from escaping back into outer space.

Causes of Greenhouse effect

Greenhouse gases are those gases that capture outgoing sun's heat (infrared radiation) from the earth thereby warming the planet. When there is too much of these gases in the atmosphere they act as a blanket trapping the sun's heat from bouncing off or escaping into outer space. These entrapped gases then remain within the earth's atmosphere making it warmer and as a result affecting the climate.

Study the drawing of a glass house in Figure 10.2.2c below. It shows in steps how the sun's heat warms the inside of the glass house but is unable to escape through the glass and as a result it becomes warmer.

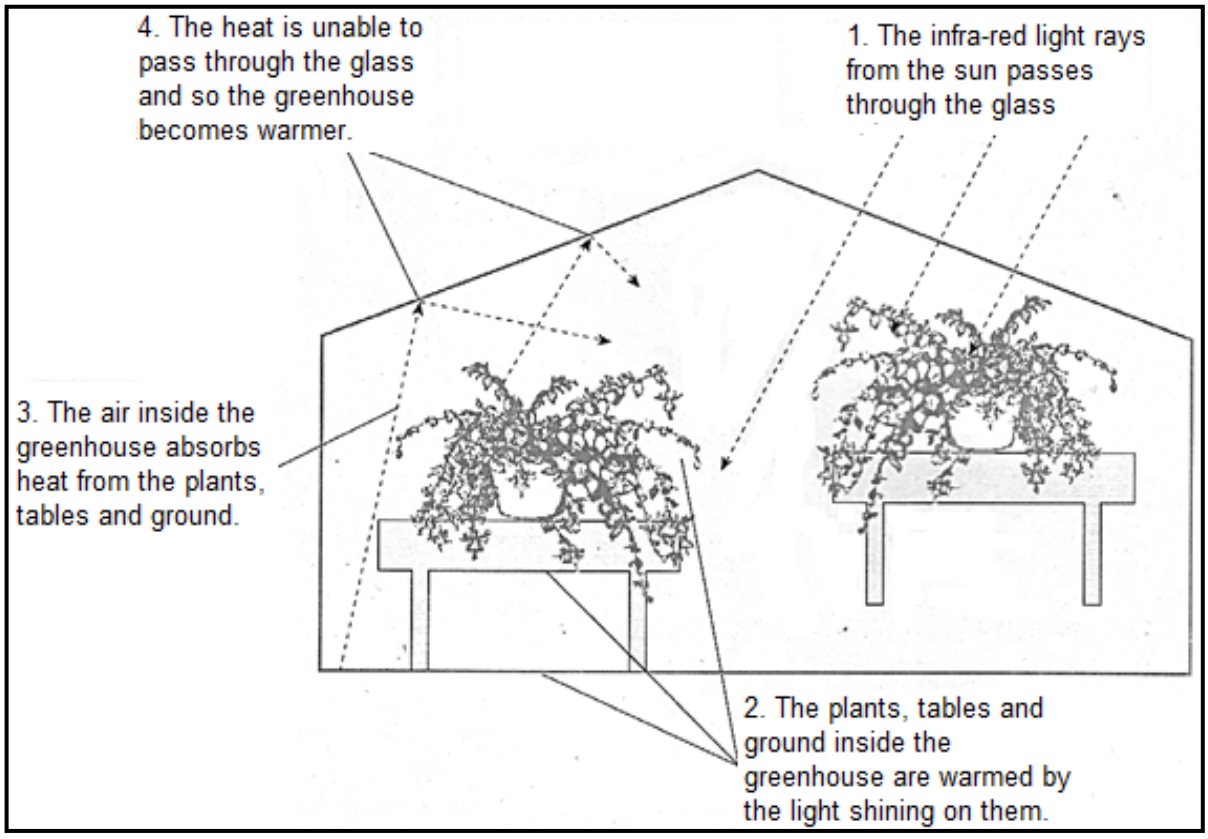


Figure 10.2.2c: Greenhouse traps so that plants can grow inside

Now do Activity.

Activity

1. What is carbon dioxide?

_____

_____

_____

2. Make a list of living and nonliving things that give off carbon dioxide.

_____

_____

_____

3. What is the infra-red radiation?

_____

_____

_____

_____

4.
   (a) Name the natural greenhouse gases.

   _____

   (b) Name the other forms of manmade greenhouse gases.

   _____

5.
   (a) Is Papua New Guinea affected by rising sea levels? _____

   (b) Name an island in PNG that is affected by rising sea levels. _____

Check your answers after the summary.

How is carbon dioxide removed from the atmosphere?

How important is the carbon dioxide in the earth's atmosphere?

Carbon dioxide is removed from the atmosphere in 3 ways.

1. **Photosynthesis of green plants and trees**
2. **Dissolving in the oceans**
3. **Being converted into calcium carbonate to make the skeleton for plankton, corals and shell fish which eventually form lime stone rock**

Over millions of years carbon dioxide is given off by various means and at the same time removed from the atmosphere. In this way carbon dioxide is balanced just enough to sustain life on earth.

The amount of carbon dioxide in the atmosphere must be balanced, there must not be too much or too little of it or else the planet's systems will be affected.

Ways to reduce global warming

To lessen those long-term effects of global warming, many nations, communities and individuals are taking action now to reduce greenhouse gas emissions and slow global warming through these activities.

- reducing dependence on fossil fuels
- increasing the use of renewable energy
- expanding forests, and
- making lifestyle choices that help to sustain the environment.

Now read the summary.

Summary

You have come to the end of Lesson 2. In this lesson, you have learnt that:

- greenhouse gases keep the Earth warm through a process called the greenhouse effect.
- there are many causes and effects of global warming
- burning fossil fuels causes pollution and gives off huge amounts of carbon dioxide into the atmosphere.
- excessive carbon dioxide in the atmosphere acts like the glass of a greenhouse
- carbon dioxide is removed from the atmosphere in 3 ways
- examples of natural greenhouse gases include carbon dioxide, methane, and ozone and man-made gases are nitrogen oxide and fluorinated gases.
- global warming is an increase in the world's temperatures, believed to be caused by too much carbon dioxide in the atmosphere - which acts as a blanket, trapping more heat and warming the planet.
- a small increase in the global temperature would lead to significant climate and weather changes.
- there are many ways to reduce global warming
- the greenhouse got its name from a glass house that is used to trap sun's heat to grow vegetables in very cold conditions.

Answers to Activity

1. It is a greenhouse gas.
2. It is given off by human beings, and the melting of the Arctic tundra ice and snow, forest fires, fumes from car exhaust and factories, burning of fossil fuels
3. It is sun's heat energy that traps gases from escaping from the earth's atmosphere
4.
   (a) carbon dioxide, methane, ozone, water vapour
   (b) nitrogen oxide, fluorinated gases, chlorofluorocarbons (CFCs)

5.
   (a) Yes
   (b) Cataret Island in North Solomons; or any other tiny atolls you may have named.

NOW DO PRACTICE EXERCISE 2 ON THE NEXT PAGE

Practice Exercise 2

Read the lesson notes and answer questions.

1. What is the greenhouse effect?

_____

_____

_____

_____

2. What is global warming?

_____

_____

_____

_____

_____

3. What is the major cause of global warming?

_____

_____

_____

4. List 2 ways in which methane is released into the atmosphere.

_____

_____

_____

_____

5. What are the effects of global warming? List and explain briefly each one.

_____

_____

_____

_____

_____

_____

_____

_____

CHECK YOUR ANSWERS AT THE END OF TOPIC

Lesson 3: El Nino and La Nina

Welcome. In the last lesson you learnt about global warming, its causes and effects. In this lesson, you will learn about El Niño and La Niña and their effects on the environment.

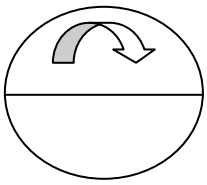
Your Aims:

- define El Niño and La Niña and explain why they occur.
- identify world patterns of el Niño and la Niña and their effects.
- explain global effects of the 1997 el Niño and la Niña on people and the environment.

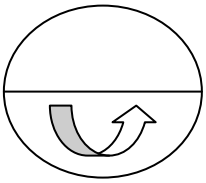
What is El Niño?

El Niño is the name given to the unusual weather condition occurring around the eastern and central Pacific Ocean along the equator. El Niño refers to the arrival of an unusually warm ocean current along the coasts of Ecuador and Peru that causes disturbances in the climate. In the eastern Pacific, it affects countries such as Ecuador, Peru, Chile, Mexico and USA. In the western Pacific, it affects countries such as Australia, Papua New Guinea, most of the other Pacific Island countries including Tahiti, Fiji, and countries in South East Asia such as Indonesia, Philippines and Malaysia.

The major surface currents in the world's oceans are caused by **prevailing** winds. Currents circulate in paths, moving in a clockwise direction in the northern hemisphere as shown here.



and a counterclockwise direction in the southern hemisphere as shown here.



The name El Niño in Spanish means 'the child'. It refers to the *Christ Child* because Peruvian fishermen have some years back, noticed the arrival of this warm ocean current during Christmas season. Scientists have since decided to use the name El Niño for this unusual occurrence.

Causes

The flow of ocean currents is caused by the prevailing wind systems that exists and blows from the high pressure zones of the earth towards the low pressure zones.

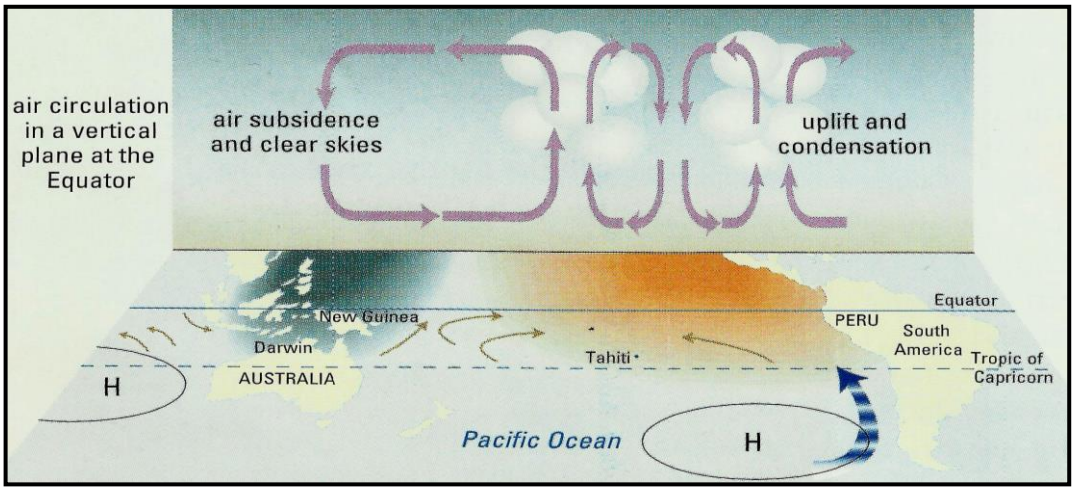


Illustration 10.2.3a: El Nino conditions in the Pacific region

El Nino is one of the most well-known climatic patterns. Every three to seven years during the months of December and January, the balance between, wind, ocean currents, atmospheric temperature and biosphere breaks down, resulting in a severe impact on global weather. During an El Nino event the trade winds weaken. The warm, nutrient-poor water is not pushed westward but occupy the tropical Pacific Ocean. The cold water is not forced to the surface and the coastal waters of Peru and Ecuador are unusually warm. The warmer water has a vast impact on their fish population which relies on cool waters to survive. The region also experiences very high amounts of rainfall.

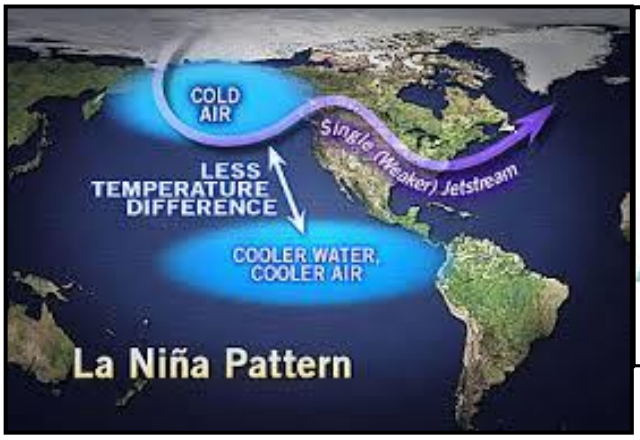
The impact of El Nino is most intense off the coast of Western South America which is felt in weather around the world. A strong El Nino will increase the wind currents over the western Pacific and shift it eastward, leading to stronger winter storms over California and southern United States, with floods and landslides. El Nino may also cause severe droughts over Australia, Indonesia, and parts of southern Asia. Further, while El Nino is known to lower the chances of hurricanes in the Atlantic, it increases the chances of cyclones and typhoons in the Pacific.

What is La Niña?

La Niña is the opposite of El Niño. It is the cold phase of El Niño and appears when surface ocean temperature in the eastern Pacific is unusually cold. This also creates unusual weather conditions in the Pacific Island countries, northern Australia, and parts of South East Asia.

Causes

When temperature is low, the air above the surface is cooler and it sinks in. A high pressure system occurs within this zone. The major impact of La Niña is very prolonged periods of drought, and the development of thunderstorms, tropical cyclones and hurricanes. See below illustrations of La Nina.



Map 10.2.3c: La Nina in the Pacific

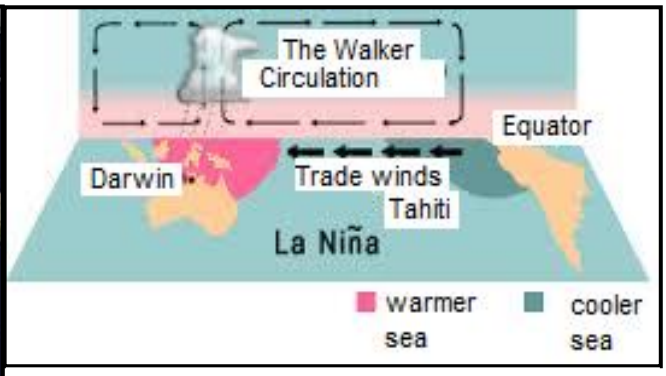
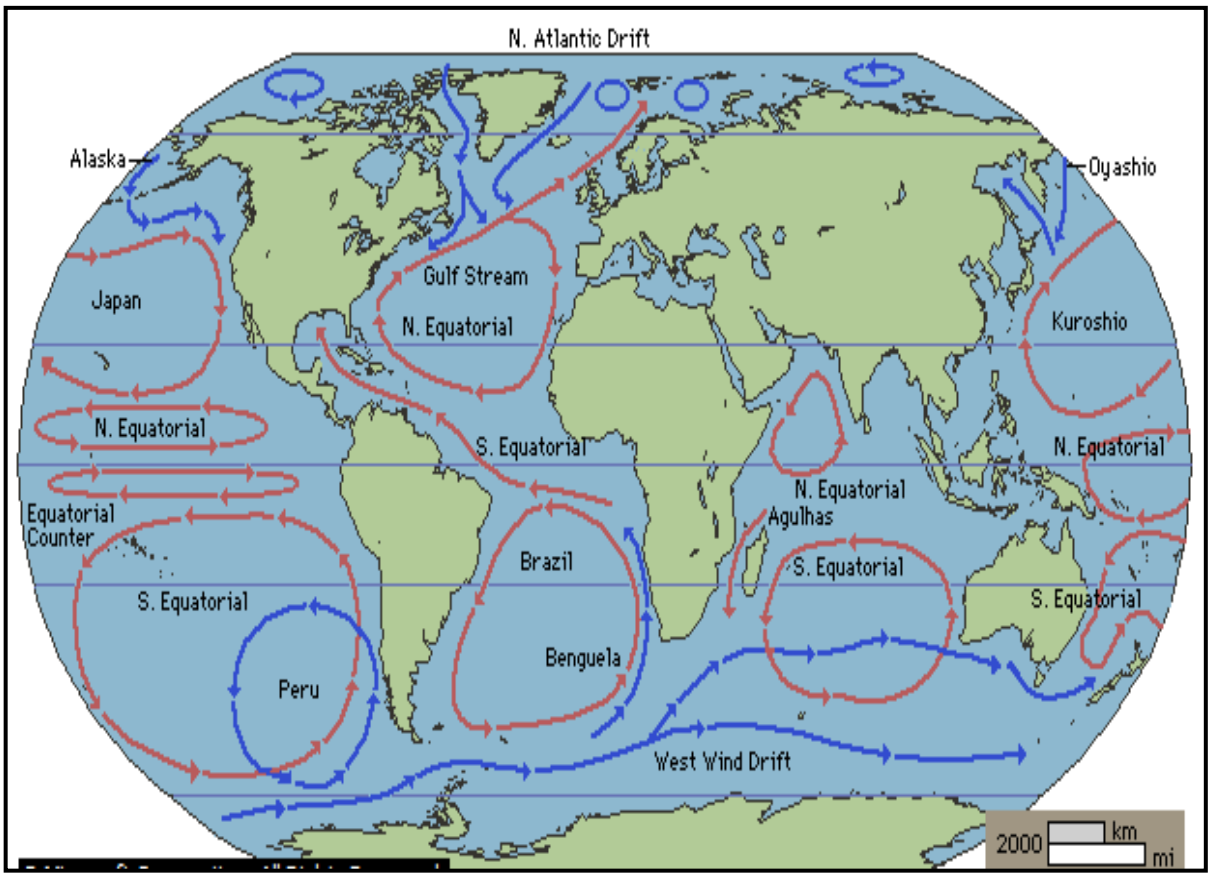


Illustration 10.2.3d: Explanation of La Nina in diagram

Figure 10.2.3b shows what is being discussed above. Study it carefully and try to make a link between the explanation and what you see in the map below here.



Map 10.2.3e: The different types of ocean currents during the El Nino and La Nina.

Now do Activity 1.

Activity 1

1. Name the two South American countries that are greatly affected by the El Nino?

   _____

   _____

2. Which countries in the Pacific are most affected by El Nino?

   _____

3. What causes El Nino to occur?

   _____

   _____

   _____

Check your answers after the summary.

World patterns of El Niño and La Niña and their effects

In normal conditions, the warm waters are confined to the western Pacific, with temperatures more than 10 degrees Celsius, which is higher than the waters around Peru and Ecuador. The air pressure is usually low over the warmer waters. Moist air rises in the region, causing the formation of clouds and heavy rainfall patterns of South East Asia, New Guinea (including Papua New Guinea), and the northern parts of Australia as shown in Figure 10.2.3f. In the eastern Pacific, the water is cold and air pressure is high, creating arid conditions along coastal South America. The trade winds blow from east to west, pushing the warm surface waters westward and creating an upwelling of cold water to the surface in the east.

During El Niño in Illustration 10.2.3f, the easterly trade wind loses its strength and reverses direction. The weakening of the winds causes a change in sea surface temperature, the change in wind and pressure increases. The warm water of the western Pacific flows back eastward. This results in an increase in sea surface temperatures off the western coast of South America. This warm water allows greater evaporation, condensation, cloud and rain. When this happens, the wet weather conditions normally present in the western Pacific is now shifted to the Eastern Pacific, and the dry conditions that are common in the east appear in the west. The effect of this reversal in surface water temperature is heavy rains to the continent of South America and droughts in South East Asia, India, and southern Africa. It also brings unusual weather conditions to the west coasts of the United States.

In a normal year the trade winds blow westward and push warm surface water near Australia and New Guinea. When this warm water builds up in the western Pacific Ocean,

nutrient-rich cold waters are forced to rise up from the deeper ocean just off of the west coast of South America. This colder nutrient-rich water helps the growth of the fish population.

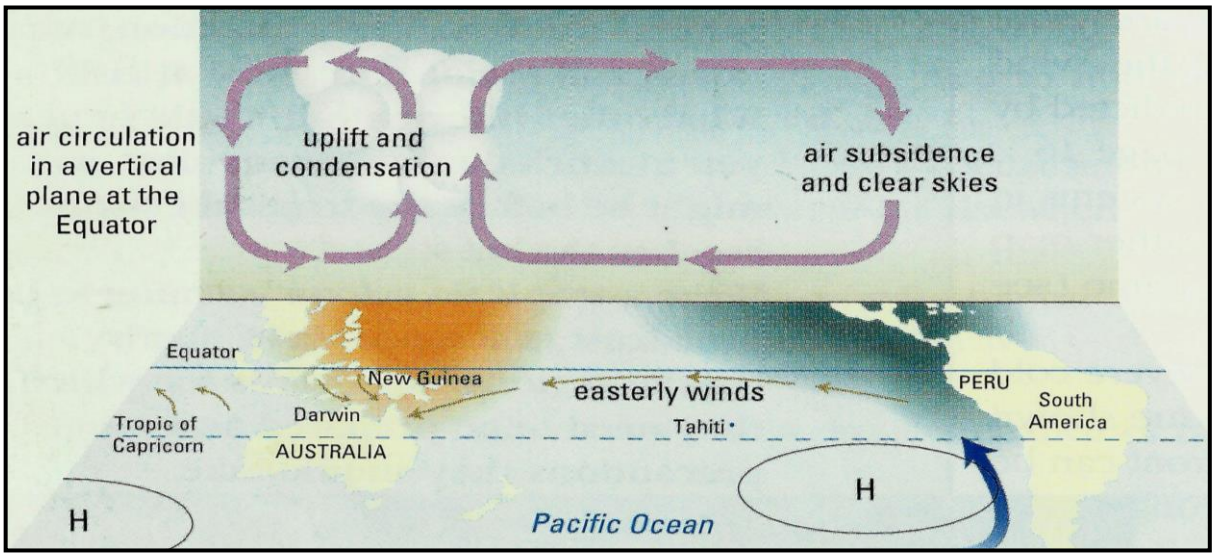


Illustration 10.2.3f: Atmospheric and ocean conditions in non-El Nino years

Now do Activity 2.

Activity 2

1. Differentiate between El Nino and La Nina.

_____

_____

_____

_____

2. What happens to the trade winds during El Nino?

_____

_____

Check your answers after the summary.

Effects of the 1997 El Nino

The El Nino events that began in 1982 and in 1997 were the most severe of the 20th century. Other occurrences began in 1972, 1976, 1987, 1991, and 1994. The global impacts of El Nino are far and wide. They include;

- drought in southern Africa, Ethiopia, northeast Brazil, eastern Australia, southern Philippines, and Central America.
- flooding is most likely to occur in northern Peru, southern Ecuador, southern Brazil, northern Argentina, Uruguay and many others.
- in India the **monsoon** becomes irregular, making food production less reliable.
- scientists have linked the 1997 El Nino to the severe dry conditions that withered crops and caused widespread forest fires in Indonesia and parts of Brazil.
- El Niño events can also disturb ecosystems and put many species at risk.
- temperatures too warm can cause migration of certain animals in search of cooler water and food.
- prolonged periods of varying surface currents and temperatures can cause disturbances to food chains, and eventually lead to habitat destruction and loss of **biodiversity**.

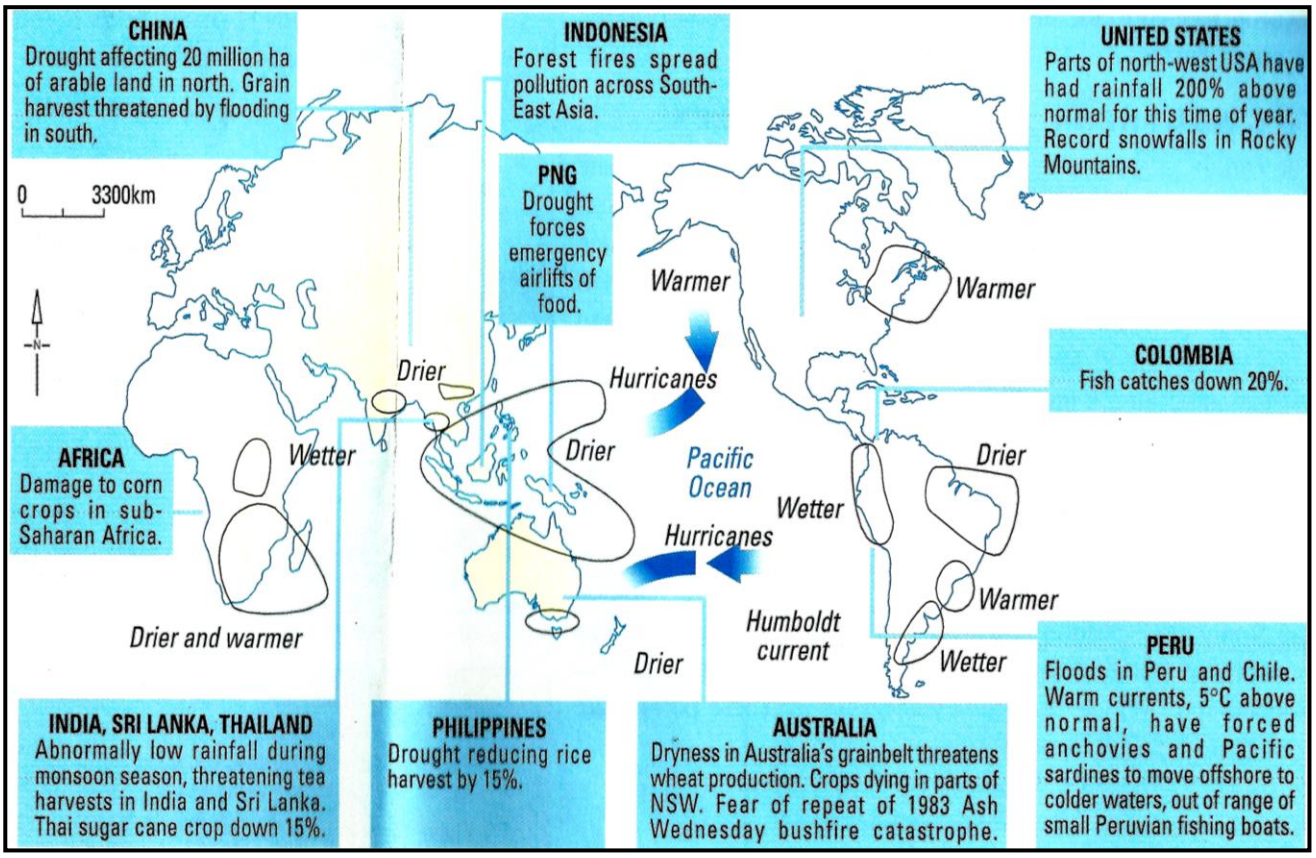


Illustration 10.2.3g: Effects of El Nino in 1997

Now read the summary.

Summary

You have come to the end of Lesson 3. In this Lesson, you have learnt that:

- El Nino is the occurrence of a warm ocean current along the coast of Ecuador and Peru.
- El Nino is caused by a weakening of the northwest trade winds that blows in an easterly direction.
- La Nina is the reversed, cold phase of El Nino and it brings dry conditions to the central coasts of South America.
- the effects of El Nino are warmer conditions in the west coast of South America and hot and dry conditions in the western Pacific.
- 1997 El Nino was the most severe and it had devastating effects beyond the borders of the Pacific Ocean.
- Normal condition exists when warm water builds up in the Western Pacific ocean, and nutrient cold rich waters rise from the deeper ocean off the coast of South America.
- The trade winds blow from east to west (Peru to Asia) bringing rain to South East Asia, PNG and northern parts of Australia.

Answers to Activity 1

1. Ecuador and Peru
2. PNG, Tahiti and Fiji
3. The flow of ocean currents is caused by prevailing wind systems that exists and blow from the high pressure zones of the earth towards the low pressure zones.

Answers to Activity 2

1. El Niño refers to an unusually warm ocean current along the coasts of Ecuador and Peru that causes climatic disturbances in varying strength. La Niña on the other hand is the opposite of El Niño. It is the cold phase of El Niño and it appears when surface ocean temperature in the eastern Pacific is abnormally cold.
2. Under El Nino conditions, the trade winds reverse direction, blowing from west to east (Asia towards Peru).

NOW DO PRACTICE EXERCISE 3 ON THE NEXT PAGE

Practice Exercise 3

Read your notes and answer questions.

1. What are the normal climatic conditions of South America around the coasts of Ecuador and Peru?

_____

_____

_____

_____

_____

2. How can El Nino affect the United States?

_____

_____

_____

_____

_____

3.

(a) How often does El Nino occur?

_____

_____

_____

_____

_____

(b) Which time of the year does El Nino affect China?

_____

4. What was the economic effect of the 1997 El Nino on Australia?

_____

_____

_____

_____

5. How did the 1997 El Nino affect China?

_____

_____

_____

CHECK YOUR ANSWERS AT THE END OF TOPIC 1

Lesson 4: Case Study: El Nino in Papua New Guinea

In the last lesson you learnt about El Nino and La Nina and why they occur. In this lesson, you will learn about Papua New Guinea's climate and El Nino in Papua New Guinea.

Your Aims:

- identify the location of Papua New Guinea
- identify and explain the climate of Papua New Guinea
- describe the climatic conditions for El Nino to occur in PNG
- describe the effects of El Nino in Papua New Guinea

Location of Papua New Guinea

Papua New Guinea is in the eastern part of the island of New Guinea, which is the second largest island in the world, after Greenland. It is in the south west Pacific and is a Melanesian country. Melanesia means dark or black. The other Melanesian countries are Fiji, Vanuatu, Solomon Islands and New Caledonia. The other regions of the south west Pacific islands and **atolls** are Micronesia and Polynesia. Micronesia means small islands and Polynesia means many islands.

The total land area of Papua New Guinea is 848,462 square kilometres. It is located between latitudes 2˚S and 12˚S, and longitudes 141˚E and 156˚E. It is in the Southern Hemisphere and is in the Eastern Time Zone.

Map 10.2.4a: Location of Papua New Guinea in the world

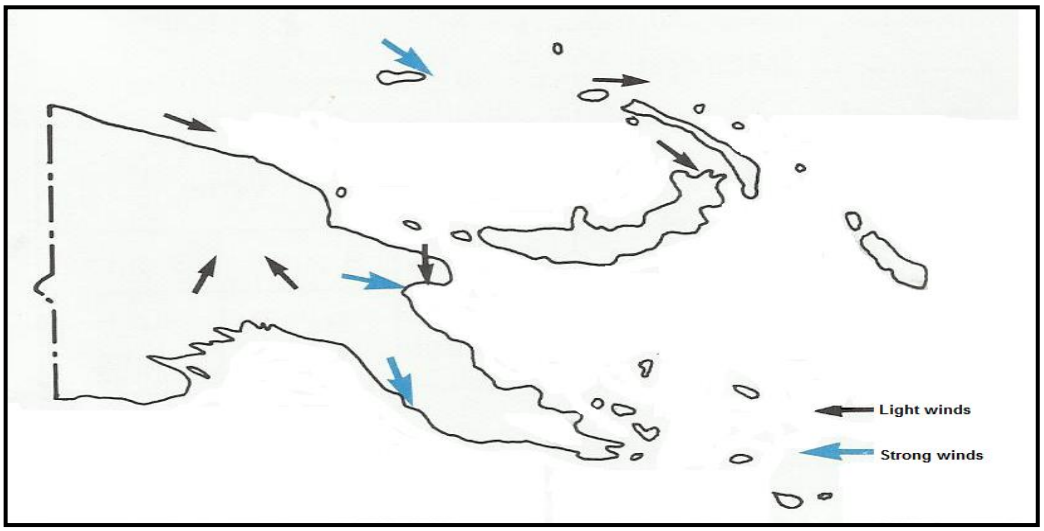
Papua New Guinea's climate

Climate refers to how wet, hot, dry, cold or cloudy it is on average in a place at a particular time. Papua New Guinea experiences a hot and wet climate because of its location along the equator. The average daily temperature is around 27°C. Rainfall is usually high in places of high altitude such as Kiunga or Tabubil, and quite low in places close to sea level, such as Port Moresby. This variation in rainfall is also an effect of the high mountain range that runs through the center of the country. Places in the **leeward** side of the mountain range experience a **rain-shadow** effect with very little rain.

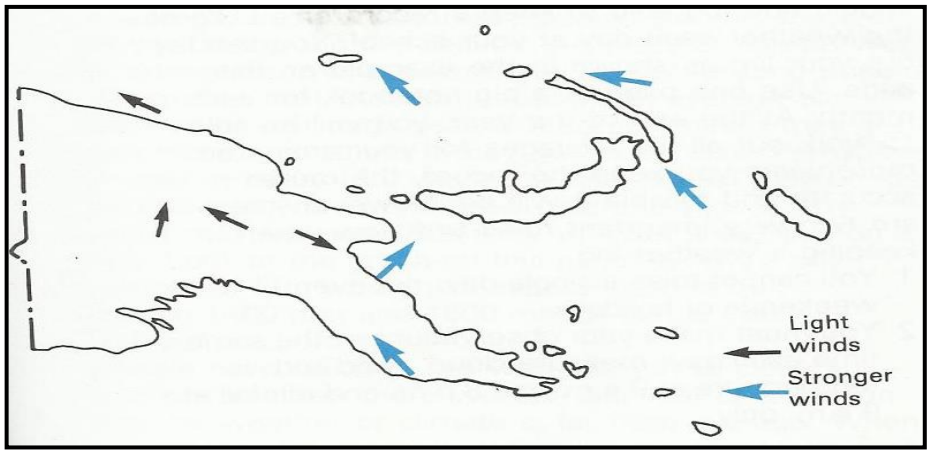
Rainfall patterns are affected by two major wind systems.

- South-east winds – occur between May and October. They are the strongest. They bring dry conditions to places like Port Moresby.
- North-west winds – usually occur between December and March. They are quite weak and bring wet conditions, which is usually the wet season.

In November and April, when the winds are changing position and direction, the air is usually very still. Because of the stillness of the air, it is usually very hot during these two months. Winds are very important because a change in season is usually indicated by a change in wind direction. Map illustrations 10.2.4b-c show wind systems in Papua New Guinea.



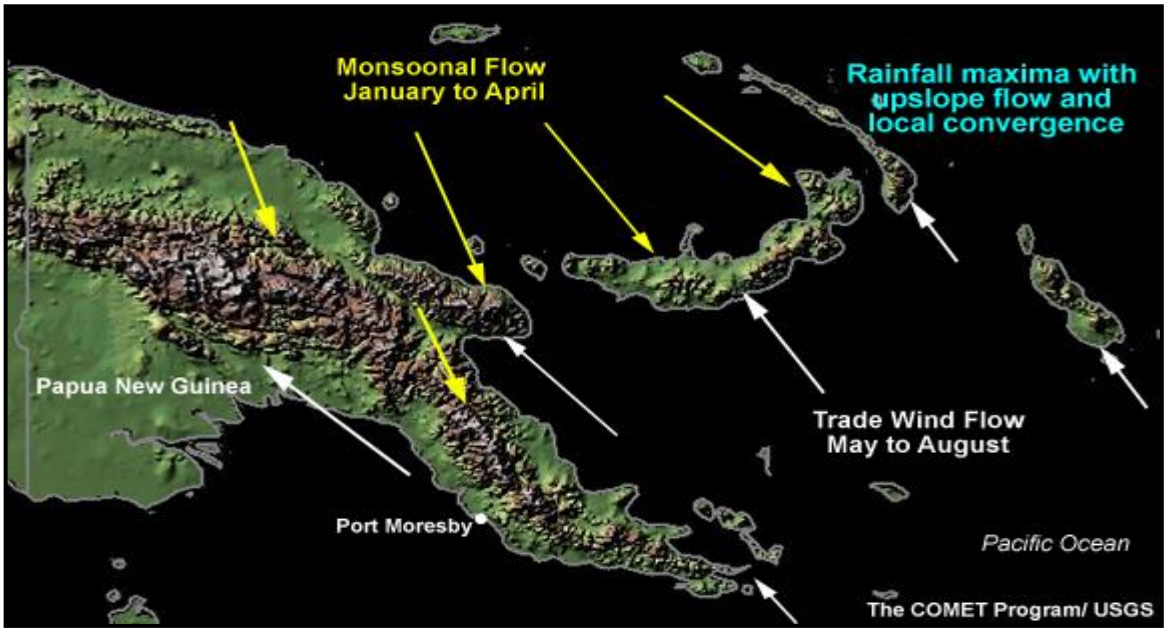
Map 10.2.4b: North-west winds in December to March



Map 10.2.4c: South-east winds from May to October

Source:
Exploring Geography through Papua New Guinea

Study the prevailing winds shown below in January and May every year in Papua New Guinea.



Map 10.2.3d: Prevailing wind patterns in Papua New Guinea

Now do Activity 1.

Activity 1

1. Briefly define these words: Melanesia, Micronesia, Polynesia.

_____

_____

_____

_____

2. Which is the second largest island in the world?

_____

_____

3. When do the south-easterly winds blow, and what do they bring with them?

_____

Check your answers after the summary.

Monsoon Winds

The word monsoon is used to describe winds which reverse their direction in different seasons. It is a seasonal change in the prevailing wind direction that brings a different kind of weather. It almost always refers to the Asian monsoon. The region where this is most common is South and East Asia, but it also occurs in Papua New Guinea, northern Australia, southern USA, and tropical areas of Africa. Illustrations 10.2.4d-e shows how the Asian monsoon affects our region. Papua New Guinea receives rain bearing winds from both the south-east and the north-west monsoonal winds.

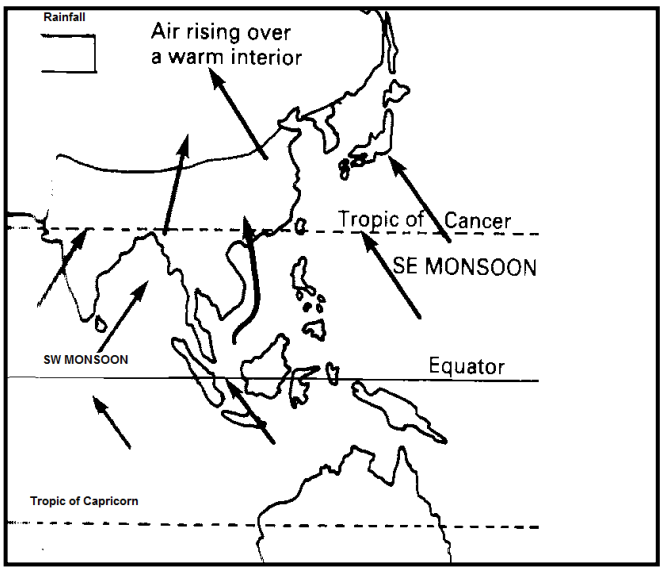


Illustration 10.2.4d: Dry Winter Monsoon May-October

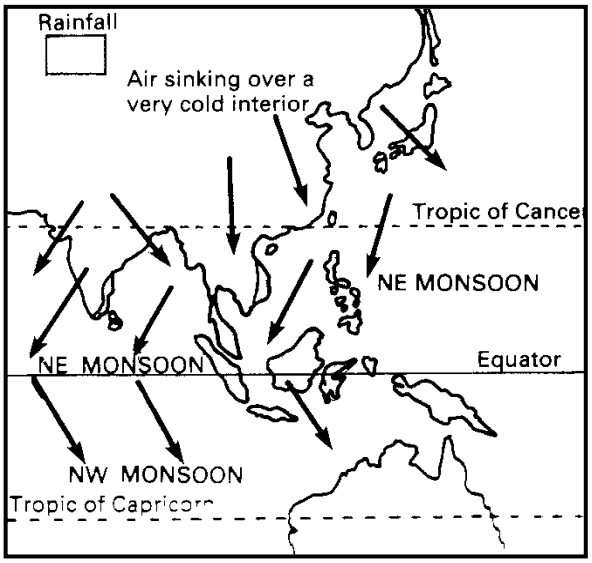


Illustration 10.2.4e: Wet Summer Monsoon November-April

Illustration 10.2.4d shows the Southeast Monsoon from May to October. This is a drier and cooler time when the winds that blow are affected by the "Southeast Trades" when they reach their most highest in the months of July and August. Rain throughout this period is usually low. Illustration 10.2.4e shows the Northwest Monsoon from December to March. This is the main rainy season and in December and January. This period is also warm with some winds that are mainly directed from the West to northwest.

Climatic conditions necessary for El Nino to occur

Scientists are yet to accurately identify the cause of this weather condition known as the El Nino. It is mostly expected to be found in the western Pacific in which Papua New Guinea is part of.

This occurrence is an effect of rising warm air over the equator and sinking cold air from the 30°N/S latitude in the atmosphere. The **Inter-Tropical Convergence Zone** (ITCZ) is known by sailors as the doldrums; it is the area encircling the earth near the equator where the northeast and southeast trade winds meet. Figure 10.2.4f, shows the Inter-tropical convergence zone in relation to the climatic pattern of El Nino.

When warm air meets cold air, over land and sea, it is also affected by the principles of “Land and Sea Breeze”. The land heats up faster and cools down faster than the sea, which heats up slowly and loses heat slowly. When there is a difference in local winds that operate on the surface, due to large land and sea surfaces it also affects the flow and movement of the atmospheric wind and pressure systems.

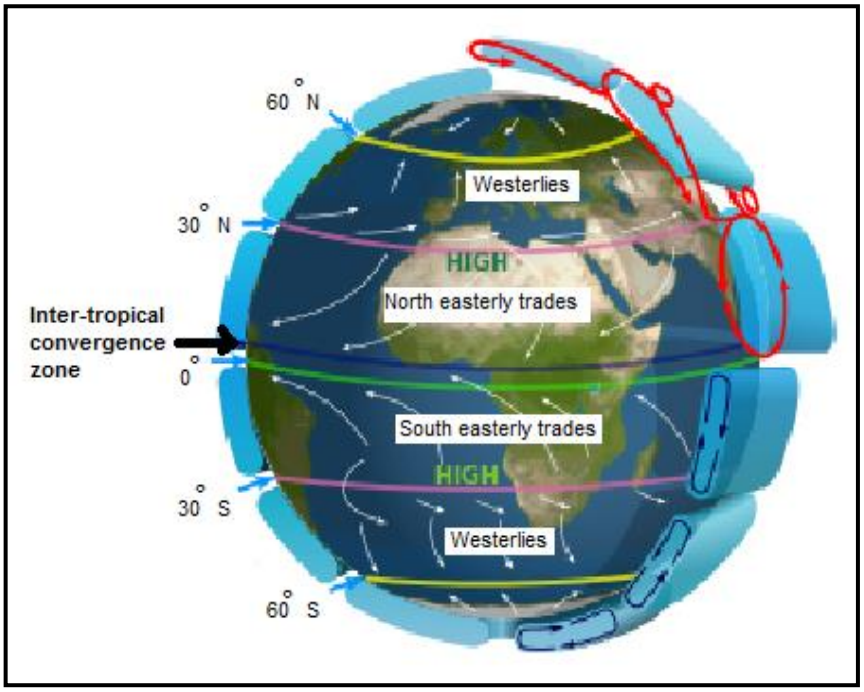


Illustration 10.2.4f: Inter-tropical Convergence Zone

It is along the equator and especially the western Pacific that this uneven heating and cooling takes place. The Pacific Ocean is so large that it takes a very long time for sea surface temperature to decrease. That is why when the seasons change from summer to autumn to winter in South America, the sea surface temperature is still high. This causes the pressure system to be weakened. When pressure is weak, the ocean current is reversed.
Surface winds or local winds; usually move from high pressure to low pressure areas. Therefore, the conditions necessary for El Nino to occur is that the waters around the tropical Pacific is much warmer than its usual surface temperature.

Now do Activity 2.

Activity 2

1. What is a monsoon?

_____

_____

2. Which parts of the world experience the monsoon climate?

_____

_____

Check your answers after the summary.

Effects of El Nino in Papua New Guinea

The major climatic and environmental effect of El Nino in Papua New Guinea is a prolonged period of dry season known as drought. A lengthy period of dry season, gives rise to other conditions such as:

- bush fires
- dust storms
- shortage of fresh water
- pollution of river systems
- spread of water borne diseases such as typhoid, cholera, diarrhoea
- widespread hunger and starvation
- increase in skin diseases such as tropical ulcers, scabies, grille, white spot, tinea, ringworm
- malnutrition in old people and younger children especially in rural areas
- the coral polyps that build and maintain the reef cannot survive in water much above 18˚F
- affects both aquatic and terrestrial flora and fauna and the natural balance of the ecosystem

The socio-economic effects of El Nino are particularly a reduction in the production and harvest of cash crops such as:

- cocoa
- coffee
- vanilla beans
- reduction in quantity of fruits and vegetables produced and sold at markets
- not enough available food for the entire population
- the government has to spend money to feed drought victims by providing relief supplies
- increase in crime and unemployment
- increase in number of deaths in the population
- affect economic activities of urban centers such Lae, Madang, Goroka, Port Moresby, that depend on Hydroelectricity.

El Nino has very devastating effects on people and the environment. It is important for **meteorologists** to provide accurate forecasting of El Nino so that relief strategies can be put in place by appropriate government agencies. Early warning systems can be established so that people are prepared for disasters.

Now read the summary.

Summary

You have come to the end of Lesson 4. In this Lesson, you have learnt that:

- Papua New Guinea is a Melanesian country located in the south-west Pacific.
- it has two wind systems which influences its rainfall pattern in January and July every year.
- Asian monsoon climate also affects Papua New Guinea's climate.
- Southeast Monsoon is from May to October and is dry and cool.
- Northwest Monsoon is from December to March which is the rainy season.
- land heats up faster and cools down faster than the sea, which heats up slowly and loses heat slowly.
- El Nino occurs as a result of an interchange between warm air and cold air along the inter-tropical convergence zone.
- ITCZ is known by sailors as the doldrums; it is the area near the equator where the northeast and southeast trade winds meet.
- Papua New Guinea experiences environmental as well as socio-economic effects of El Nino.

Answers to Activity 1

1. Melanesia means dark or black islands; Micronesia means small islands; and Polynesia means many islands.
2. The island of New Guinea, which is made up of Papua New Guinea and Irian Jaya (now West Papua)
3. South-easterly winds blow between May and October, and bring dry conditions to places like Port Moresby.

Answers to Activity 2

1. A monsoon describes winds which reverse their direction in different seasons. It is a seasonal shift in the prevailing wind direction that usually brings with it a different kind of weather.
2. It is a dominant climate system in south and East Asia. It is also experienced in north Australia, southern USA, and tropical parts of Africa.

NOW DO PRACTICE EXERCISE 4 ON THE NEXT PAGE

Practice Exercise 4

Read your notes and answer questions.

1. What is the latitude and longitude range of Papua New Guinea?

   Latitude _____ Longitude _____

2. How can you describe Papua New Guinea's climate?

   _____

   _____

   _____

3. Explain the principles of "Land and Sea Breeze?"

   _____

   _____

   _____

   _____

4. What are the conditions necessary for El Nino to occur in Papua New Guinea?

   _____

   _____

   _____

   _____

5. What are 3 social effects of El Nino in Papua New Guinea?

   _____

   _____

   _____

   _____

6. Make a list of the water borne and skin diseases you can get during the lengthy, dry spell of the El Nino.

   Water borne diseases

   _____

Skin diseases

_____

_____

_____

CHECK YOUR ANSWERS AT THE END OF TOPIC 1

Answers to Practice Exercises 1-4

Practice Exercise 1

1. Word definitions:
   i) The physical environment is made up of things that are found in nature which occur naturally. Features such as forests, mountains, rivers, oceans are all part of the physical environment.
   ii) The human environment is made up of man-made features such as buildings, roads, sports- fields, recreational parks, schools, airstrips.
   iii) Economic changes are those changes that bring about development to a place.
   iv) Social changes are associated with people's behaviour, attitude and mindset, and how they interact with one another.
   v) Natural occurrences that are catastrophic in nature and can cause damage to the environment and loss of human lives.
2. Archaeologists concentrate on studying the human historical remains of the past while palaeontologists concentrate on the study of fossils of past living organisms.
3. Plants and animals that were not able to adapt to change eventually died out and became extinct.
4. Here are 4 features of global warming: greenhouse effect, hole in the ozone layer, rising sea level, melting of ice. (Accept any other correct answer, for example, more drought and flodding, less ice and snow, extreme weather conditions)

Practice Exercise 2

1. It is the trapping of the sun's heat on the earth's surface by greenhouse gases, mainly carbon dioxide.
2. Global warming is an increase in the world's temperatures.
3. Increased levels of carbon dioxide in the atmosphere
4.
   - By escaping in a mining dig up or coal well
   - By animal manure in farms
   - From volcanic eruptions
   - From a landfill of rubbish
5.
   (a) More drought and flooding
   When the weather gets warmer, evaporation from both land and sea increases. This causes drought in areas of the world where there is increased evaporation and no rain, leading to crop failure and famine.

   (b) Less ice and snow
   Glaciers and Ice caps are melting rapidly.

   (c) More extreme weather incidents

The warmer climate will cause more heat waves, violent rainfall and an increase in the number and or severity of storms.

(d) Rising sea level
Sea level has risen because of melting ice and snow and the expansion of water when warm.

Practice Exercise 3

1. A lower sea surface temperature, high pressure and cold ocean currents with dry conditions.
2. By having increasing wind currents moving eastward over California and southern United States with floods and landslides.
3. (a) Every 3 to 7 years
   (b) December and January
4. Dryness in Australia's greenbelt threatened the wheat production. Crops dying in parts of New South Wales
5. Drought affected 20 million hectares of arable land in north China, and grain harvest was affected by flooding in south China.

Practice Exercise 4

1. Latitude: 2˚S and 12˚S Longitude: 141˚E and 156˚E.
2. Papua New Guinea is an equatorial country with a hot and wet climate. It has constant daily temperatures at 27˚c, with two seasonal wind systems, which are influenced by the monsoon climate.
3. The land heats up faster and cools down faster than the sea. The sea heats up slowly and cools down slowly.
4. An increase in the surface temperature of the south west Pacific ocean, and a decrease in the strength of the south-east trade winds that blow in a westerly direction, from the eastern Pacific to the western Pacific.
5. An increase in crime and unemployment rate and an increase in the total number of deaths in the population.
6. Water borne diseases: typhoid, cholera, diarrhea

   Skin diseases: tropical ulcers, scabies, grille, white spot, tinea, ringworm

TOPIC 2: THE WAYS IN WHICH PEOPLE CHANGE AND INFLUENCE THEIR ENVIRONMENT

In This Topic, You Will Learn About:

- **Over Population and Land Use**
- **Introduction of New Plants and Animals**
- **Endangered and Threatened Species**
- **Deforestation**

TOPIC 2: INTRODUCTION

Welcome to Topic 2. This topic is about the ways in which people change and influence their environment. In this topic you will discuss these themes.

- Overpopulation and Land Use
- Introduction of New Plants and Animals
- Endangered and Threatened Species
- Deforestation

Learning Outcomes:

- Students can identify describe and explain the causes and effects of environmental changes
- Students can apply knowledge and skills to preserve and promote a sustainable environment for a better living

Lesson 5 will be about overpopulation and how people use land.

In Lesson 6, you will define terminologies and discuss new species of plants and animals in Papua New Guinea. You will identify the advantages and disadvantages of the introduction of these new species of plants and animals.

Following on from Lesson 6, is Lesson 7 in which you will research and identify endangered and threatened species located here in Papua New Guinea and the Pacific.

In the last lesson you will define, discuss and identify deforestation and its impact on lives, development and changes.

Lesson 5: Overpopulation

In Lesson 4 you learnt about El Nino in Papua New Guinea as a case study. In this lesson, you will learn about overpopulation and its usage of land. You will also discuss the causes and effects of overpopulation.

Your Aims:

- define overpopulation and identify causes
- identify ways in which overpopulation uses up land and other resources
- discuss the effects of overpopulation on various resources

What is overpopulation?

Overpopulation is an undesirable condition where human population is more than what the Earth can sustain. Overpopulation is caused by a number of factors. Reduced mortality rate, better medical facilities, depletion of natural resources are a few. It is possible for a sparsely populated area to become densely populated if it is not able to sustain life.

It would be easy to think that an area of high population density is overpopulation. However the crowding together of people is not necessarily overpopulation. Example, the farmers of Belgium in Europe has a high population density of 400 people per square kilometres but enjoy a high standard of living. They are not considered to be overpopulated because of plentiful resources, high employment and a favourable farming environment. By contrast some areas of shifting cultivation in south east Asia with population densities of about five people per square kilometre are now considered overpopulated because their resources cannot support them.

An area is overpopulated when it cannot adequately support the number of people living in the area, without damaging the environment.

Overpopulation and land use

How does overpopulation affect land use?

The global community now faces a crisis in land use and agriculture that could undermine the health, security, and sustainability of our civilisation. While climate change has received enormous attention, human population growth, and the rising global demand for meat and dairy products, as well as the growing need for **bio-energy** from corn, sugarcane, and other sources should be equal cause for concern. We are putting a lot of pressure on the world's

resources. With millions of new birth per year, we will need to double, or triple, the agricultural production of the planet in the next 30 to 40 years.

The agricultural needs of a growing global population are difficult enough, but, at the same time, countries must meet growing food production needs. Already, we have cleared or converted more than 35 per cent of the earth's ice-free land surface for agriculture. In fact, the area used for agriculture is nearly 60 times larger than the area of all of the world's cities and suburbs. Many civilisations have collapsed in the past because they have destroyed their soils that feed the population.

Since the time of the **Bubonic Plague** in the 1400s, the growth of population has been on a constant increase. Between the time of the Plague and the 21st century, there has been hundreds and thousands of wars, natural disasters and man-made hazards. However, none of these reduced the population. When we talk about overpopulation, we should first understand the causes of it.

To feed all the people in the world, two problems will have to be solved:

- **problem of increasing food production,**
- **problem of improving the distribution of the world's food resources.**

Causes of overpopulation

1.1 Decline in the death rate

The basis of overpopulation is the difference between the overall birth rate and death rate in populations. If the number of children born each year equals the number of people that die, then the population will become stable. There are many factors that can increase the death rate for a short period of time. The discovery of agriculture by our ancestors was one factor that provided them with the ability to sustain their nutrition without hunting.

1.2 Better medical facilities and people's health

Advances in technology have affected people in many ways. One of these has been the ability to save lives and create better medical treatment for all. A direct result of this has been increased lifespan and the growth of the population. In the past 50 or so years, the growth of population has become so rapid and contributed to overpopulation.

The **Industrial Revolution** was the biggest reason why the balance between birth and death rates has been permanently disturbed. Science was able to come up with better ways of growing and producing food, which allowed families to feed more mouths. Medical science advanced and cured a whole range of diseases. Illnesses that had claimed thousands of lives in the past were cured because of the invention of vaccines. Increased food supply, increased industrialisation and advances in medicine provided the perfect platform for rapid population growth, leading to overpopulation in many places of the world.

1.3 Technology advancement in fertility treatment

With latest technological advancement and more discoveries in medical science, it has become possible for couples who are unable to conceive to undergo fertility treatment methods and have their own babies. Today there are effective medicines which can increase the chance of conception and lead to rise in birth rate. Moreover, due to modern techniques pregnancies today are far safer.

1.4 Immigration

Many people prefer to move to developed countries like US, UK, Canada and Australia where facilities are available in terms of medical, education, security and employment. The end result is that those places become crowded. It leads to more demand for food, clothes, energy and homes. This gives rise to shortage of resources. Though the overall population remains the same, it affects the population density which leads to overcrowding.

1.6 Lack of family planning

Most developing nations have large numbers of people who are illiterate, live below the poverty line and have little or no knowledge about family planning. Early marriages involving young people increase the chances of producing more children.

Now do Activity.

Activity

1. Define overpopulation.

_____

_____

_____

_____

_____

2. In one sentence, briefly summarise how overpopulation impacts on land use.

_____

_____

_____

3. How does the death rate not influence overpopulation? Explain briefly in one sentence.

_____

_____

_____

4. In which countries is the lack of family planning most common? _____

5. How do we keep up with the demands of a growing population?

_____

_____

_____

Check your answers after the summary.

Effects of overpopulation

Human population is growing like never before. We are now adding one billion people to the planet every 12 years. That is about 220,000 people per day. This causes the following problems.

- *Depletion of natural resources*

One effect of overpopulation is the depletion of natural resources. The earth can only produce a limited amount of water and food. Most of the environmental damage being seen in the last fifty years is because of the growing number of people on the planet. They are cutting down forests, hunting wildlife, causing pollution and creating a host of problems.

- *Food supplies*

About 500 million people are starving or ill-fed. One out of every seven people alive, go to bed hungry. Every day, almost 25,000 people die of malnutrition and hunger-related diseases. Food production and distribution could catch up if our population stopped growing and dropped to a level that we can put up with. Growing more crops and rearing more animals to satisfy the great demand for food is placing a great strain on the Earth.

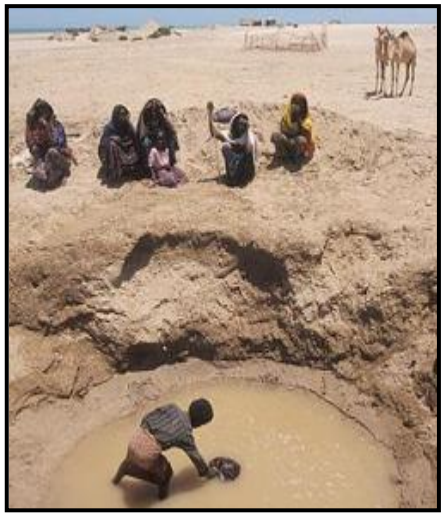


Illustration 10.2.5a: Woman collecting water from water well, North Africa.

- *Wild life*

As a result of the increasing population, all living things on this planet are threatened. As more space is needed for people there is less room for wildlife. As more land is needed for farms there is less room for wilderness. Soon the increase in the world's human population will greatly reduce our wildlife. More forests are cut down for housing and as a result wildlife is threatened and many species have decreased in numbers. The increase in human

population has also increased the destruction of natural habitats of many species. People are invading the habitats of those species, replacing them with unfamiliar and sometimes hostile environments and forcing the native species into extinction.

- *Water Supplies*

Agriculture puts pressure on lands, but also on water systems. Here are some facts about water shortages due to overpopulation.

i) People will have less water as the population grows

ii) About 1.8 million people suffer from water related diseases

iii) A growing population will lead to a higher demand for water, leading to water shortages

iv) Some areas have new high-tech electrical pumping techniques that drain water more quickly

As a result, many large rivers have greatly reduced flows and some normally dry up. And the extraction of water from deep groundwater reserves is almost generally unsustainable, and has resulted in rapidly declining water tables in many regions of the world. About one billion people lack access to sufficient water for consumption, agriculture and sanitation. **Aquifers** are being depleted faster than they can be replenished. Melting glaciers threaten the water supply for billions of people.

2.2 Degradation of environment

The overuse of coal, oil and natural gas has started producing some serious effects on our environment. The rise in the number of vehicles and industries has badly affected the quality of air. The rise in the amount of carbon dioxide **emissions** leads to global warming. Melting of polar ice caps, changing climate patterns and rise in sea level. (Refer to Lesson 2 for more details).

- *Pollution*

A growing population means that more waste will be produced, including sewerage and these wastes will contribute to air pollution, land and water pollution. Current agricultural practices also create pollution. The use of industrial fertilisers and other chemicals has upset the chemistry of the entire planet. Already, the use of fertilisers has more than doubled the flows of nitrogen and phosphorus compounds in the environment, resulting in widespread water pollution and the massive degradation of lakes and rivers. Excess nutrient pollution is now so widespread, it is even contributing to the disruption of coastal oceans and fishing grounds by creating “dead zones”. Another form of pollution results from current agricultural and land use practices is carbon dioxide emissions.

Illustration 10.2.5b: Pollution from factory

Current practices, including clearing forests for agricultural land, contribute 30 percent of the currently unsustainable carbon dioxide emission levels. Air quality is another major problem.

2.3 Conflicts and wars

Overpopulation in developing countries puts a major strain on the resources. Conflicts over water are becoming a source of tension between countries, which could result in wars. It

causes more diseases to spread easily. Starvation is a huge issue facing the world and the mortality rate for children. All of this will only become worse if solutions are not found. We can no longer prevent it, but there are ways to control it.

2.4 Rise in unemployment

When a country becomes overpopulated, it gives rise to unemployment as there a fewer jobs to support a large number of people. Rise in unemployment gives rise to crime.

A good education is vital if people are to earn a good wage and enjoy a higher standard of living. Over a third of those old enough to work have no job or only work part-time because there is no full-time work available.

2.5 High cost of living

The prices of various supplies including food, shelter and healthcare will increase due to the demand and supply of overpopulation. This means that people have to pay more to survive and feed their families.

Solutions to overpopulation

- *Better education*

One of the first measures is to educate the masses to undertake family planning. Families that are facing a hard life and choose to have four or five children should be discouraged. Family planning and efficient birth control can help women make their own reproductive choices. Open dialogue on abortion and voluntary sterilisation should be encouraged.

- *Tax benefits or concessions*

Tax benefits should be awarded to those couples who have two or less children. This is one way of encouraging family planning.

- *Knowledge of sex education*

Imparting sex education to young teenagers at secondary school level should be a must. Most parents feel shy in discussing such things with their children which result in their children going out and looking for such information on internet or from their peers. Mostly, the information is incomplete which results in sexually active teenagers experimenting with sex at an early age or before getting married.

If you are young and do not have any children, consider not having children at all. If you feel compelled to have children, only have one or two at the maximum and no more. Or consider adopting a child. There are plenty of children that need good, loving homes. This is the best, long-

Now read the summary.

Summary

You have come to the end of Lesson 5. In this lesson, you have learnt that:

- overpopulation is an undesirable condition where the number of existing human population exceeds the carrying capacity of Earth.
- overpopulation is caused by a number of factors and has many effects.
- an area is overpopulated when it cannot adequately support the number of people living in the area, without damaging the environment.
- to feed all the people, two problems will have to be solved- the problem of increasing food production and the problem of improving the distribution of the world's food resources.
- children in the poorer, developing world countries are about five times more likely to die of illness at birth than those in the industrial world.
- the global community faces a crisis in land use and agriculture that could undermine the health, security, and sustainability of our civilisation.
- the accelerated growth of the human populations has increased the destruction of natural habitats of many species.
- about one billion people lack access to sufficient water for consumption, agriculture and sanitation.
- a growing population means that more waste will be produced, including sewerage and these wastes will contribute to air, land and water pollution.
- there are solutions to overpopulation which should have already been applied to both developing and developed countries.

Answers to Activity

1. Overpopulation is a condition where the number of existing human population exceeds the carrying capacity of Earth.
2. Overpopulation would put a lot of pressure to clear more land for agriculture.
3. The number of children born each year is more than the number of people that die.
4. Developing countries
5. By doubling, or tripling the agricultural production on the planet in the next 30 or 40 years.

NOW DO PRACTICE EXERCISE 5 ON THE NEXT PAGE

Practice Exercise 5

Read your notes and answer questions.

1. When is a place considered to be overpopulated?

_____

_____

2. What two problems will have to be solved in order to feed world population?

_____

_____

3. Why have many civilisations collapsed in the past?

_____

_____

4. How will the increase in population affect wild life?

_____

_____

5. How did better medical services improve people's health and increased population?

_____

_____

6. According to the notes, what are the 5 main effects of overpopulation?

_____

_____

7. Briefly explain how conflicts and wars are an effect of overpopulation.

_____

_____

_____

CHECK YOUR ANSWERS AT THE END OF THE TOPIC 1

Lesson 6: Introduction of New Plants and Animals

In Lesson 5, you learnt about overpopulation and land use, and the effects of overpopulation. In this lesson you will study the effects of introduced plants and animals in the environment. You also will classify plants and animals in their scientific groups.

Your Aims:

- identify some new plants and animals that were introduced to PNG.
- identify how some species of plants and animals were introduced to an area
- discuss why introduced species of plants and animals are successful when introduced
- explain how introduced plants and animals affect native species and the environment

Introduced plants and animals in Papua New Guinea

Many of the food plants and animals we have today have been introduced to Papua New Guinea from overseas. For example, sweet potato originated in South America, and the yam in Asia. Chicken arrived in Papua New Guinea from south-east Asia about 5000 years ago. As far as we can tell, none of these introductions has had a serious effect on the ecosystems of our country, although they have certainly improved the diet of our people. However, some introduced animals and plants have become pests and have a disastrous effect on an ecosystem.

See below pictures of foods introduced to Papua New Guinea from South America.

Illustration 10.2.6a: Sweet potatoes came from South America.

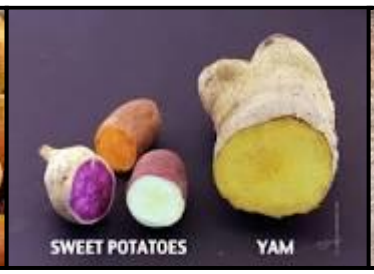


Illustration 10.2.6b: Sweet potatoes and yam are introduced food crops

Illustration 10.2.6c: Poultry, mainly roosters and hen are introduced

Introduced species in an area

An introduced species is one that invades an area where it was not historically present and where it has not evolved. Most often, humans help these species cross barriers such as mountains and oceans that had previously stopped the species' movement. For instance, the many plants and animals that humans brought from Europe to North America allowed these species to cross a major barrier, the Atlantic Ocean. Everywhere when humans settle they bring along familiar animals and plants. As a result, a few tough species are enjoying world-wide distributions while the local native species disappear. Some of these introduced tough species in PNG are Salvinia, hyacinth, cane toad, snails and carp fish among others.

See below some pictures of these introduced species in Papua New Guinea.

Illustration 10.2.6d: Cane toad

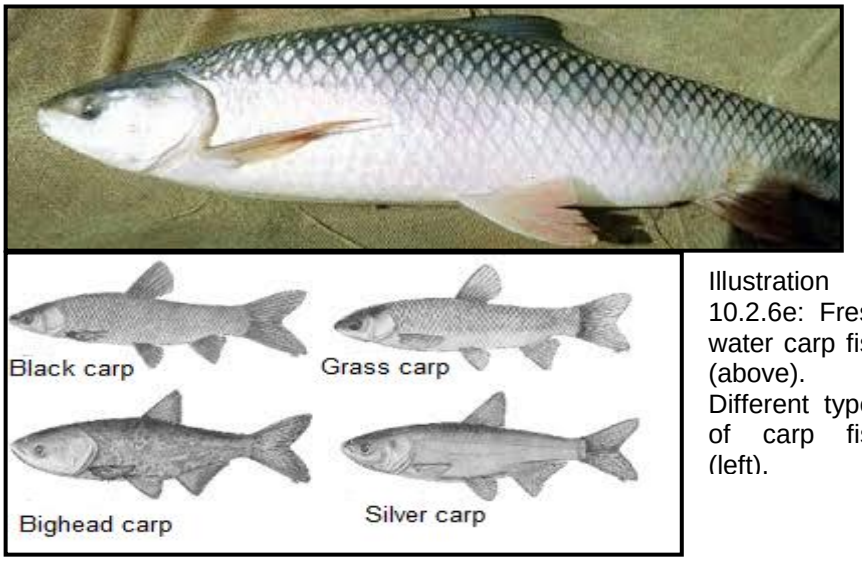


Illustration 10.2.6e: Fresh water carp fish (above). Different types of carp fish (left).

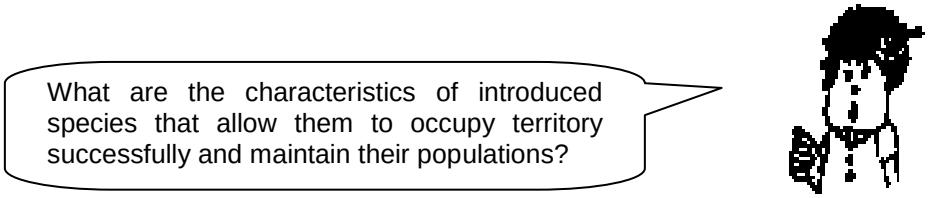
Why are species introduced at the first place?

Species can be introduced for a variety of reasons. One of these is to improve the appearance of the surrounding environment. It can be a plant, a type of grass or an animal of some sort. Some are introduced as a food source. Common carp are a good example of this.

Another reason is that species are introduced for recreation. This has been most commonly done with fish, mammals, and birds that are introduced as game species. In many cases, these introductions are beneficial to people because they provide opportunities for fishing and hunting. However, these species may end up doing harm because they threaten the existence of popular native species.

Some are introduced to control another species. This technique is used when a species, often an introduced plant or small animal species, becomes so plentiful that it creates problems. To control the spread of the pest species, another species that is known to consume the pest is introduced. In the past, control species have become pests as well.

Successful species



To successfully live in an area, an introduced species must be able to accept the physical conditions (such as temperature and moisture) in the area. A characteristic of many introduced species is the ability to endure a wide range of physical conditions. They lack natural enemies or pests in the new ecosystem. The ability to survive on different kinds of foods is another important characteristic of many introduced species. This ability allows the introduced species to find food in areas that have different types and arrangements of food than found in their native ranges. Successful introduced species often reproduce and spread their offspring rapidly. The ability to compete well with similar species is another important characteristic.

These plant-specific characteristics can include invasive plants' ability to:

- produce abundant, easily dispersed seeds that can withstand adverse conditions.
- reproduce through multiple pathways: roots, stems, and seeds.
- release chemicals that inhibit the growth of surrounding native plants.

Effect on native species and environment

When is a species invasive?

A species is invasive when it is both non-native to the ecosystem in which it is found and capable of causing environmental, economic, and human harm. Invasive species often compete so successfully in new ecosystems that they displace native species and disrupt important ecosystem processes. Plants, fish, insects, mammals, birds, all can be invasive. In many cases these introduced species become pests because they alter habitats and or become harmful competitors or predators on native species. They may also bring with them diseases and parasites that threaten humans and other species.

When does a species seen as a pest or feral plant or animal?

A pest is any living thing that causes damage to the environment in which it lives. English rye grass, for example, may be a pest to the Australian wheat farmer, but to the cattle farmer it is highly valued as stock food. Kangaroos and emus may be seen by conservationists as a valuable part of Australia's environment, but to the grazier they may be a pest that damages stock pasture and fencing.

Illustration 10.2.6f: Type of rye grass,

In Papua New Guinea, many plants and animals that have been introduced from other countries are now considered pests. They are called exotic species, and because most have only been in PNG for less than 200 years, they often do not live in harmony with the natural environment. Other introduced species have spread from houses and gardens into the wild. These are called feral plants or animals.

Impact of animal and plant pests

As there are so many different types of pests, they can produce a wide range of hazardous effects. Pests can carry fatal diseases, resulting in major epidemics (that is, diseases affecting a large number of people in a community at the same time). Pests can cause serious damage to crops and livestock. For example, introduced water plants, such as mimosa and water hyacinth, **clog** up rivers and lakes, and destroy native vegetation. Once plants are destroyed, the habitats of native animals and birds are also lost. Invasive species can negatively impact ecosystems in a variety of ways. They can:

- displace native species
- reduce native wildlife habitat
- reduce forest health and productivity
- alter ecosystem processes
- degrade recreation areas

Figure 10.2.6g: Mimosa plant

What are exotic plants?

The term exotic plants is often used to describe plant species that have been, or are being, introduced into parts of the world by humans often as ornamental plants. The illustrations below show salvinia molesta, an exotic plant introduced to PNG with severe results.

Illustration 10.2.6h: Boats hindered by salvinia molesta in the backwaters of the Sepik River, Papua New Guinea.

Case study- Salvinia molesta in Papua New Guinea

Salvinia molesui is a floating fern that originally came from South America. It is able to spread very rapidly, doubling its size every ten days in tropical conditions. Salvinia was first reported in the Sepik River system in 1977. No-one is sure how Salvinia got into the Sepik River, but it is believed to have been brought to Papua New Guinea to grow in fish tanks. It is likely that one of these tanks was emptied into the Sepik River by someone who was not aware of how rapidly the plant would spread. In Papua New Guinea there are no natural predators that feed on the plant so Salvinia was able to grow unchecked. The main effect of Salvinia was on the people who lived around the Sepik River, downstream. Much of the Sepik flood plain is swampy and the main form of transport is by canoe. The weed grew so thick that in many places it blocked the waterways and lakes, making it almost impossible

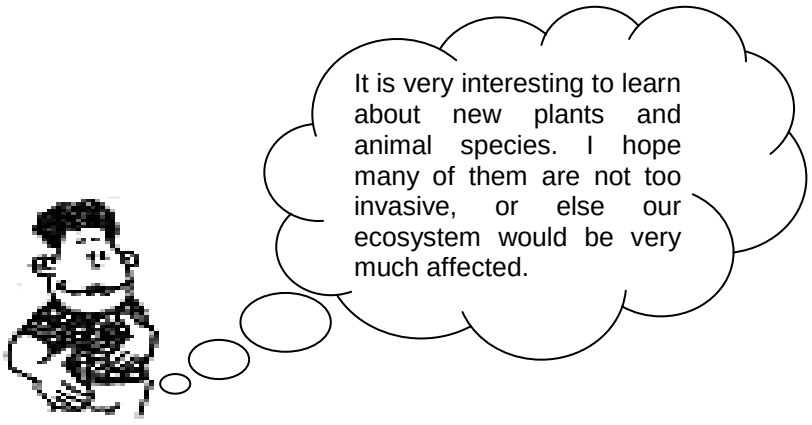
to reach gardens, traditional crocodile-hunting area and the place where the sago palm grew. People also found it difficult to travel to the local markets to sell fish, crocodile skin and traditional artefacts.

After many attempts to get rid of the pest, scientists finally, after visiting South America, the natural home of Salvinia scientist discovered a water beetle that fed on the Salvinia plants. By eating the new bud, the beetle caused the Salvinia to die and sink to the bottom of the lakes. The beetle was brought to Papua New Guinea and released into one of the infested lakes in 1982. Over the next two years, nearly 1 million beetles were distributed by hand to another 130 lagoons and lake. By June 1985, the beetle had reduced the Salvinia to less than 1 per cent of its original area, destroying 250 km or 2 million tonnes of the weed.

Now, read the story about the water hyacinth in Papua New Guinea.

The water hyacinth was first reported at Bulolo, in the Morobe Province, in 1962. Since then, it has been observed growing in lakes in Morobe, Madang, West and East Sepik and Central Provinces.
The water hyacinth is an aquatic plant that was introduced for its beautiful flowers and can grow up to 1 metre tall; and can produce one new plant every 2 to 3 days.

Its thickness makes it difficult for outboard motors to go through it. This plant has very attractive pale purple flower and often kept in ponds as an ornamental plant. However, anyone caught growing water hyacinth can now be prosecuted because it has been declared a harmful weed and should be destroyed to prevent another environmental disaster.



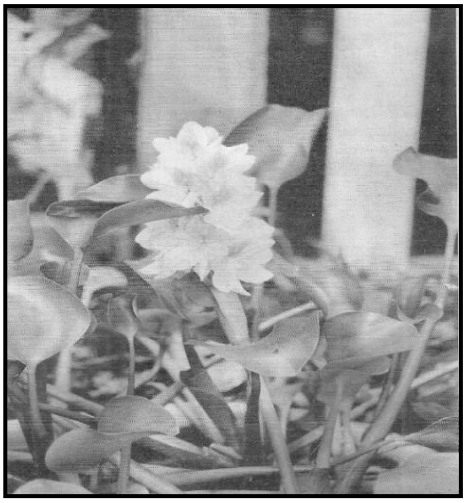


Illustration 10.2.6i: Water hyacinth

Now do Activity.

Activity

1. How is a species invasive?

_____

_____

_____

_____

_____

2. What is the negative effect of invasive species?

_____

_____

_____

3. What are *feral* plants and animals?

_____

_____

_____

_____

4. What does the term exotic plant refers to?

_____

_____

_____

Check your answers after the summary.

Now read the summary.

Summary

You have come to the end of Lesson 6. In this lesson, you have learnt that:

- an introduced species is one that invades, an area where it was not historically present and where it has not evolved.
- a species is invasive when it is both non-native to the ecosystem in which it is found and capable of causing environmental, economic, and human harm.
- introduced species become pests because they alter habitats and or become harmful competitors or predators on native species.
- a pest is any living thing that causes damage to the environment in which it lives in.
- species can be introduced for many reasons.
- to successfully live in an area, an invader species must be able to tolerate the range of physical conditions, that is, temperature and moisture in the area.
- exotic plants is a phrase often used to describe plant species that have been, or are being, introduced into parts of the world by humans often as ornamental plants. Figure 1 shows

Answers to Activity

1. A species is invasive when it is both non-native to the ecosystem in which it is found and causes environmental, economic, and human harm.
2. Invasive species often compete successfully in new ecosystems that they displace native species and disrupt important ecosystem processes.
3. Feral plants and animals are introduced species that have spread from houses, gardens and farms into the wild.
4. It describes plant species that have been, or are being, introduced into parts of the world by humans often as ornamental plants.

NOW DO PRACTICE EXERCISE 6 ON THE NEXT PAGE

Practice Exercise 6

Read the lesson notes and answer questions.

1. How do humans help the spread of plants and animals species?

_____

_____

_____

_____

_____

2. List three survival characteristics of introduced new plants and animal's species.

_____

_____

_____

_____

_____

3. Write a paragraph on the effect of pests.

_____

_____

_____

_____

_____

4. How was Salvinia removed from the Sepik River?

_____

_____

_____

_____

_____

5. Why are species introduced in the first place?

_____

_____

_____

_____

CHECK YOUR ANSWERS AT THE END OF TOPIC 1

Lesson 7: Endangered and Threatened Species

In the last lesson you learnt about introduced species of new plants and animals. In this lesson, you will learn about endangered and threatened plant and animal species.

Your Aims:

- define endangered species, threatened species, flora and fauna, and extinction.
- identify plants and animals that are at risk of becoming endangered and extinct.
- describe causes that lead to species becoming endangered.
- identify possible solutions to save endangered species.

Definitions

Extinction: Dying out of a group of plants or animals because they cannot get used to a changing or new environment.

Endangered species: Plants and animals that are in danger of extinction.

Threatened species: Species that are at risk of becoming extinct due to too much human activities on the natural environment

Flora and Fauna: Flora refers to any member of the plant species like mosses, liverworts, ferns, woody plants, bushes, vines, trees, and various other plant forms.

Fauna refers to all forms of animal life that gets energy by eating food. Animals are the most diverse forms of life on earth. They come from tiny microscopic organisms such as bacteria to very gigantic elephants. They live in a vast variety of habitats, from deserts and arctic tundra to the deep sea-floor.
Animals are the only living things that have evolved nervous systems and senses to monitor their surroundings.

Extinction threatens individual species as well as species that are members of the same family, order or class. The dodo, for example, a species of pigeon that do not fly, once lived on the island of Mauritius but has become extinct in 1665. About 10,000 years ago, most of the woolly mammoths and the last of the mastodons, both members of the elephant family became extinct. And about 245 million years ago at the end of the Paleozoic Era, an entire class of primitive marine animals called trilobites disappeared forever. Fossil remains of

prehistoric plants and animals buried and preserved in rocks or trapped on other deposits of ancient organic matter provide a record of the history of life on earth.

See pictures below of these animals which are already extinct thousands of years ago.

Illustration 10.2.7a (*left to right*): Dodo, woolly mammoths, mastodon and trilobite.

Paleontologists have learned that extinction is natural and ongoing. Extinction happens as a result of competition between species which is known as natural selection. This means that living things must compete for food and space. It is known as survival of the fittest. Species that are strong can adapt to their habitat and survive. They must have the ability to deal with predators and diseases and with unpredictable changes in their environment. Those species that are not able to adapt face **imminent** extinction. The term imminent refers to something that is about to happen. A predator is an animal or plant that kills other animals or plants (for food).

Now do Activity 1.

Activity 1

1. What are microscopic organisms?

   _____

2. What is natural selection?

   _____

   _____

   _____

Check your answers after the summary.

World endangered animals

The world is filled with a range of extraordinary animals. Thousands have not yet been identified. Most become extinct before they are even identified. These animals are endangered for many reasons such as

- over hunting for food, medicine, *bilas* for traditional sing-sings, magic,
- population increase,

- logging,
- mining,
- roads,
- agriculture,
- introduction of new plants and animals, in which some become predators,
- massive shift in the climate such as rising surface temperatures, melting of the polar ice caps, and
- volcanic eruptions.

Below in the box is the explanation of terms you will find in Tables 7.2a-e. Each terminology is represented by two letters in upper case, for example, *extinct* is represented by (EX) in parenthesis or ( ).

- **Extinct (EX): No reasonable doubt that the last individual of the species has died.**
- **Extinct in the Wild (EW): Species only survives in cultivation, captivity, or as a naturalized population well outside of its native range.**
- **Critically Endangered (CR): Species faces extremely high risk of extinction in the wild in the immediate future.**
- **Endangered (EN): Species faces very high risk of extinction in the wild in the near future.**
- **Vulnerable (VU): Species faces high risk of extinction in the wild in the medium-term future.**
- **Lower Risk (LR): Species does not satisfy criteria for above categories, but may be near threatened or dependent on conservation activities for survival**

Table 7.2 provides information on selected endangered animals around the world; where they are found and their status, and the reasons why they are at risk of becoming extinct.

Table 7.2a, Mammals

Species	Status	Range	Reasons for decline
Ass, African wild (Equus africanus)	*CR*	*Somalia, Sudan, Ethiopia*	*Habitat destruction, poaching, interbreeding with domestic donkeys*
Bat, Indiana (Myotis sodalis)	*EN*	*Eastern and mid-western U.S.*	*Habitat destruction (commercialization of caves)*
Cheetah (Acinonyx jubatus)	*VU*	*Africa to India*	*Habitat destruction, fur trade*
Dugong (Dugong dugon)	*VU*	*Western Pacific, Indian Ocean*	*Hunting (for food and hide)*
Elephant, Asian (Elephas maximus)	*EN*	*South central and southeast Asia*	*Habitat destruction (agricultural development)*
Ferret, Black-footed (Mustela nigripes)	*EW*	*Known only in captivity*	*Poisoning of food source*
Gazelle, Mountain (Gazella	*VU*	*Arabian peninsula, Egypt,*	*Poaching, habitat destruction*

gazella)		*Israel, Syria, Jordan*	
Gibbon, Silvery (Hylobates moloch)	*CR*	*Indonesia*	*Habitat destruction*
Gorilla (Gorilla gorilla)	*EN*	*Central and western Africa*	*Habitat destruction, poaching*
Leopard, Snow (Uncia uncia)	*EN*	*Central Asia*	*Fur trade*
Lion, Asiatic (Panthera leo persica)	*CR*	*India*	*Habitat destruction, overhunting for sport*
Mouse, Saltmarsh harvest (Reithrodontomys raviventris)	*VU*	*California*	*Drainage and filling of salt marshes*
Orangutan (Pongo pygmaeus)	*EN*	*Borneo, Sumatra*	*Habitat destruction, over-collection of young for zoos*
Panda, Giant (Ailuropoda melanoleuca)	*EN*	*China*	*Habitat destruction*
Prairie Dog, Utah (Cynomys parvidens)	*LR*	*Western U.S.*	*Habitat destruction, poisoning*
Rhinoceros, Black (Diceros bicornis)	*CR*	*South of Sahara in Africa*	*Habitat destruction, poaching for horn*
Tiger (Panthera tigris)	*EN*	*Temperate and tropical Asia*	*Habitat destruction, hunting for sport*
Whale, Blue (Balaenoptera musculus)	*EN*	*Oceans*	*Commercial hunting*
Whale, Fin (Balaenoptera physalus)	*EN*	*Oceans*	*Commercial hunting*
Wolf, Red (Canis rufus)	*CR*	*Southeastern U.S. to central Texas*	*Habitat destruction, hunting, trapping, and poisoning*

Table 7.2b, Birds

Species	Status	Range	Reasons for Decline
Akepa (Loxops coccineus)	*EN*	*Hawaiian Islands*	*Habitat destruction, infection from disease-carrying prey*
Amazon, Imperial (Amazona imperialis*)*	*EN*	*West Indies, Dominica*	*Habitat destruction, illegal collection for pet market*
Amazon, Puerto Rican (Amazona vittata)	*CR*	*Puerto Rico*	*Habitat destruction, predators, nest destruction by rats*
Condor, California (Gymnogyps californianus)	*CR*	*California*	*Habitat destruction, loss of food source, low reproductive rates*
Crane,Whooping (Grus americana)	*EN*	*Central U.S., Canada*	*Habitat destruction, low reproductive rates*
Macaw, indigo (Anodorhynchus leari)	*CR*	*Brazil*	*Habitat destruction, collection for pet market*
Parrot, orange-bellied (Neophema chrysogaster)	*CR*	*Australia*	*Collection for pet market*
Scrub-bird, noisy (Atrichornis clamosus)	*VU*	*Australia*	*Habitat destruction, introduction of predators (cats), drought*
Warbler, Kirtland's (Dendroica kirtlandii)	*VU*	*U.S., Canada, West Indies, The Bahamas*	*Habitat destruction (for fire control)*
Woodpecker, red-cockaded (Picoides borealis)	*VU*	*South central and southeastern U.S.*	*Nesting habitat destruction (logging)*

Table 7.2c, Invertebrates

Species	Status	Range	Reasons for Decline
Amphipod, Hay's spring (Stygobromus hayi)	*EN*	*District of Columbia*	*Very limited distribution*
Isopod, Madison cave (Antrolana lira)	*VU*	*Virginia*	*Water pollution, human traffic in cave*
Mussel, Ring pink (Obovaria retusa)	*CR*	*Kentucky, Tennessee*	*Habitat alteration-damming, water pollution, dredging*
Peacock, Luzon (Papilio chikae)	*EN*	*Philippines*	*Over-collection*
Pearlshell, Louisiana (Margaritifera hembeli)	*CR*	*Louisiana*	*Dam construction, water diversion, polluted runoff*
Shrimp, Alabama cave (Palaemonias alabamae)	*EN*	*Alabama*	*Habitat destruction*
Swallowtail, Corsican (Papilio hospiton)	*EN*	*Corsica (France), Sardinia (Italy)*	*Habitat destruction*
Tiger beetle, Columbia River (Cicindela columbica)	*VU*	*Idaho*	*Habitat destruction (dam construction)*

Table 7.2d, Reptiles and Amphibians

Species	Status	Range	Reasons for Decline
Crocodile, American (Crocodylus acutus)	*VU*	*Florida, Mexico, Central and South America, Caribbean Islands*	*Killing for hides, habitat destruction*
Komodo Dragon (Varanus komodoensis)	*VU*	*Indonesia*	*Competition for food supply*
Lizard, Hierro giant (Gallotia simonyi)	*CR*	*Hierro Island (Spain)*	*Introduced predators (cats and dogs)*
Olm (Proteus anguinus)	*VU*	*Bosnia and Herzegovina, Croatia, France, Italy, Slovenia*	*Over-collection, water pollution*
Platanna, Cape (Xenopus gilli)	*EN*	*South Africa*	*Precise habitat preferences, hybridization*
Salamander, Texas blind (Eurycea rathbuni)	*VU*	*Texas*	*Habitat destruction (drainage of wetlands)*
Toad, Houston (Bufo houstonensis)	*EN*	*Texas*	*Habitat destruction, drought*
Turtle, Kemp's Ridley sea (Lepidochelys kempii)	*CR*	*Tropical and temperate Atlantic ocean*	*Overhunting for leather, over-collection of eggs for food*
Turtle, Leatherback (Dermochelys coriacea)	*CR*	*Tropical and temperate seas and oceans*	*Killing, collection of eggs for food*
Viper, Cyclades blunt-nosed (Macrovipera schweizeri)	*CR*	*Cyclades Islands (Greece)*	*Collection for trade, mining*

Table 7.2e, Fish

Species	Status	Range	Reasons for Decline
Catfish, Giant (Pangasianodon gigas)	*CR*	*China, Laos, Myanmar, Thailand, Cambodia, Vietnam*	*Dam construction, fishing*
Cod, Clarence River	*EN*	*Northeast New South Wales*	*Habitat destruction, water pollution*

(Maccullochella ikei)		*(Australia)*	
Cui-ui (Chasmistes cujus)	*CR*	*Nevada*	*Habitat destruction*
Darter, Fountain (Etheostoma fonticola)	*VU*	*Texas*	*Depletion of underground aquifer, habitat alteration*
Galaxias, Swan (Galaxias fontanus)	*CR*	*Tasmania*	*Introduced competitor species, logging*
Minnow, Maluti (Pseudobarbus quathlambae)	*CR*	*Lesotho*	*Habitat destruction (road and dam construction)*
Pupfish, Devils Hole (Cyprinodon diabolis)	*VU*	*Nevada*	*Habitat destruction*
Sculpin, Pygmy (Cottus pygmaeus)	*CR*	*Alabama*	*Restricted range, contamination of underground aquifer*
Sucker, Shortnose (Chasmistes brevirostris)	*EN*	*California, Oregon*	*Habitat destruction (dam construction)*
Totoaba (Totoaba macdonaldi)	*CR*	*Gulf of California (Mexico)*	*Overfishing, habitat alteration*

Source: World Conservation Union (IUCN) Red List of Threatened Species, 2004

Now do Activity 2.

Activity 2

1.

(a) Why do people kill animals in Papua New Guinea?

_____

_____

_____

_____

(b) What animals are most commonly killed?

_____

_____

2. What is the work of a palaeontologist?

_____

_____

Check your answers after the summary.

Endangered plant species

Read below a passage on an endangered plant in Papua New Guinea.

Illustration 10.2.7b: an endangered orchid in PNG.

1. Papua New Guinea is one of the most diverse areas in the tropics with 15,000 to 25,000 species of plants. PNG has one of the most diverse tropical wildernesses in the world. Many of the plant species are common. Papua New Guinea's landform developed in isolation many thousands of years ago. This brought about the formation of new and distinct plants species found only on the island of New Guinea.

   Many plant species are listed as threatened or endangered by The World Conservation Union's IUCN Red List (2007). See Appendix 1.

Illustration 10.2.7c: An endangered plant species in PNG

Illustration 10.2.7d: Endangered plant species

Causes for endangering plants and animals

1. Habitat Destruction

Every living organism needs a place to live. But habitat is not simply a home; it is also the place where an animal finds food and raises its babies.

Human beings take up a lot of space on the planet building houses in wild animal habitats, clearing forests to get timber and building sports field where farm should be. Development processes affect natural habitats in these ways:

- native plants are dug up to grow single crops like corn and wheat
- rivers are drained to irrigate crops
- farming methods cause soil to lose its nutrients and microbes.

Man-made developments and changes in the environment destroy animals' habitats and pollute the natural landscape with petroleum products, pesticides, and other chemicals. These actions kill some species entirely and push others into areas where they cannot find

the food and shelter they need to survive. Often, when one animal suffers from human violation it affects many other species in its food web, and so more than one species' population drops. The destruction of habitats is one of the main issues why species are endangered.

2. Introduction of Exotic Species

An exotic species is an animal, plant, or insect that is transplanted, or introduced, to a place where it did not **evolve** naturally. For example, a species like the *bighead carp* that was brought from China and turned loose in the United States. Refer to Lesson 6.

3. Illegal Hunting and smuggling

Animal species all over the world are hunted illegally (also known as poaching). When hunters do not follow government rules on how animals should be hunted, they reduce species populations and species become endangered. **Poachers** are often hard to catch because governments do not have enough money to hire game wardens to patrol large areas of wilderness. Poachers are also very sneaky. They transport live animals and animal parts in ways that are hard for law officials to track. Bird smugglers bind live birds tightly to their legs so that they cannot be seen when the criminals pass through airports. Baby bears, leopards, and monkeys have been **sedated** and stuffed into suitcases for transport. Live animals are sold to people who want exotic pets or for medical research. Animal pelts (furs/skins) and other body parts are also secretly smuggled across borders and sold through "black market" where buyers pay high prices for these illegal items for display as decorations or used in cosmetic products.

4. Exploiting (by law)

Even legal hunting, fishing, and gathering of wild species can lead to population reductions that force species to become endangered.

5. Natural Causes

Over the past 200 years, humans have made important changes to natural environments all over the globe, and most of these changes have negatively affected wildlife. This forces large numbers of species toward extinction. However, extinction is a natural biological process that has been a part of species' evolution since the beginning of time. Natural factors such as **overspecialisation** , competition, sudden climatic change, or natural disasters like volcanic eruptions and earthquakes have caused species to become endangered and extinct.

How we can save endangered plants and animals

What is biodiversity?

Bio means life. Diversity means a variety of something. Biodiversity includes all the different species of plants and animals and environments in which they live in.

Importance of biodiversity

It is very important that we understand the value of biodiversity to life on planet earth. Biodiversity control chemical and climatic systems. This provides energy, clean air, water and oxygen. Removing one part of the species from an ecosystem will cause huge impact

on the balance of nature. This will affect food chains and food webs that enable the flow of energy from organism to organism.
As population increases the need for food and energy consumption increases. As more resources are extracted, more biodiversity is lost. The world climate and energy systems are also affected and this leads to environmental problems. That is why preserving and conserving biodiversity and habitats is an important concern.

Conserving endangered species
Some positive steps to preserve and conserve endangered species are enacting laws to protect wildlife.
For example, the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES) is an international law that went into effect in 1975, to minimise the trade of endangered animals and animal parts. Other steps and actions taken include:

- marine parks and aquariums
- wildlife sanctuaries
- botanical gardens
- zoos
- special breeding grounds

Other non-governmental organisations (NGOs) such as the World Wild Life Foundation (WWF), Habitat for Humanity, Green Peace International, are international organisations that act against corruption and malpractices by countries and governments around the world that try to misuse the environment for development purposes. The main goal of the NGOs is to make people aware of why we should look after our limited resources and the environment in which they are part of. The NGOs do this through campaigns, rallies, the internet, radio, television and newspapers.

Now read the summary.

Summary
You have come to the end of Lesson 7. In this lesson, you have learnt that:

- the effects of human activities on the environment, is increasing as population increases.
- habitat loss and destruction is an impact of people's excessive use of the environment.
- damage to the environment and the overuse of animals for subsistence and commercial reasons has led to many plant and animal species becoming extinct in the last 200 years.
- a balanced and healthy ecosystem is vital for life to exist on earth.
- biodiversity includes the different species of plants and animals and the variety of environments in which they live in.

- governments, NGOs, and development agencies should all take combined, positive measures, towards conserving and protecting the world's biodiversity.

Answers to Activity 1

1. Microscopic organisms are very tiny organisms that cannot be seen with the naked eye. They can only be seen with the use of a microscope.
2. Competition between different species of both plants and animals for food and space for survival.

Answers to Activity 2

1.
   (a) In PNG people kill animals for reasons such as food, medicine, bilas for traditional singsings, and magic.
   (b) Animals such as cassowary, cuscus, bird of paradise, crocodile, deer, pigs and others that are not written.
2. A palaeontologist is someone who studies the remains of plants and animals.

NOW DO PRACTICE EXERCISE 7 ON THE NEXT PAGE

Practice Exercise 7

Read your notes and answer questions.

1. In which country is the Komodo dragon at high risk of becoming extinct?

   _____

2. Name the marine animal in Laos that is at very high, critical risk of becoming extinct in the near future?

   _____

3. What commercial activity is taking place in the south central and southeastern part of USA that is causing a decline in the woodpecker bird population?

   _____

4. What is the importance of biodiversity?

   _____

   _____

   _____

   _____

6. List the causes of plants and animals species becoming endangered and extinct.

   _____

   _____

   _____

   _____

7. Make a list of the steps and actions taken by countries worldwide to preserve and protect the environment?

   _____

   _____

   _____

   _____

   _____

CHECK YOUR ANSWERS AT THE END OF TOPIC 2

Lesson 8: Deforestation

In Lesson 7, you learnt about the endangered and threatened plants and animals' species. In this lesson you will learn about deforestation. You will find out about how and why forests are destroyed and its effects on wildlife and communities.

Your Aims:

- explain the importance of forests
- discuss types of forests and why they are cut down
- identify main causes and consequences of deforestation

What is deforestation?

Deforestation is the removal of trees, under growth and all other vegetation in that particular area of the land. Today only about 30 per cent of the land is still covered by trees, and most of these have been planted by people. Only a small amount of the original natural forest remains. People cut down trees for a variety of reasons.

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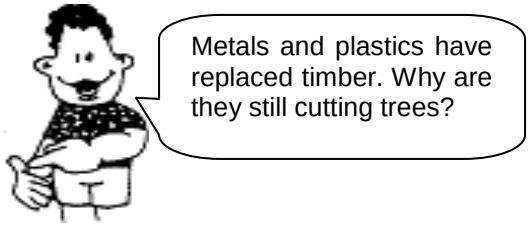
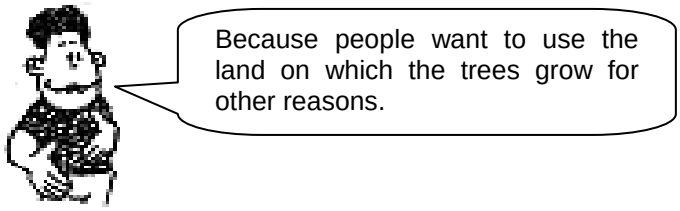




Tropical soils are naturally poor. When the forest is cleared, rain water falling on the ground washes away the nutrients in the top soil. And after two or three harvests the soil becomes exhausted that crops do not grow. In this condition, not even tropical forest will grow again. In temperate regions, most of the deciduous forests have been cleared. The soil under deciduous forests is naturally fertile. Sensible agricultural practices and, more recently, the use of fertilisers have maintained the quality and productivity of the soil. Temperate regions today produce most of the world's crops.

However, some mistakes have been made. Over-use of the soil in the drier parts of the North American prairies resulted in crop failure in the 1930s and 1940s. Because the soil had no vegetation cover, it quickly dried out and turned into dust. Strong winds and sudden rainstorms washed millions of tonnes of valuable topsoil away in just a few years. This situation is known as dustbowl conditions.

Importance of Forests

A forest is a large area of land covered with trees. A forest includes mosses, shrubs, and many kinds of birds, insects, and other animals. The living things and their environment together make up the forest ecosystem. An ecosystem consists of all the living and nonliving things in a particular area and the relationships among them. The forest ecosystem is very complicated. If the forest is wisely managed, it provides us with a continuous source of wood, and many other products. Before people began to clear the forests for farms and cities, great stretches of forestland covered about 60 per cent of the earth's land area. Today, forests occupy about 30 per cent of the land. The forests differ greatly from one part of the world to another.

Today, people depend on forests more than ever, especially for their economic, environmental and enjoyment value. The following paragraphs explain each of these points.

1. *Economic value*

   Forests supply many products. Wood from forest trees provides lumber, plywood, railroad ties, and shingles. It is also used in making furniture, tool handles, and thousands of other products. In many parts of the world, wood serves as the fuel for cooking and heating. Various manufacturing processes change wood into a great number of different products. Paper is one of the most valuable products made from wood. Other processed wood products include cellophane, plastics, and such fibres as rayon and acetate.

   Forests provide many important products besides wax. Latex, which is used in making rubber, and turpentine come from forest trees. Various fats, gums, oils, and waxes used in manufacturing also come from trees.

2. *Environmental value*

   Forests help conserve and enrich the environment in several ways. For example, forest soil soaks up large amounts of rainfall. It thus prevents the rapid runoff of water that can cause erosion and flooding. In addition, rain is filtered as it passes through the soil and becomes ground water. This ground water flows through the ground and provides a clean, fresh source of water for streams, lakes, and wells.

   Forest green plants, help renew the atmosphere. As the trees and other green plants make food, they give off oxygen. They also remove carbon dioxide from the air. Human beings and nearly all other living things require oxygen. If green plants did not continuously renew the oxygen supply, almost all life would stop. If carbon dioxide increases in the atmosphere, it could severely change the earth's climate.

   Forests also provide a home for many plants and animals that can live only in the forest and without it, many kinds of wildlife could not exist.

3. *Enjoyment value*

   The natural beauty and peace of the forest offer a special source of enjoyment. In the United States, Canada, and many other countries, huge forestlands have been set aside for people's enjoyment. Many people use these forests for such activities as camping,

hiking, and hunting. Others visit them simply to enjoy the scenery and relax in the quiet beauty. (World Book 2005)

Types of forests

There are three main types of forest in the world today: Tropical forest, Temperate Deciduous forest and Temperate Coniferous forest. Today, mature tropical rainforests cover about 900 million hectares. Fifty years ago, they covered about 1600 million hectares. See below Figure 10.2.8a.

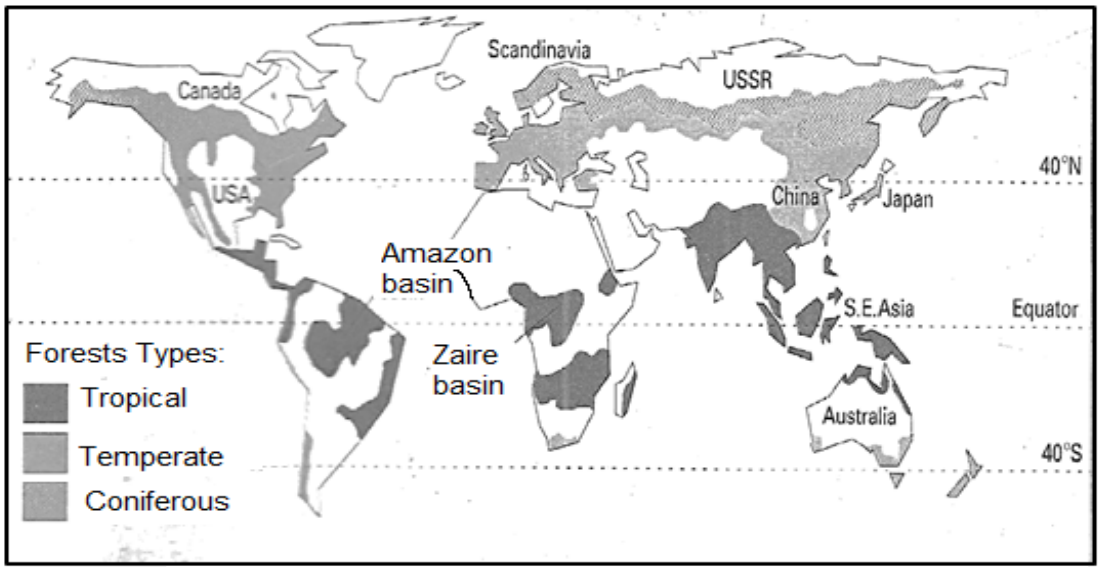


Illustration 10.2.8a: Distribution of forests today

Here are pictures of these three main types of forest.

Illustration 10.2.8b: Tropical rainforest in the Amazon.

Illustration 10.2.8c: A temperate Coniferous forest ecosystem in Petroglyphs Provincial Park, Ontario, Canada

Illustration 10.2.8d: Temperate Deciduous forest in Germany just as the leaf canopy is opening (beginning of spring)

See the different types of forest in the world in Illustrations 10.2.8e-j.

Illustration 10.2.8e: A Coniferous forest in the Swiss Alps (National Park).

Illustration 10.2.8f: The Andirondack Mountains of Upstate New York form the southernmost part of the Eastern forest-boreal transition Eco region.

Illustration 10.2.8g: Temperate rainforest in Tasmania's Hellyer Gorge, Australia

Why forests are cut down

1. Forests for timber

The clearance of tropical rainforests only started on a large scale about 50 years ago. Many valuable tree species are found scattered throughout the forests, including mahogany, teak and rosewood. The cutting down of trees for timber is one of the largest causes of deforestation. Much of the hardwood is exported to developed countries, where it ends up as replacement doors and window frames, lavatory seats, chopping boards, furniture and flooring. Although the loggers only want about 1 tree in 20 in the forest, the machinery damages about 60 per cent of the other trees surrounding the one that is needed.

2. Forests for hamburgers (cattle grazing)

Vast areas of the Amazon rainforest are burned each year to clear the forest for cattle ranches. Much of the beef used to make hamburgers in the United States is imported from Brazil. In other parts of South and Central America large areas of rainforest have been cut down to make way for cattle ranches. Because the grassland can be obtained at a low cost, the beef that is produced is not very expensive. Unfortunately, the heavy rain soon washes the mineral salts out of the soil and the grassland becomes so infertile that more forest has to be cleared to provide enough land for the cattle to graze on. In addition, poor people often move to forest areas and clear the trees to grow food for themselves and their families. Some governments encourage them to do this.

3. Forests for tropical crops

In the past few years, more than 10,000 kilometres of roads have been built through the Amazon rainforest. This is so that the forest can then be cleared and used for other activities, like plantations of crops such as tea, coffee, tobacco, sugar, cotton and palm oil, which are then sold abroad. Some of the forest is replaced with faster-growing foreign trees. These are grown for wood pulp that is used to make paper and rayon.

4. Forest for Minerals

Also in the Amazon and anywhere else in the world, mining and drilling for oil have destroyed large areas of rainforest and polluted many waterways. Large areas of the rainforest are also cleared in the search for minerals. This leads to the pollution of the rivers that flow through the forest. Hydro-electric power schemes have flooded large areas of lowland rainforest. Not only is the wildlife being destroyed but also the homes of many tribes of Amazon Indian.

5. Forests for Fuel

Another major cause of deforestation is the cutting down of trees to provide fuel for cooking and heating. In many parts of the world, people use trees for firewood, because they have no other fuels. Often they cut down trees faster than new ones can grow. In times of drought, they have to feed their goats, sheep and other livestock on the leaves and twigs of trees.

Consequences

Clearing forests often deprives local people of their homes and way of life. As well as endangering many wild plants and animals, in the case of tropical rainforests it also deprives the world of many possible future foods, drugs and medicines. About a quarter of the drugs and medicines that doctors use today were developed from rainforest plants and animals. There are thought to be thousands of plants, still unknown to modern science that may be useful in medicine.

Tree-covered slopes can help to prevent flooding, mudslides and soil erosion. When there is heavy rain, tree roots soak up much of the water as it sinks into the soil. If the trees did not act as living sponges, the water would quickly fill rivers and streams, making them flood the land. The tree roots also hold the soil together. When forests are cut down there is nothing to hold the soil in place and it washes away. This soil often ends up in rivers, where it builds up and eventually causes them to overflow. For example, many of the devastating floods that have affected Bangladesh are thought to have been caused by people cutting down forests for firewood in the nearby mountainous country of Nepal.

Clearance of forests is also speeding up global warming. This is because when people clear forests for farmland, mining, roads or other purposes they often do this by setting fire to the trees. Burning trees release large quantities of carbon dioxide into the air, and carbon dioxide is one of the so-called greenhouse gases that are making the world warmer. At the same time, removal of the trees means that they can no longer take carbon dioxide from the air when they make their food—making global warming even worse. At least 1650 rainforest plants have potential as vegetable crops. Many of the foods that people eat today originated in tropical rainforests.

How we can preserve the forest

- Forest conservation is the practice of planting and maintaining forested areas for the benefit and sustainability of future generations.
- It is the protection of the natural resources within a forest that are beneficial to both humans and the ecosystem. Forest conservation supports life on earth.

- Source of revenue to the Government in the form of royalty, from leases of forest products.
- Provides employment

Now read a wonderful poem about trees.

SPIRIT OF THE TREES

By Denise Tansley

I can hear the cry of the sacred trees
The giver of life as the axe plays part in a gruesome execution.
I pray for men of greed and lust that wields the axe
For the trees are of spirit, forgiving but never forgetting.
I pray for the pain I hear from the woods as the chainsaw tries to hide the cries
Their lives cut short in a never-ending attempt to furnish our fashions.
I pray that the spirit of the tree lives on to haunt and perish those lavish homes and palaces
Where no regard to spirit be given.
God I pray
God I pray,
Your garden of Eden disappearing as we, your children, look away.
And let me be there at Judgement Day and cry for the pain of the Spirit of the Tree and let me look at you for here, I am unable to look away

Now read the summary.

Summary

You have come to the end of Lesson 8. In this lesson, you have learnt that:

- deforestation is the term given for the removal of trees, undergrowth and all other vegetation growing in a particular area.
- population of the world had grown, so has the demand for product made from wood.
- cutting down of trees for timber is one of the largest causes of deforestation.
- forests are cleared and used for many other things.
- in the Amazon and other parts of the world, mining and drilling for

oil have destroyed large areas of rainforest and polluted waterways.

- clearing forests often deprives local people of their homes and way of life, and endangers many wild plants and animals.
- forest conservation will support life on earth.
- Forests are useful in many ways, they
  - take in CO_2 and release oxygen
  - release carbon and mineral elements such as nitrogen and phosphorus (important in plant growth) as they decay
  - absorb moisture for growth and releasing it as vapour through transpiration
  - prevent erosion by reducing the force of rainfall at the soil surface and by intercepting and absorbing water, rather than allowing it to run off directly
  - harbour a diversity of wildlife
  - act as windbreaks
  - provide us with shade and beauty on a largely agricultural and urban landscape
  - help in the occurrence of rainfall, and preventing soil erosion

---

NOW DO PRACTICE EXERCISE 8 ON THE NEXT PAGE

Practice Exercise 8

Read the notes and answer questions.

1. Where is traditional wood obtained?

_____

2. List 5 reasons forests are cut down and explain briefly each one.

_____

_____

_____

_____

3. How does deforestation affect wildlife?

_____

_____

_____

_____

4. How does deforestation cause global warming?

_____

_____

_____

_____

_____

_____

_____

5. How do tree covered slopes help prevent erosion and floods?

_____

_____

_____

_____

_____

6. What is the main way of conserving the forest?

_____

_____

_____

_____

7. What are the three important values of forests?

(i) _____

(ii) _____

(iii) _____

CHECK YOUR ANSWERS AT THE END OF THE TOPIC 2

Answers to Practice Exercises 5-8

Practice Exercise 5

1. An area is overpopulated when it cannot adequately support the number of people living in it, without damaging the environment.
2. The world would have to increase food production and improve the distribution of the world's food resources.
3. Because they have destroyed their soils that feed the population.
4. The rapid growth of the human populations will increase the destruction of natural habitats of many species for various land uses. Many species will die.
5. Growing advances in technology saved lives and created better medical treatment for all. A direct result of this has been increased lifespan and population growth.
6.

   -Depletion of natural resources
   -degradation of environment
   -conflicts and wars
   -rise in unemployment
   -high cost of living
7. Overpopulation in developing countries puts a major strain on the resources it should be utilising for development. Conflicts over water are becoming a source of tension between countries, which could result in wars. Conflicts and wars may lead to creating more diseases to spread and makes them harder to control.

Practice Exercise 6

1. By bringing them across barriers like oceans, mountains, and rivers.
2.

   -Can be able to tolerate wide range of physical conditions i.e. temperature and moisture in the area.
   -Ability to survive on a wide variety of foods
   -Reproduce and spread their offspring rapidly
3. Pests can carry fatal diseases, resulting in major epidemics. They can cause serious damage to crops and livestock, and can have a negative impact on the ecosystem in an area.
4. A water beetle was used that fed on the Salvinia plant
5. Species are introduced for many reasons:
   -to improve the appearance of the surrounding environment
   -as a food source
   -recreation
   -introduced on occasion to control another.

Practice Exercise 7

1. Indonesia
2. Giant Catfish
3. Logging
4. Biodiversity control chemical and climatic systems. This provides energy, clean air, water and oxygen. Removing one part of the species from an ecosystem will cause huge impact on the balance of nature. This will affect food chains and food webs that enable the flow of energy from organism to organism.
5. Habitat destruction, introduction to exotic species, illegal hunting and smuggling, exploiting (by law), natural causes
6. - Enact laws to protect wildlife
   - Build marine parks and aquariums, wildlife sanctuaries, botanical gardens, zoos, and special breeding grounds

Practice Exercise 8

1. Forest
2. -Timber, for building

   -meat, the forest is cleared for cattle grazing. Beef from cattle is used to make hamburger (in the USA).

   -crops, the Amazon tropical rainforest in Brazil is cleared to make plantations for other cash crops

   -minerals, large areas of the rainforest are cleared in the search for minerals; mining and drilling for oil has destroyed forests.

   -fuel, trees are cut down to provide fuel for cooking and heating. In many parts of the world, people use trees for firewood, because they have no other fuels.

(Any other answers such as to build road, towns, and houses).

3. Destroy the habitat of the animals, destroy their food source, and destroy the ecosystem.
4. Burning trees release large quantities of carbon dioxide into the air, and carbon dioxide is one of the so-called greenhouse gases that are making the earth warmer. At the same time, removal of the trees means that they can no longer take carbon dioxide from the air when they make their food—increasing global warming.
5. Tree-covered slopes help to prevent flooding, mudslides and soil erosion. When there is heavy rain, tree roots soak up water as it sinks into the soil. The tree roots also hold the soil together. When forests are cut down there is nothing to hold the soil in place and it washes away. This soil often ends up in rivers, where it builds up and eventually causes them to overflow.

6. The main way to conserve forests is to plant and maintain forested areas for the benefit of everyone.

7.

   (i) Economic
   (ii) Environmental
   (iii) Enjoyment values

TOPIC 3: LOCAL ENVIRONMENTAL ISSUES

In This Topic, You Will Learn About:

- **Pollution of River Systems**
- **Marine Pollution**
- **Industrial Pollution**

TOPIC 3: INTRODUCTION

In this Topic, you will learn about:

- Pollution of River Systems
- Marine Pollution
- Industrial Pollution

Learning Outcome: Students will be achieving this outcome when they, for example:

- apply knowledge and skills to preserve and promote a sustainable environment for better living

This topic will cover the different aspects and types of pollution that occurs in Papua New Guinea, and the world.
The aspects of pollution include industrial fumes, metallic wastes from mines, non-biodegradables, oil spills, deforestation, and automobile emissions. The release of solid wastes and oil spills into the environment affects the seas and waters we depend on for our food and livelihoods. The air also is constantly being filled with industrial fumes and automobile gas emissions which affect the quality of the air we breathe. Thus this topic will identify these aspects and elaborate on the types of pollutions of water, river, marine and the air.

It also discusses ways to control, minimise and improve pollution in the waters, rivers, seas and air. You must answer all the questions given in the Activities and Practice Exercises that will help you to understand this topic.

This is a very interesting topic, and we hope you enjoy learning about pollution so that in your own little way you can contribute to minimising its effects on our environment!

Lesson 9: Pollution of River Systems

In the last lesson you learnt about deforestation. In this lesson, you will learn about river systems and pollution.

Your Aims:

- define pollution and river system
- state the importance of river systems
- identify and explain causes of pollution of river systems and oceans
- identify and explain causes of water-borne diseases
- list down ways to manage the quality of water

What is pollution?

Pollution is a general term for littering, spoiling and infecting the environment. Pollution can occur in a river, the sea, air or on land. It is caused by many different factors.

What is a river system?

Every river is part of a larger system—a watershed, which is the land drained by a river and its tributaries. Rivers are large natural streams of water flowing in channels and emptying into larger bodies of water.

The diagram of a river system shows what a river system is all about. The diagram makes it easy to see how and why pollution of the river system can spread easily and rapidly affecting all forms of life.

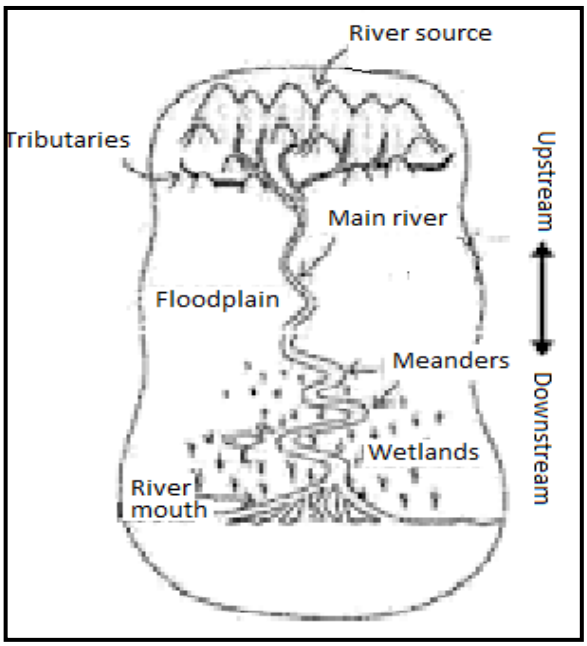


Illustration 10.2.9a: Sketch of a river system.

We have to study what a river system is as pollution affects river. Once pollution has taken place all parts of a river are affected depending on the type of pollution, amount released, and the river processes itself.

All rivers consist of fresh water. Water in a river comes from rain, melted snow or underground springs. The water that forms a river collects in an area called watershed. Rivers expand and get bigger when smaller streams flow into them. These streams are called **tributaries**. A small river is a tributary of a big river that usually forms a river system. The area that a river system flows through is called a **drainage basin**. Drainage basins can cover thousands of square kilometres. The size of a river depends on the size of its drainage basin and the amount of rain that falls in the basin. A river system drains into a lake or ocean, where the river usually ends. The end of a river is called its mouth and the start of a river is called its source. A river system is in itself an energy system that has considerable power and strength. Water energy systems such as hydroelectricity can be harnessed and generated. The following points further explain how a river system operates as an energy system.

A food chain is a chain of life forms that feed on one another, starting with a producer and ending with a consumer. A food web is made up of more than one food chain.

The importance of rivers

Rivers have always been an important resource to people throughout human history. Humans and all living things need water to survive. The first civilisations formed between the Tigris and Euphrates river valley in the Middle East (Iraq), and the Nile River delta in Egypt. People built settlements near rivers because rivers provided water for drinking, fish for food, and transportation routes. People used water from rivers to grow crops and sailed boats down rivers for transportation. Today people still use rivers for water and transportation. They also learned how to control rivers by building walls called levees along rivers to keep them from overflowing. They build dams to harness the power and energy of water to produce hydroelectricity. They build reservoirs to collect water for drinking, irrigation and other industrial use. They have even divided and straightened the natural course of a river and its bends called meanders by building waterways and canals. Some of the things that people did have harmed rivers and river systems.

Now do Activity 1.

Activity 1

1. What is a river system?

_____

_____

_____

_____

2. Why is a river important?

_____

_____

_____

Check your answers after the summary.

Water pollution and causes

Water pollution is the contamination of streams, lakes, underground water basins, seas by substances harmful to living things.

Water is necessary to life on earth. All organisms contain it, some live in it, some drink it. Plants and animals require water that is moderately pure, and they cannot survive if their water is loaded with toxic chemicals or harmful microorganisms. Severe water pollution can kill large numbers of fish, birds, and other animals, in some cases killing all members of a species in an affected area. Pollution makes streams, lakes, and coastal waters unpleasant to drink, look at, smell, and swim in. Fish and shellfish harvested from polluted waters may be unsafe to eat. People who drink polluted water can become very ill, and with prolonged exposure, may develop cancers or bear children with birth defects. The main sources of water pollution are:

- sewage
- chemical waste from factories and mines
- agricultural waste
- oil spills from oil tankers

Sewage

In cities and urban areas, sewage, which is made up of domestic as well as industrial waste easily find their way into rivers, lakes and streams and eventually reach the sea. Sewage when untreated is quite harmful and toxic in nature. It can greatly alter both aquatic and marine life forms. Water contains only about 1 percent dissolved oxygen which is essential for the existence of fish and other forms of aquatic and marine life. When untreated sewage gets into these habitats, bacteria and algae quickly multiply in large numbers and use up the available oxygen. This causes all other forms of life that cannot survive without oxygen to die and are rotted by the bacteria. The only remaining organism is a special kind of algae that can exist without oxygen. Many countries around the world dispose their sewage directly into the rivers and oceans without proper treatment because of population increase. That is why the fish and other forms of life cannot survive in those places.

Chemical wastes from industries and mines

These are poisonous and very toxic in nature. Waste products of many factories usually contain heavy metals such as lead and mercury. These heavy metals are often used in industrial processes of a lot of chemical products by chemical industries. As they get into the food chains and food webs and as people consume fish that are already contaminated with these substances they can experience mercury poisoning which is known as the

Minamata disease. Minamata disease is a condition that people in most parts of the world are not familiar with. It got its name from the City of Minamata in 1956, which the disease was first identified in. The condition began affecting residents and local wildlife, and cats; and continued to affect more people in the following decades as nothing was done to control its contamination. Minamata is not really a disease but a neurological syndrome that results from industrial pollution and environmental contamination. The consuming of the pollutant through polluted fish affects the central nervous system. The specific pollutant responsible for this condition is methyl-mercury. The Japanese contracted the disease in the 1970s due to industrial waste disposal into rivers and waterways around Tokyo bay.

See figure 10.2.9b, about how minamata disease is occurs.

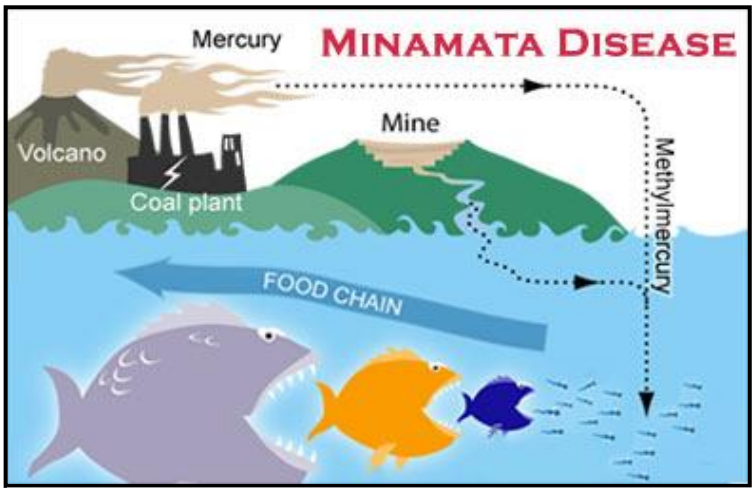


Figure 10.2.9b: How minamata disease occurs.

See illustration below on industrial waste.

Illustration 10.2.9b (left): Liquid waste that runs into a stream from a factory can kill wildlife and cause health problems for humans. In the United States the amount and quality of wastewater a factory can discharge is strictly controlled.

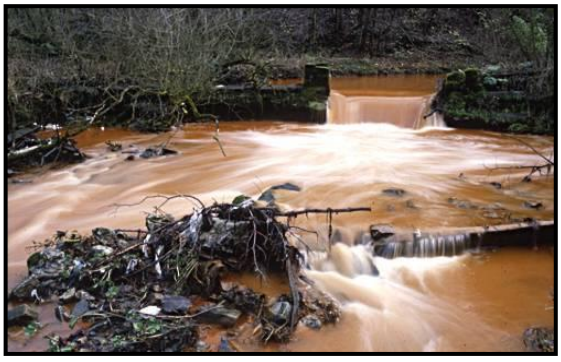


Illustration 10.2.9c: The pollution of rivers and streams with chemical contaminants has become one of the most critical environmental problems of the century.

Agricultural waste

Water pollution can also come from farms. Farmers put chemicals on the ground to help crops grow and to kill insects. Rain washes these chemicals into lakes and rivers. Big ships called oil tankers can pollute the ocean if the oil leaks out of the tankers. There can be a huge oil spill if a tanker has an accident and sinks at sea. See following illustrations on causes of water pollution.

Illustration 10.2.9d: The insecticide being sprayed on this potato field will get rid of a generation of Colorado potato beetles; it may also pollute local food and water sources.

Oil spill

What is an oil spill?

An oil spill is the release of a liquid petroleum hydrocarbon into the environment, especially marine areas, due to human activity, and is a form of pollution. The term is usually applied to marine oil spills, where oil is released into the ocean or coastal waters, but spills may also occur on land. See below the following illustrations on oil spill and its effects on marine life and the ocean.

Some big oil tankers tip crude oil into the ocean because they do not want to spend money on decomposing their waste oil. This is illegal. Natural disasters (like hurricanes) may cause an oil spill, too, by flipping an oil tanker over, causing oil pour out. But however, mostly, oil spills are caused by humans.

Illustration 10.2.9e: A leaking oil tanker causes an oil spill in the ocean.

Now, read the main causes of pollution of the river systems in Papua New Guinea.

The table below shows the major water pollutants, their sources and effects in Papua New Guinea.

Table 1: Main causes of water pollution

Pollutant	Source	Effects
Disease causing agents	Domestic sewage and animal waste	Illness from water- borne diseases such as; typhoid, cholera, dysentery, diarrhea
Oxygen demanding waste	Natural runoff from land, human sewage, animal waste, decaying plant life, urban storm water runoffs	Loss of oxygen and therefore fish killed, plant life destroyed, smelly water
Sediments	Erosion, logging, runoff from agricultural, mining and urban land uses, especially land left bare and mud is the pollutant in volume	Rivers become **silted** and choked by sandbars, flooding increases, fish are suffocated, and there is a reduction in the waters ability to adapt oxygen demanding waste.
Organic chemicals	Oil from oil drilling, vehicle wastes, pesticides used on forest plantations, plastics and detergents from homes and industries	Oil disrupts all ecosystems, detergent encourage algae growth, kill fish, take oxygen, and chlorine compounds harm fish, cause smells, may cause cancer in humans
Organic waste	Human and animal wastes (excreta) and agricultural fibrous waste which can be decomposed through biological action, that is , are biodegradable but is being degraded and they use up oxygen in rivers and lakes , and the germs of cholera, typhoid, dysentery can also be spread.	

The sources and types of pollution vary from place to place in their impact and importance. Many rural based Papua New Guineans still lack basic sanitation. That is they have no toilet of any kind and use river banks and other places as their toilet. These situations are not only experienced by Papua New Guineans but are commonly experienced by most people in rural areas of developing countries. Disease carrying agents such as germs, bacteria and viruses can spread very easily when people are not careful in the ways they dispose their wastes.

Now do Activity 2.

Activity 2

1. What is water pollution?

_____

_____

_____

_____

_____

2. State two sources of water pollution?

_____

_____

Check your answers after the summary.

Water borne diseases

Transmission

Water borne diseases are spread by contaminated drinking water systems with the urine and faeces of infected animals or people.

This is likely to occur where public and private drinking water systems get their water from surface waters (rain, creeks, rivers, and lakes), which can be polluted by infected animals or people. Runoff from landfills, septic fields, and sewer pipes, residential or industrial developments can also sometimes pollute surface water.

This has been the cause of many outbreaks of diseases such as cholera and typhoid. However, there are many other ways in which faecal bacteria can reach the mouth, for instance on the hands or on contaminated food. In general, contaminated food is the single most common way in which people become infected.

The germs in the faeces can cause the diseases by even slight contact and transfer. This contamination may occur due to floodwaters, water runoff from landfills, septic fields, and sewer pipes.

These are diseases that are caused by the contamination and pollution of water. The three common types are:

- Cholera – severe infectious disease caused by the cholera bacteria. Symptoms of cholera are diarrhea and loss of water and salts in the faeces. A person becomes infected by coming in to contact with water and faeces of others who have the disease.
- Typhoid – a severe infectious disease caused by the typhoid bacteria- *bacillus salmonella*. The bacteria is transmitted by milk, water, or solid food contaminated by faeces of typhoid patients or other healthy persons who are carriers of the bacteria.

- Diarrhoea – frequent passing of watery faeces. It is a symptom caused by food poisoning from contaminated food or drink, infections by bacteria or viruses, and anxiety.

The following figure shows the routes of diseases transmission from faeces to the mouth.

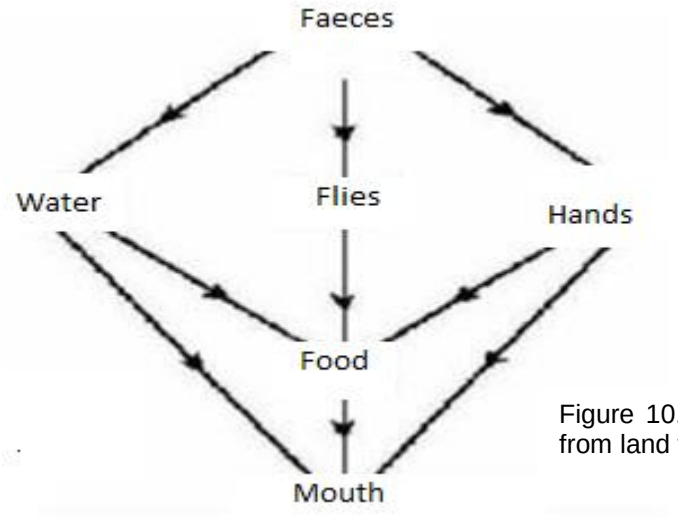


Figure 10.2.9e: Transmission of bacteria from land to humans

Management of water as a resource

Water is a very important and scarce resource. About 78% of the human body contains water. People can go without food for a day but it is impossible to go without water even in a day. Only 0.1% of the world's water is available as surface water for people's consumption. The other 99.9% of water is found in natural surroundings such as lake, sea, and river. That is why the quality and quantity of water is very important because it affects people's health, their ability to stay clean and grow crops.

The management of water as a resource is very important as surface water is very unevenly distributed. Many parts of the world experience water shortages because of arid climate, and in other areas most of the water sources have been severely polluted.

Many people in developing countries do not have access to clean water. People have to go very long distances in search of water. In many parts of developing countries water is usually carried by women and children. The most common sources of water available to people in developing countries are: wells, rivers, tanks, and transported through pipes and water pumps.

Now read the summary.

Summary

You have come to the end of Lesson 9. In this Lesson, you have learnt that:

- a river system is made up of a larger river and its tributaries.
- all rivers contain fresh water.
- fresh water is vital for life on earth.
- water is a scarce resource and is unevenly distributed on the earth's surface.
- available fresh water is only 0.1%.
- water pollution is caused by untreated sewage disposal, agricultural waste, chemical wastes from factories and mines, and oil spill from oil tankers.
- the main pollutants of the river systems in Papua New Guinea are sediments, organic and chemical wastes, disease causing agents and oxygen demanding wastes.
- water-borne diseases are infectious and can spread very easily when people use polluted and contaminated water.
- management and conservation of the quality and quantity of fresh water is important as it affects people's lives.

Answers to Activity 1

1. A river system is made up of a large river and its tributaries.
2. A river is an important resource to people because it provides water for cooking, drinking, irrigating crops, washing, and transport, to people throughout human history.

Answers to Activity 2

1. Water pollution is the contamination of streams, lakes, underground water, bays, or oceans by substances harmful to living things.
2. Sources of water pollution are; sewage, mine waste, industrial waste, agricultural waste.

NOW DO PRACTICE EXERCISE 9 ON THE NEXT PAGE

Practice Exercise 9

Read your notes and answer questions.

1. Define these words.

   I. Tributary

   _____

   _____

   _____

   II. Food chain

   _____

   _____

   III. Food web

   _____

   _____

   IV. Scarce resource

   _____

   _____

2. What are some effects of contaminated water?

   (a) _____

   (b) _____

   (c) _____

   (d) _____

3. Why is it important for people to manage and control the quality and quantity of water?

   _____

   _____

   _____

_____

_____

4. What are the major water pollutants, their sources and effects in Papua New Guinea?

_____

_____

_____

_____

5. What are waterborne diseases? Name at least 3 waterborne diseases.

_____

_____

_____

6. What are the main sources of water pollution and river systems in the world?

_____

_____

_____

_____

CHECK YOUR ANSWERS AT THE END OF TOPIC 3

Lesson 10: Marine Pollution

In the last lesson you learnt about pollution of river systems. In this lesson you will learn about marine pollution and how it affects marine life.

Your Aims:

- define and explain marine life and identify examples
- define and explain marine pollution
- identify and explain sources of marine pollution
- discuss the importance of coral reef habitats and how they are threatened
- discuss effects of oil spill on the environment
- list and explain ways to protect reefs in Papua New Guinea.

First of all, what comes to your mind when you see or hear the word marine? Of course, it will have to do with the sea or ocean environment. The sea or oceans are bodies of salty water that covers most or about 78% of the earth's surface.

What is marine life?
The oceans form a vast marine environment covering over 70 percent of the earth surface. A variety of habitats is found from near-shore communities to the deep, cold ocean trenches. The ocean habitats are divided into regions and habitats based on how deep it is and other characteristics. The coastal habitats vary from the shoreline to the edge of the continental shelf while the open ocean environment includes the area beyond the continental shelf. Marine habitats can be divided into near-surface *pelagic* and deep-water *demersal* habitats.

Marine ecology is the branch of ecological science concerned with organisms that live in or near the ocean, their behaviours and how they interact with the environment. A marine habitat refers to the home of a host of different species ranging from planktons to large marine mammals, for example, whales.

Organisms are living things such as plants and animals while planktons refer to a collection of small or microscopic organisms, including algae and protozoans. They float or drift in great numbers in fresh or salt water, especially at or near the surface, and serve as food for fish and other larger organisms.

Scientists who specialise in ecosystem ecology spend months or even years researching a specific region such as a shoreline to see the various impacts that both living and nonliving

things have on the local environment. Marine scientists often think about the effects of nonliving things such as light, temperature and salt level in water on living things.

What is marine pollution?

Firstly, pollution is defined as the introduction of harmful substance into the natural environment which can cause harm or changes to the natural state of the environment (refer to Lesson 9 of this unit). Pollution can take the form of chemical substances or energy such as noise, heat or light. **Pollutants** are harmful substances that create pollution and they can either be foreign substances or naturally occurring toxins.

Marine pollution occurs when harmful or possibly harmful effects from chemicals, particles, industrial, agricultural and residential waste, noise or the spread of invasive organisms enter the ocean. Invasive (or exotic) organisms are introduced from outside and are non-native species.

Factories and sewage treatment plants are two common types of sources of pollution into the seas. Factories including oil refineries, pulp and paper mills and chemical, electronics and automobile manufacturers typically discharge one or more pollutants in their discharged waters called **effluents**. Some factories discharge their effluents directly into a waterbody. Others treat it themselves before it is released and still others send their wastes to sewage treatment plants for treatment. Sewage treatment plants treat human wastes and send the treated effluent to a stream or river. When waste water is treated, it is made less harmful.

Illustration 10.2.10a: Pollution of Minimata Bay in Japan shows how the unseen pollutants can cause most harm to people.

Most sources of marine pollution are land based. This means they are either dumped by people or through the activities of humans. The pollution often comes from sources such as agricultural runoff and windblown debris and dust.

Take a look at the following photographs. They show examples of marine pollution.

Illustration 10.2.10b: Tanker Torrey Canyon Oil spill, March 18, 1967.

This photograph shows tanker Torrey Canyon ran aground off Cornwall on March 18, 1967 in the United Kingdom. This spilled 80,000 tones (119,000 barrels) of crude oil. Though this oil spill happened way back in 1967, the scenario today is much the same. This is an example of pollution from vessels.

Port oil spills are also sources of pollution. Storm water runoff carries all those poisonous and oily wastes from ports and harbours and leads them directly into the sea.

Illustration 10.2.10c: Dealing with port and harbour storm water runoff.

If you live near a port or harbour, you could try visiting these parts of town and check out the type of environment there which may have been affected by oil leakage from oil tankers at the wharf.

According to a report released in 1980, of the 3.2 million tonnes of oil released into the ocean, almost half of it was from vessels. This estimation will help you get an idea of how serious this issue is. Some common sources of marine pollution are accidental oil spills from tankers, commercial vessels, deliberate or operational discharges from commercial vessels, grounded and abandoned vessels.

Wastewater from loading and unloading cargo near the port contaminates the sea with tar balls, and also threatens the ecology by introducing foreign species of organisms into the water. The discharged water also contains human wastes which can cause serious damage to the environment.

Effects of oil spill on the environment

How do oil spills affect animals?

Birds die from oil spills if their feathers are covered in oil. When they try to clean their feathers, they are poisoned. Animals may die because they get hypothermia, causing their body temperature to be really low. Oil can also enter an animal's lungs or liver, poisoning it from the inside. Oil also blinds animals when it gets into their eyes, so they can no longer see.

Illustration 10.2.10d: Sea birds get poisoned by oil spills.

Illustration 10.2.10e: These two sea otters are covered in oil from a spill.

Sea Otters' bodies may get covered in oil, which causes buildup in the air bubbles located in their fur, which are specially designed to help them survive the cold oceans and help them to float. When oil builds up in the air bubbles, the otters may die of low body temperature.
Oil spills are also a major reason that killer whales are endangered. The oil may be eaten or enter the whale's blowhole. A blowhole is a hole to help them breath. Whales will rise up over the water to take a breath. If the blowhole is plugged with oil, the whale cannot breathe! Or, if a whale eats a fish that swam through oil, it will be poisoned and then dies.

All the animals in the ocean

Many people do not realise but the oil spill affects all the animals in the ocean. Plankton, larval fish and bottom-dwelling organisms, and even seaweed, clams, oysters and mussels can be affected by oil spills. When hundreds of plankton dies because of oil, fish do not have enough food to eat, which will cause them to die. If the fish die, there will not be enough food for whales, and they will die, too. As you can see, oil spills can damage the entire food chain in one blow.

Illustration 10.2.10f: Seals that swim in the ocean are killed by oil spills.

Read the following illustrations on oil spill clean-ups in the Gulf of Mexico and the Black Sea. The Black Sea is an inland sea located between far-southeastern Europe and the far-western edges of the continent of Asia and the country of Turkey. It is bordered by Turkey, and by Bulgaria, Romania, Ukraine, Russia and Georgia. See map on the right.

Illustration 10.2.10g: A U.S Air Force Reserve plane sprays Corexist dispersant over the Deepwater Horizon oil spill in the Gulf of Mexico.

Illustration 10.2.10h: A U.S Navy oil spill response team drills with a "Harbour Buster high-speed oil containment system".

Illustration 10.2.10i: Clean-up efforts after the Exxon Valdez oil spill.

Illustration 10.2.10j: Exxon Valdez Oil Spill Cleanup. Workers wash the shoreline on Latouche Island, Alaska, after the Exxon Valdez oil tanker ran aground in 1989, dumping more than 38 million litres (more than 10 million gallons) of oil into Prince William Sound. The resulting environmental damage prompted the United States Congress to pass federal safety requirements for oil tankers and barges and to assign the principal cost of spill cleanup to oil companies.

Illustration 10.2.10k: Workers use special nets to clean up a California beach following an oil tanker spill. Tanker spills are an increasing environmental problem because once oil has spilled, it is virtually impossible to completely remove or contain it. Even small amounts spread rapidly across large areas of water. Because oil and water do not mix, the oil floats on the water and then washes up on broad expanses of shoreline. Attempts to chemically treat or sink the oil may further disrupt marine and beach ecosystems.

Illustration 10.2.10l: Bags of oily waste from the Exxon Valdez oil spill.

Illustration 10.2.10m: A bird covered in oil from the Black Sea oil spill.

Importance of coral reefs

Papua New Guinea has one of the most striking marine environments in the world with diverse life forms like fish, sharks, dolphins, turtles and the brightly coloured corals.

Coral reefs are some of the most valuable, diverse and spectacular communities on our planet. They are amazingly complex underwater communities composed of stony structures built by living plants and animals. There are hundreds of different types of corals, including **hard and soft corals**. Scientists estimate that coral reefs are home to approximately 25% of the ocean's species. Corals are made up of colonies of tiny animals called coral **polyps**. Polyps are **nocturnal** animals that live in groups or colonies and look like tiny interconnected **sea anemones**. Some coral polyps feed on plankton and some get food from tiny algae (simple plants) that live inside the coral and produce food for the coral using the sun's energy.

In the case of hard, reef-building corals, the polyp grows and leaves behind its skeleton. These layers of old polyp skeletons covered with life corals growing on their surface provide the rocky frameworks and massive branching structure of coral reefs. Coral reefs grow very slowly and they are actually the oldest communities on earth. Most of the reefs

we see now have been growing for over 5,000 years. Since they grow so slowly, reef ecosystems are very fragile and cannot recover quickly from damage. Coral reefs are full of life. They provide homes for a huge variety of animals including fish, sharks, turtles, sea urchins, lobsters, giant clams, sea cucumbers, and many more. Marine creatures find food, protection and shelter in coral reefs. Scientists estimate that more than 25,000 species live in reef habitats more than in tropical rain forests.

Study the parts of the coral reef in the diagram below.

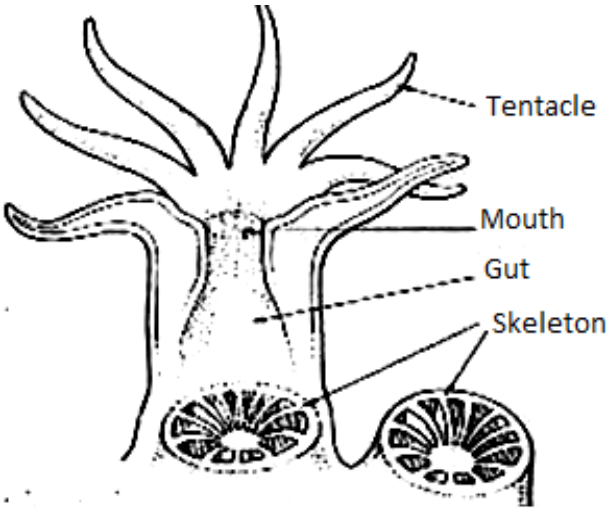


Illustration 10.2.10n: A coral polyp showing the major parts of the polyp and the skeleton beneath. A skeleton without its polyp is shown on the right.

Coral reefs form three main structures:

(1) *Fringing reefs:* Usually present along mainland shores and around the edges of islands,

(2) *Barrier reefs:* Coral reefs separated from nearby land by open water

(3) *Atolls:* Circular reefs growing upwards from an underwater volcanic peak with a lagoon in the centre.

A side view diagram below shows the difference between an atoll, fringing and barrier reefs.

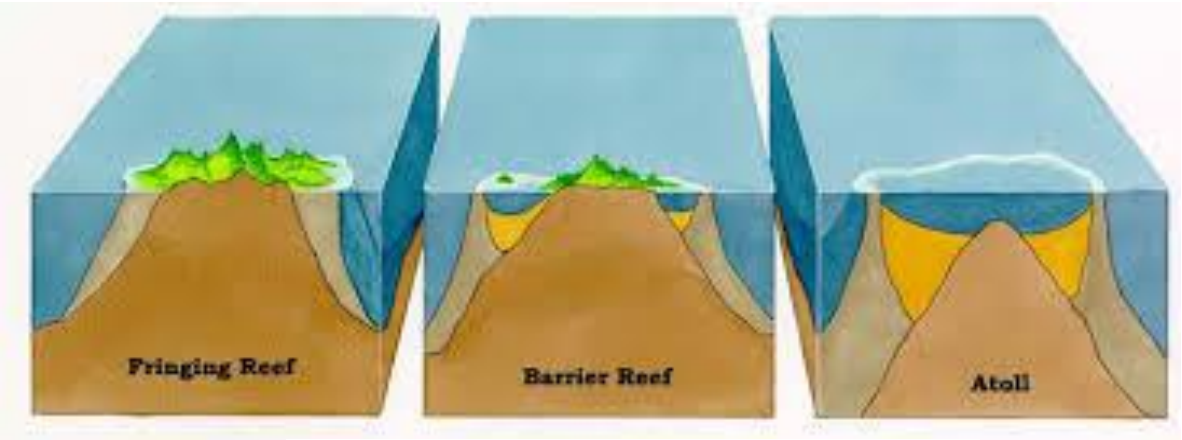
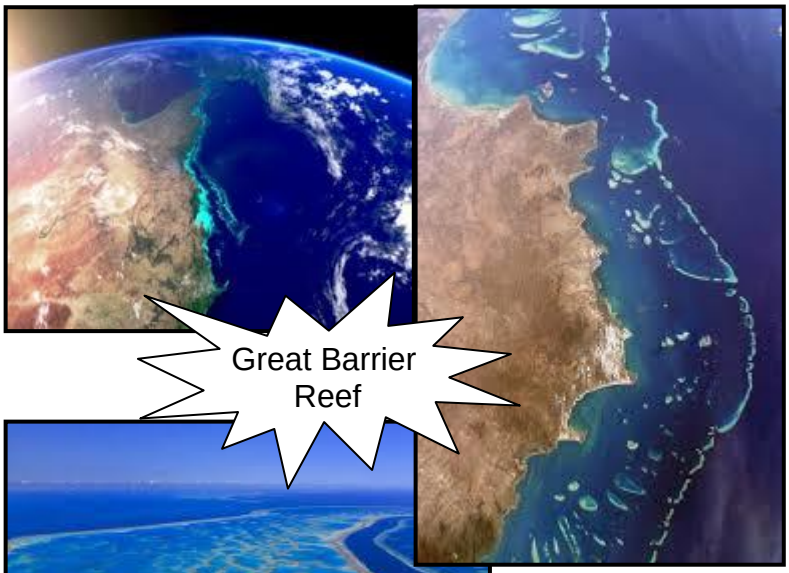
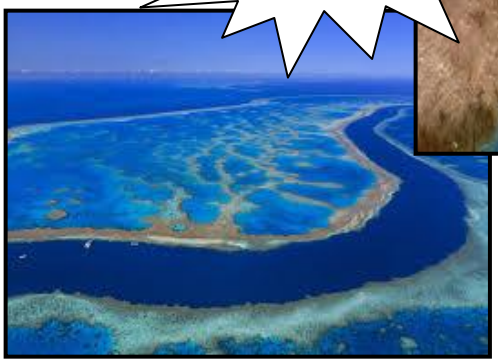


Illustration 10.2.10o: Fringing, barrier reefs and an atoll

Now, turn to the next page to see pictures of the fringing and Great Barrier Reefs in Australia, and an atoll in Papua New Guinea.

Fringing reef, Australia





Takuu Atoll, Papua New Guinea

Now do Activity 1.

Activity 1

1. What is an atoll mostly made of? What shape is an atoll?

   _____

2. Briefly explain why coral ecosystems are described as fragile.

   _____

   _____

   _____

   _____

3. In which state is the Great Barrier Reef located in Australia? _____

4. Differentiate between fringing reef, barrier reef and an atoll.

_____

_____

_____

_____

_____

What is special about Papua New Guinea's reef habitats?
PNG is privileged to have one of the longest coastlines in the world, with over 600 islands surrounded by coral reefs. Coral reefs occur along most of PNG's coasts and there are many offshore reefs as well. The coastal areas and reefs in PNG support some of the richest marine biodiversity in the world.

Milne Bay Province has been recognised as a place with reef biodiversity. There are over 430 species of corals, 1100 species of fish and 900 species of molluscs in Milne Bay. Other coastal provinces in PNG also have so many rich and unspoiled coral reefs. People in PNG depend on coral reefs for food, income and even for cultural practices. PNG's fishing industry is one of the country's most important sources of income which depends on healthy reefs for its survival.

Most of the commercial species of fish like lobster and sea cucumbers live or breed in reefs. Reefs protect coastal villages and coastlines from the enormous waves caused by cyclones and storms, by breaking the force of the waves before they reach the shore. The skeletons of old corals are eventually broken down into sand by waves, helping to build up our beaches. These beaches and healthy coral reefs are potentially worth millions of kinas in tourism to PNG. This is because no tourist wants to dive in a dead reef with no fish. Corals can help save lives, since certain important medicines from corals are being developed and used to help cure people around the world of diseases like cancer. We still have much to learn about coral reefs. Some reef organisms do not even have names yet.

Most reefs in PNG are in fairly good condition, but we must remember that despite their size, we can affect the health of the oceans. Coral reefs happen to be one of Earth's most fragile environments. Reefs around the world are in serious trouble and we have brought many reef species to extinction. Many animals depend on coral reefs for protection and when reefs are damaged, they die.

Species of fish are disappearing from coral reefs around the world due to unsustainable fishing techniques and over-fishing (fish are being harvested faster than they are reproducing). This is the greatest threat to PNG's reef ecosystems. Our traditional fishing methods are being replaced with modern technologies that have drastically increased the rate at which fish are caught.

There is great evidence of over-fishing around Port Moresby. All around the country, people are over-harvesting creatures like sea cucumbers, trochus, green and clams.

Many species die when they become entangled in old discarded nylon fishing lines, nets and plastic 'six-pack' rings. Sea birds and turtles can also suffocate after feeding on plastic bags and balloons that look like jellyfish which is one of their favorite food sources.

Destruction of reef habitats

There are a number of unfortunate ways in which human beings impact marine ecosystems in Papua New Guinea. The major impacts include: destruction and pollution of marine habitats.

Destruction of marine habitats often occurs along coastlines where human beings live. It is reported that in PNG, one quarter of the coral reefs have already been lost due to human activities. Run off from soil and deforestation (cutting down trees from forests) increases the amount of dirt in the water. This dirt enters the sea and makes it cloudy. The animals that make up the coral reefs cannot live in cloudy water.

The following human activities are seriously threatening the health of our coral reefs in PNG:

- *Harmful fishing practices*
  These include the use of dynamite to supply the high demand for fresh fish to Port Moresby and to other countries. Derris roots, dynamite, and cyanide poisoning are used illegally to collect fish. These methods not only kill fish but also kill the coral polyps.
  Reefs are occasionally damaged by fishermen who mechanically break them in order to capture life fish. Fishing nets often accidentally capture unwanted animals such as juvenile fish, dugongs, sharks, turtles, whales or porpoises. Over-harvesting one type of animal from the reef often has a bad effect on the delicate balance between living things on the reef.

- *Pollution*
  The biggest threat to corals worldwide is pollution from industrial chemicals, sewage, agricultural chemicals and toxic household wastes. After it rains, water running over the ground carries rubbish trash, oils, and other wastes from the land into the rivers and eventually into the sea. Large quantities of pollution are poisonous to corals. Littering is a major concern consisting mostly of plastic waste piles up in PNG's mangroves, reefs and coastal areas.

Other threatening activities include:

- *Collection of life corals* to sell to tourists as souvenirs. In the case of coral mining, coral is collected to use as building blocks in construction, since materials to build roads, buildings and schools are often scarce or non-existent on islands. Corals are also used for lime production for chewing betel nut.

- *Deforestation* of coastal forests can cause soil to erode and wash down to the ocean with the rains. When the soil gets to the ocean, it clogs up the coral reefs with sediments and suffocates them. Coral polyps get deprived of necessary nutrients and oxygen. Furthermore, silty waters prevent sunlight from reaching the corals thus preventing photosynthesis and coral growth stops. Corals grow best in clear, salty water.

- *Boats and divers* add to the problem by anchoring or poling boats on top of reefs. These damage coral reefs which take hundreds of years to grow back. People who dive or snorkel damage reefs when they accidentally break off pieces with their gear. Propellers from boats can also churn up sediments that smother reefs**.**

- *Coral bleaching* is due to increase in surface temperature of the oceans caused by global warming and climate change. The tiny algae that live in the corals provide corals with food and bright colouring. When they are stressed by increase in temperature the algae can die making corals lose their colours and turn white. In 1996 and 1997 about 54% of the coral in Milne Bay experienced bleaching.

Now do Activity 2.

Activity 2

1. List the illegal fishing techniques and give reasons why they are regarded as illegal.

_____

_____

_____

_____

_____

2. What is coral bleaching?

_____

_____

_____

3. Define overfishing.

_____

_____

_____

Check your answers after the summary.

Can we save Papua New Guinea's coral reefs?
Yes, we can save the coral reefs. If we do not act quickly to protect our unique coral reefs now, these destructive practices could threaten the survival of marine life and the future of fisheries in our country. In Indonesia and the Philippines, people have destroyed most of

their coral reefs. Without reefs, people have less fish left to feed their families or to sell to make a living.

The following are some practical steps people are taking to protect reefs around the world:

- *Education*
  The most important thing you can do to help save reefs is to maximise your role as an educator. In order to protect coral reefs, people need to understand the important role they play in the natural balance of the Earth, and in the diversity of life that they hold. Understanding often leads to concern, concern leads to a desire to protect, and a desire to protect leads to action – the ultimate goal. If you can help even several of your friends and relatives to understand, care about, and protect coral reefs, you have fulfilled a very important goal.

  If you want to take your role one step further, you can even lead a coral reef conservation club in your community or village. You could take the conservation message to each home. When reefs are lost, the human communities that depend upon them can also be threatened, as they no longer have their primary source of food, jobs, cultural heritage, and prosperity. By working together, we have the potential to help protect PNG's coral reefs.

- *Fishing reserves and marine protected areas*
  A fishing reserve is a place where fishing is prohibited in certain areas or times of year to provide safe areas for breeding. These reserves allow areas that have been overfished to regenerate damaged fish populations. In order for the reserves to be successful the local people or fishers must be involved.

  Conservation International, along with PNG government and other organisations, is working towards implementing a community-based Marine Protected Areas in Milne Bay Province and or areas where destructive fishing practices are restricted or closely monitored.

- *Marine zoning*
  Different uses can be assigned to different areas of a reef, which is called marine zoning. One zone can provide total protection from humans, while another area can be used for tourism, and another for fishing.

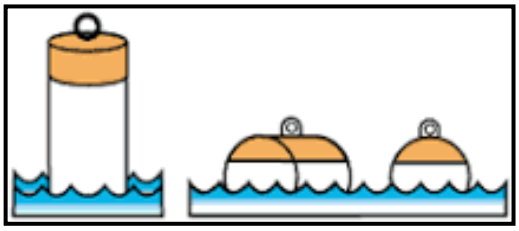
- *Pollution prevention*
  Preventing pollution is a much better solution than cleaning it up later. Some companies are looking for new ways to make their products without using potential pollutants. Consumers play an important role in pressuring companies to stop polluting. Another way to reduce industrial pollution is through carefully designed government regulations.

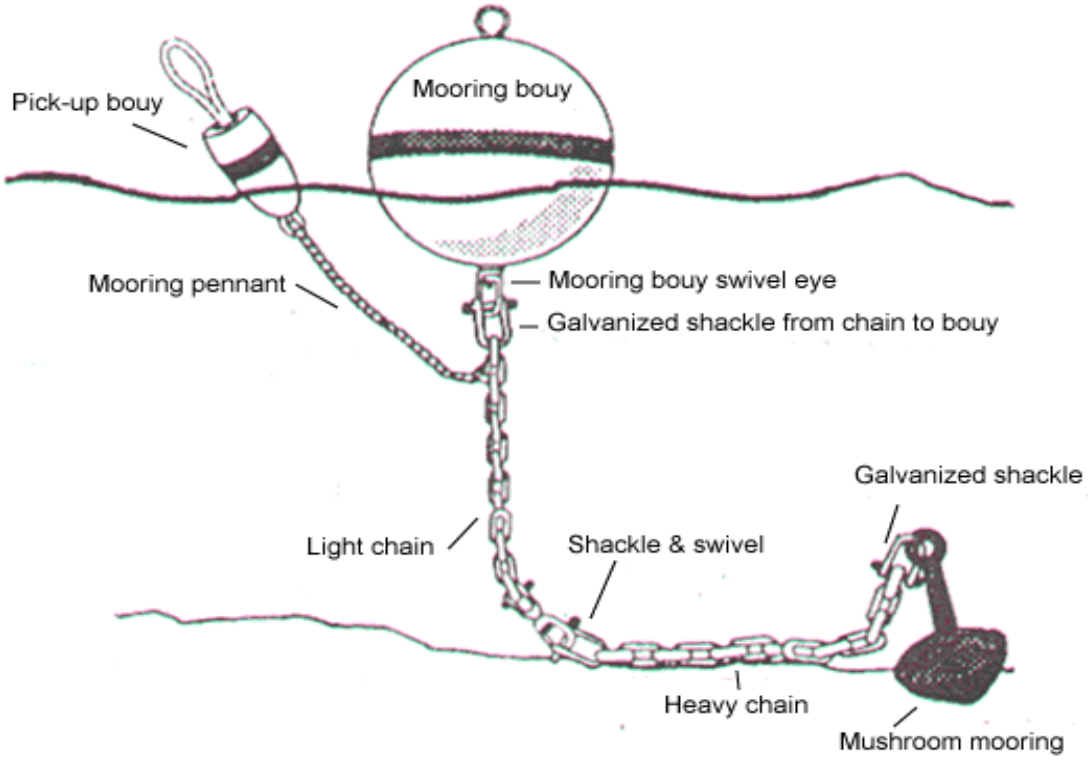
- *Government regulations*
  The fourth goal of our nation's constitution pledges to safeguard PNG's environment, including marine ecosystems. The government also has several legislative acts protecting marine resources like the Fauna Protection and Control Act (1982) which

declares the dugong and leatherback turtle protected species. Under the Fisheries Management Act (1998), the use of destructive fishing methods such as explosives and poisonous chemicals are prohibited.

- *Moorings, not anchors*
  To protect reefs, boats can use permanent **mooring buoys** that are drilled into the sea floor instead of using anchors along the reef. (Using an anchor would destroy coral when it is thrown in and lifted out of the water).

See below here a picture of a mooring buoy and what it may look like on the surface of the sea. The rest of the mooring buoy stays below. (See diagram below)





- *Decrease deforestation*
  One strategy to prevent siltation on coral reefs is to stop cutting trees on steep slopes near water bodies. Logging and exposing loose soil on steep slopes is particularly damaging, since erosion occurs faster on steep slopes. One way to prevent deforestation is to find ways to use coastal forests without cutting them, since standing forests can provide many financial rewards for local people.

Conservation and protection of reefs will ensure continued abundance of fish for the coming generations.

Most Importantly, REMEMBER: Save energy, save oil, prevent oil spills.

Think about how many lights you have in your house, as well as all the electronics like computers or TVs. All of these things use electricity. If we all were to turn off lights, computers and televisions when you are not using them, we would not be using as mush oil to create the electricity throughout the house. If everyone around the world decided to use less oil, we would lower the risk of a large spill, like the one that recently happened in the Gulf of Mexico.

Now read the summary.

Summary

You have come to the end of Lesson 10. In this Lesson, you have learnt that:

- seas or oceans are bodies of salty water.
- oceans form a vast marine environment covering over 70 percent of the earth surface.
- marine habitat refers to the home to a host of different species from planktonic organisms that form the base of the marine food web to large marine mammals.
- pollution is defined as an harmful substance in the natural environment that can cause harm or adverse change to the natural and human environment.
- marine pollution occurs when harmful effects from chemicals, particles, industrial, agricultural and residential waste, noise or the spread of invasive organisms enter the ocean.
- Papua New Guinea has diverse marine environments.
- human beings impact marine ecosystems in Papua New Guinea. In two main ways: destruction and pollution of marine habitats.

- some harmful human activities includes: harmful fishing practices, pollution, collection of life corals, deforestation, boats and divers, coral bleaching and mangroves destruction.
- we can save PNG coral reefs through education, fishing reserves and marine protected areas, marine zoning and pollution prevention, government regulations, moorings and decrease deforestation.

Answers to Activity 1

1. Sand, circular or round shape
2. Coral reefs grow very slowly and they are actually the oldest communities on earth. Most of the reefs we see now have been growing for over 5,000 years. Since they grow so slowly, reef ecosystems are very fragile, and cannot recover quickly from damage.
3. Queensland
4. Fringing reef: grow along mainland shores/coastlines and edges of islands

   Barrier reef: coral reefs separated from land by open sea

   Atoll: circular reefs growing upwards from an underwater volcanic peak with a lagoon in the centre.

Answers to Activity 2

1. The use of dynamite fishing to supply the high demand for fresh fish to Port Moresby. Derris roots, dynamite, and cyanide poisoning are used illegally to catch fish. These methods not only kill fish, but also kill the coral polyps.
2. Coral bleaching is due to increase in surface temperature of the oceans caused by global warming and climate change. The tiny algae that live in corals provide corals with food and bright coloring. When they are stressed by increase in temperature the algae can die making corals lose their colors and turn white.
3. Overfishing is when fish are being harvested faster than they are reproducing.

NOW DO PRACTICE EXERCISE 10 ON THE NEXT PAGE

Practice Exercise 10

For Question 1 fill in the missing words in the blank spaces.

1. Marine habitats can be divided into near-surface _____ and deep-water _____ habitats.

2. Define marine habitat.

_____

_____

_____

_____

_____

3. Explain why factories need to treat their discharge waters first before releasing them into the main water bodies?

_____

_____

_____

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_____

_____

_____

4. Define marine pollution.

_____

_____

_____

_____

5. Give at least 6 names of life forms that are found in PNG marine environment.

(i)

(a) _____

(b) _____

(c) _____

(d) _____

(e) _____

(f) _____

6. Discuss the formation of corals.

_____

_____

_____

_____

_____

7. State one way of stopping siltation on coral reefs.

_____

_____

_____

_____

8. What are some ways to save coral reefs? List three ways and briefly explain each one.

_____

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_____

9. List four harmful practices that damage coral reefs?

CHECK YOUR ANSWERS AT THE END OF TOPIC 3

Lesson 11: Industrial Pollution

In the last lesson, you learnt about marine pollution. In this lesson you will continue to learn about pollution, particularly industrial.

Your Aims:

- explain industrial pollution
- identify the different types of industrial wastes that harm the environment.
- describe the environmental problems and solutions to industrial pollution.
- identify and explain solutions to industrial pollution

Can you recall the definition of pollution you have learnt in the last lesson? You will have to keep that definition in mind as we go through this lesson.

What is industrial pollution?

Illustration 10.2.11a: The world's most polluted city is Linfen, China**.** China's State Environmental Protection Agency also reported that Linfen—in Shanxi province—has the worst air in the country.

Source: China Mike

Industrial pollution is pollution from the factories and industries. It is the major source of global air, water and soil pollution. It refers to all types of pollution which can directly or indirectly be linked with industry. Industrial pollution is the biggest source of pollution in most of the developed world because they have many, many industries. In the United States for instance, industrial pollution makes up for more than half of the nation's total pollution (data from the U.S. Environmental Agency). Industrial pollution is becoming a major problem in fast developing countries like China and India where it has already created huge problems in the form of too much water and air pollution (see above illustration and column graph on amount of carbon dioxide released into air.)

Fossil fuels are usually the main causes of too much industrial pollution. The main source of fossil fuel is coal, and it is the dirtiest energy source. When coal is burnt, carbon dioxide is released into the atmosphere. Carbon dioxide is the main greenhouse gas that traps heat and increases global air temperature. Industries that deal with the burning of fossil fuel is the main reason for the big increase in carbon dioxide (CO_2) being produced in the last few decades.

Due to rapid global industrialisation, industrial pollution has even spread to the Earth's poles. Scientists have found traces of industrial pollutants in samples of ice cores from Antarctica and the Arctic. Industrial pollution does not only affect our environment but human health as well. Those people who work in high polluting factories and those who live close to factories are in the same way exposed to this pollution.

Study this figure showing the amount of carbon Dioxide released into the air between 2007 and 2030.

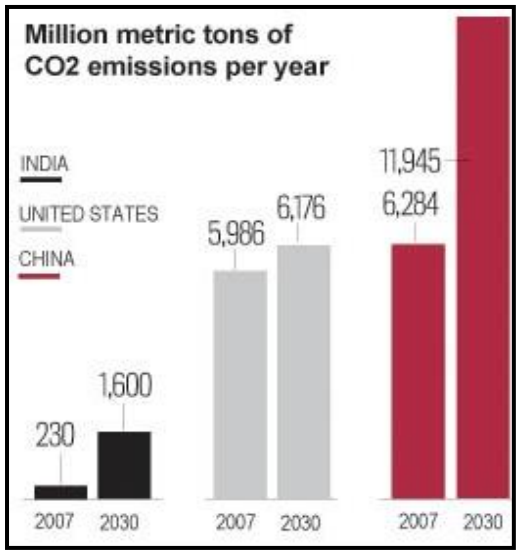


Figure 10.2.11b: By 2030, China's carbon dioxide emissions could equal the entire world's CO2 production today**,** if the country's carbon usage keeps pace with its economic growth.
Source: China Mike

Many industrialised nations have realised the importance of this issue and have carried out very tight restrictions to control industrial pollution. However, in order to successfully tackle the issue of industrial pollution, the world will have to reach several international deals such as international climate change. Reaching such types of deals is very difficult because of the difference in opinion between developed and the developing countries. For example, China and India do not want to slow down their rapid industrialisation because they argue that the responsibility for current environmental issue lies mainly on the developed countries. Due to globalisation, industrial pollution can reach every part of the world and its effects widespread. The most obvious proof to this is 'climate change' and rising sea level.

Globalisation describes a process by which national and regional economies, societies, and cultures become integrated through the global network of trade, communication, immigration and transportation.

Let us now look at the different types of industrial wastes.

Types of industrial wastes

Industrial waste is the waste produced from industrial activity such as that of factories, mills and mines. This activity has existed since the start of the Industrial Revolution.
Just about every company and industry that manufactures a product creates waste in the process.
In Papua New Guinea we are familiar with (these) activities in,

- mining,
- agricultural,
- hospital, and
- industrial gaseous,
- solid wastes, and the wastes these activities produce.

In industrialised and developed countries like Japan and North Korea they have nuclear power plants that generate wastes as well. Industrial waste types include substances like **synthetic** chemicals, acids, oils and metals. Industries that produce metals also produce scrap metal and slag (a byproduct of smelting ore). Mining processes leave behind chemical wastes which are usually dumped into river systems. Nuclear plants, meanwhile, create radioactive waste, and manufacturing plants generate many types of chemical waste.

Environmental problems

1. Mining wastes

In February, 2013, *Mining Watch Canada* reported on an investigation by Earthworks that revealed mining companies dump more than 180 million tonnes of hazardous mine waste each year into rivers, lakes and oceans worldwide. This is threatening vital water bodies with toxic heavy metals and other chemicals poisonous to humans and wildlife. Six out of twelve of the world's waters that are suffering the greatest harm or are at greatest risk from dumping of mine waste are here in Papua New Guinea. The mines are Ok Tedi, Porgera, Ramu Nickel, Lihir, Simberi and Tolukuma.

Illustration 10.2.10b: Incised braided reach transporting mine waste, Kawerong River, Bougainville.

Before the closure of the Bougainville Copper Mine, the Kawerong River was a steep gravel bed river transporting both waste rock and more than 100,000 milligram per litre of tailings. Large amounts of waste rock were deposited on the valley floor until drainage was diverted away from the toe of the waste rock dump. This reduced erosion and loss of material. A *wave of incision* then moved through the valley leaving the terraces shown here. Most of the tailings passed through the Kawerong were deposited in the Jaba River, downstream.

Mine processing wastes, also known as *tailings,* can contain as many as three dozen dangerous chemicals including arsenal, lead, mercury and processing chemicals such as petroleum byproducts, acids and cyanide. Waste rock or *overburden*, is the extra rock that does not contain significant amounts of ore, but can also generate acid and toxic pollution.

The dumping of mine tailings and waste rock pollute waters around the world, threatening drinking water, food supply, health of communities, and aquatic life and ecosystems.

2. Air pollution

Industrial pollution is one major cause of air pollution. With the increase in the number of industries and factories due to Industrial Revolution (and to the present), air pollution has also increased significantly. The gases given off from various industries contain large amounts of carbon dioxide, sulphur and nitrogen, among others. These gases, when present in high levels in the atmosphere, often result in various environmental and health hazards such as acid rain, and various skin disorders in individuals.

Disposal of all kinds of wastes has become a major issue of modern industrial life. Here are some ways of disposing industrial wastes;

- Depositing them in landfills
- Incineration
- Releasing them into oceans
- Burial in underground caverns
- Deep-well injection, where wastes are injected into permeable rocks inside deep wells
- Recycling
- Finding new uses for byproducts of industrial processes
- Using waste products as fuel

3. River Pollution

Let us now examine the Ganges River in India, and the nature of industrial pollution in the river.

The Ganges River starts in the western Himalayas and flows south then east and empties into the Bay of Bengal. It is the longest river in India by its water discharge. It is the most heavily populated river basin in the world with over 400 million people.

It was ranked among the five most polluted rivers of the world in 2007, with *fecal coliform* (waterborne bacteria) levels in the river to be more than one hundred times the official Indian government limits. Pollution threatens not only humans, but also fish and amphibian species and the endangered Ganges river dolphin. The Ganga Action Plan, an environmental initiative to clean up the river, has been a major failure. This is due to corruption and lack of technical expertise, good environmental planning and support from religious authorities. From the plains to the sea, pharmaceutical companies, electronics plants, textile and paper industries, tanneries, fertiliser manufacturers and oil refineries discharge toxic waste

Map 10.2.10c: Location of the Ganges River in India

into the river. These hazardous wastes include hydrochloric acid, mercury and other heavy metals, bleaches and dyes, and pesticides. These are highly toxic compounds that add up in animal and human tissue. Water runoff from farms in the Ganges basin also adds chemical fertilisers and pesticides such as DDT, which is banned in the United States because of its toxic and cancerous effects it has on humans and wildlife.

Now, take a look at the following illustration. It shows industrial wastes in the Ganges.

Illustration 10.2.10d: Wastes pollution in the Ganges

When industrial wastes, public wastewater, hospital and hazardous nuclear wastes, and agricultural chemical wastes are dumped directly into the river it causes river pollution. This affects the quality of the river water and aquatic environment including fisheries, silt, flora and fauna and other living and non-living things related to river.

4. Soil Pollution

Soil pollution occurs when the soil loses its fertility due to natural and man-made reasons. Dumping of industrial wastes is one of the main factors contributing towards soil pollution. Industrial wastes contain large amounts of various chemicals which add up on the top layer of the soil, and leads to the soil losing its fertility.

The table below shows three of Papua New Guinea's mines that are among the six worst water polluting mines in the world.

Mines, Location	Type of dumping	Tailings dumped each year
Grasberg, West Papua	River	Greater than 80 million [1]
Batu, Hijau, Indonesia	Marine	Greater than 40 million [2]
Ok Tedi, Papua New Guinea	River	Greater than 22 million [3]
Wabush Scully, Labrador, Canada	Lake	Greater than 13 million [4]
Lihir, Papua New Guinea	Marine	Greater than 5 million [5]
Porgera, Papua New Guinea	River	Greater than 5 million [6]

If wastes coming from industries and factories is not treated to neutralise its harmful effects and let to flow into water bodies including river, sea, lake or water canal, it adds to pollution of water. Similarly, if waste water coming from homes is not treated before dumping into water bodies it also adds to the already polluted water. If we consume polluted water we may suffer from various diseases of serious nature like gastro, joint aches, kidney problems and liver diseases.

If fumes from vehicles and factories are more than the limits set by environmental supervisory bodies they add to air pollution and in the end destroy the air. Therefore,

smoke producing systems of our vehicles, aeroplanes and factories must be scientifically developed to give off less gas.

Now do Activity.

Activity

1. Explain Industrial Pollution.

_____

_____

_____

2. Describe how fossil fuels are seen as the main cause of excessive industrial pollution.

_____

_____

_____

_____

_____

3.

(a) Describe the type of industries that dump waste into the Ganges River.

_____

_____

_____

_____

_____

_____

_____

_____

(b) Describe the types of wastes that is dumped into the Ganges.

_____

_____

_____

_____

_____

_____

_____

Check your answers after the summary.

Industrial waste management in PNG

Currently there is no waste management policy that outlines procedures and processes involved in industrial waste management in Papua New Guinea.Total Waste Management (TWM) in Papua New Guinea was established in October 2011 with a key focus to provide worthwhile and logical waste management solutions to major industrial operators in PNG. The service also extended to those operating in remote locations. Since its introduction to Papua New Guinea, TWM has been successful in securing major contracts with major mining, and Oil and Gas Companies in Papua New Guinea.

TWM specialises in providing industrial waste management services within Papua New Guinea. TWM always aims to meet its goals, with all waste management services in this order.

1. Avoid 2. Reuse 3. Recycle 4. Dispose

Export of hazardous wastes and other intractable types

Many waste types, even those that can be **recycled**, cannot currently be treated in PNG for a number of reasons. Waste **lubrication** oils are made in huge amounts for the development of projects in the mining and petroleum sectors. Waste oil is a recyclable product. Recycling requires a constant supply of waste oil and a use for the recycled product.

TWM has license to export waste oil. It has exported over 300kL of product for recycling overseas. Waste oil is safely packaged and transported to Lae or Port Moresby ports and then exported to Australia. TWM has a close relationship with an award winning Australian company that specialises in dealing with all forms of intractable waste.

Obsolete chemicals

TWM employs expert industrial chemists to help customers deal with left over or **obsolete** chemicals. The staff has a wealth of knowledge in classifying, packaging, transport and disposal of all kinds of industrial waste and chemicals. They bring a team into any part of the country to undertake projects.

Now read the summary.

Summary

You have come to the end of Lesson 11. In this Lesson, you have learnt that:

- industrial pollution is directly or indirectly linked with industry.
- fossil fuels are the main causes of excessive industrial pollution.
- many industrialised nations have forced strict restrictions to control industrial pollution.
- countries such as China and India do not want to slow down their rapid industrialisation because they blame the developed countries for industrial pollution
- industrial wastes are produced by industrial activity from factories, mills and mines.
- industrial wastes include substances like synthetic chemicals, acids, oils and metals.
- the Ganges basin is heavily populated with millions of people.
- six out of twelve of the world's waters that are suffering the greatest harm or at greatest risk from dumping of mine waste are in Papua New Guinea.
- tailings can contain as many as three dozen dangerous chemicals including arsenic, lead, mercury and other chemicals.

Answers to Activity

1. All types of pollution which can directly or indirectly be linked with industry.
2. Fossil fuels are usually the main causes of too much industrial pollution. The main source of fossil fuel is coal, and it is the dirtiest energy source of them all. When coal is burnt, carbon dioxide is released into the atmosphere.
3.
   (a) Pharmaceutical companies, electronics plants, textile and paper industries, tanneries, fertiliser manufacturers and oil refineries.
   (b) These hazardous wastes include hydrochloric acid, mercury and other heavy metals, bleaches and dyes, pesticides, and polychlorinated biphenyls--highly toxic compounds that collect in animal and human tissue. Runoff from farms in the Ganges basin adds chemical fertilisers and pesticides such as DDT.

NOW DO PRACTICE EXERCISE 11 ON THE NEXT PAGE

Practice Exercise 11

1. What is seen as spreading to the earth's poles?

   _____

2. What is seen as the main obstacle to reaching international agreements on Climate Change deals?

   _____

   _____

   _____

3. State the difference in opinion between the developed and the underdeveloped countries.

   _____

   _____

   _____

4. List the four industrial wastes types.

   (a) _____

   (b) _____

   (c) _____

   (d) _____

5. Differentiate between tailings and overburden.

   _____

   _____

   _____

   _____

   _____

   _____

6. Explain how industrial pollution can create air pollution.

   _____

   _____

_____

_____

_____

7. Explain why it is important to treat wastes coming from industries, factories and homes?

_____

_____

_____

_____

_____

_____

CHECK YOUR ANSWERS AT THE END OF TOPIC 3

ANSWERS TO PRACTICE EXERCISES 9-11

Practice Exercise 9

1. Words and meanings.
   I. Tributary. A stream or river that feeds its discharge into a larger river.
   II. Food chain. A chain of life forms and their feeding patterns, starting with a producer and ending with a consumer.
   III. Food web. Made up of more than one food chain.
   IV. Scarce resource. A resource that is limited in quantity and will soon run out if it is not managed wisely.

2.
   (a) An imbalance in aquatic and marine ecosystems
   (b) Species loss and extinction
   (c) Intestinal diseases contracted by people who eat fish harvested from polluted waters.
   (d) Spread of water borne diseases from person to person.

3. Water is necessary to life on earth. Plants, animals and humans need water for survival. Polluted water affects life and can kill fish, birds, and other animals. Pollution makes waters unpleasant to drink, look at, smell, and swim in. Fish and shellfish harvested from polluted waters may be unsafe to eat and people who drink polluted water can become very ill.

4.

Pollutant	Source	Effects
Disease causing agents	Domestic sewage and animal waste	Illness from water- borne diseases such as; typhoid, cholera, dysentery, diarrhea
Oxygen demanding waste	Natural runoff from land, human sewage, animal waste, decaying plant life, urban storm water runoffs	Loss of oxygen and therefore fish killed, plant life destroyed, smelly water
Sediments	Erosion, logging, runoff from agricultural, mining and urban land uses, especially land left bare and mud is the pollutant in volume	Rivers become silted and choked by sandbars, flooding increases, fish are smothered, there is a reduction in the waters ability to assimilate oxygen demanding waste.
Organic chemicals	Oil from oil drilling, vehicle wastes, pesticides used on forest plantations, plastics and detergents from homes and industries	Oil disrupts all ecosystems, detergent encourage algae growth, kill fish, take oxygen, and chlorine compounds harm fish, cause smells, may cause cancer in humans
Organic waste	Human and animal wastes (excreta) and agricultural fibrous waste which can be decomposed through biological action, that is , are biodegradable but is being degraded and they use up oxygen in rivers and lakes , and the germs of cholera, typhoid, dysentery can also be spread.	

5. Waterborne diseases are diseases that are caused by the contamination and pollution of water. The three common types are:
   - Cholera – severe infectious disease caused by the cholera bacteria. Symptoms of cholera are diarrhoea and loss of water and salts in the faeces. A person becomes infected by coming in contact with water and faeces of others who have the disease.
   - Typhoid – a severe infectious disease caused by the typhoid bacteria- *bacillus salmonella*. The bacteria is transmitted by milk, water, or solid food contaminated by faeces of typhoid patients or other healthy persons who are carriers of the bacteria.
   - Diarrhoea – frequent passing of watery faeces. It is a symptom caused by food poisoning from contaminated food or drink, infections by bacteria or viruses, and anxiety.
6. Main sources of water pollution and river systems are:
   - Sewage
   - Agricultural waste
   - Chemical waste from factories and mines
   - Oil spills from oil tanker

Practice Exercise 10

1. Pelagic and demersal
2. A marine habitat refers to the home to a host of different species ranging from planktonic organisms that form the base of the marine food web to large marine mammals.
3. When waste or discharge water is treated, it is made less harmful.
4. Marine pollution occurs when harmful or potentially harmful effects from chemicals, particles, industrial, agricultural and residential waste, noise or the spread of invasive organisms enter the ocean.
5.
   (a) Sharks
   (b) fishes,
   (c) sea cucumber
   (d) coral polyps
   (e) dolphins
   (f) starfish
   (g) tortoise

   (Any one of these 6 answers is correct.)
6. Corals are made up of colonies of tiny animals called coral polyps. Polyps are nocturnal animals that live in colonies. Some coral polyps feed on plankton and some also get food from tiny algae.
7. Decrease deforestation. The cutting of trees on steep slopes near water bodies must be reduced because erosion of loose soil is faster on steep slopes.

8.

Education
- The most important thing you can do to help save reefs is to maximize your role as an educator. In order to protect coral reefs, people need to understand the important role they play in the natural balance of the Earth, and in the diversity of life that they hold.

Fishing reserves and marine protected areas
- A fishing reserve is a place where fishing is prohibited in certain areas or times of year and also providing safe areas for breeding. These reserves allow areas that have been over-fished to regenerate damaged fish populations.

Marine zoning
- Different uses can be assigned to different areas of a reef, which is called marine zoning. One zone can provide total protection from humans, while another area can be used for tourism, and another for fishing.

Pollution prevention
- Preventing pollution is a much better solution than cleaning it up later. Some companies are looking for new ways to make their products without using potential pollutants. One way to reduce industrial pollution is through carefully designed government regulations.

Government regulations
- The fourth goal of our nation's constitution pledges to safeguard PNG's environment, including marine ecosystems. Effective monitoring and enforcement is crucial to successful regulations.

Moorings, not anchors

To protect reefs, boats can use permanent mooring buoys that are drilled into the sea floor instead of using anchors along the reef.

Decrease deforestation
- One strategy to prevent siltation on coral reefs is to stop cutting trees on steep slopes near water bodies. Logging and exposing loose soil on steep slopes is particularly damaging, since erosion occurs faster on steep inclines.

(Accept any three correct answers)

9. Harmful practices that destroy coral reefs.
-Harmful fishing practices
-Pollution
-Collection of life corals
-Deforestation
-Boats and divers
-Coral bleaching
-Destruction of mangroves

(Any four of these answers are correct)

Practice Exercise 11

1. Rapid global industrialisation
2. Difference in opinion between developed and the developing countries.
3. China and India did not want to slow down their rapid industrialisation because they argue that the responsibility for current environmental issue lies mainly with the developed world.
4. Synthetic chemicals, acids, oils and metals
5. Tailings can contain dangerous chemicals such as lead and mercury, and other chemicals. Waste rock or *overburden*, is the extra rock that does not contain significant amounts of ore, but can also generate acid and toxic pollution.
6. The gases given off from various industries contain large amounts of carbon dioxide, sulphur and nitrogen. These gases result in various environmental and health hazards such as acid rain and various skin disorders in individuals.
7. If wastes coming from industries and factories is not treated to neutralise its harmful effects and let to flow into water bodies including river, sea, lake or water canal, it adds to more water pollution. Similarly, if waste water coming from homes is not treated before dumping into water bodies it also adds to the already polluted water.

TOPIC 4: CONSERVATION AND THE PRESERVATION OF THE ENVIRONMENT

In This Topic, You Will Learn About:

- **Conservation of the Environment**
- **The Green Revolution**
- **Conservation in Papua New Guinea**
- **Environmental Repair and Protection**
- **Case Study: Conservation in Papua New Guinea**

TOPIC 4: INTRODUCTION

In this Topic, you will learn about these themes:

- Conservation of the Environment
- The Green Revolution
- Conservation in Papua New Guinea
- Environmental Repair and Protection
- Case Study: Conservation in Papua New Guinea

Learning Outcome:

Students will be achieving this outcome, when they, for example:

- communicate ideas and information in a variety of ways

In Topics 1, 2 and 3, you learnt about the environment and how people changed and influenced their environments and consequences of these changes on the environment.

In Topic 4, you will identify and discuss ways to conserve our local environment through the assistance of non-government organisations and the government of Papua New Guinea. Papua New Guinea has a vast biodiversity of plants and animals which we must look after for the future generations. In your own communities you can get involved by carrying out informal awareness on the importance of conserving the environment by planting trees where necessary.

You will also look at a case study about conservation in Papua New Guinea which will discuss the different efforts by people, and conservation organisations in the country. It will identify endangered and threatened plant and animal species in PNG and suggest ways to protect these living things from extinction.

Towards the end of the topic you will look at ways to repair and protect the environment. It is important to know that before any part of an environment is protected by law it must be repaired. Deforestation is one harmful human activity that causes a lot of problems to the environment. Therefore if trees have been cut new trees must be planted or if certain animal population is decreased in a part of the sea or forest, hunting or overfishing, for example, must stop to allow for particular animal or plant species to grow again.

Lesson 12: Conservation of the Environment

In Lesson 11, you learnt about the marine pollution in the environment. In this lesson you will look at why we need to conserve the environments of the world. You will discuss also the issues and effects of peoples' actions on the environment.

Your Aims:

- discuss what conservation is
- identify our resources in the world
- how we can preserve these resources
- tell the impacts of our actions on world resources

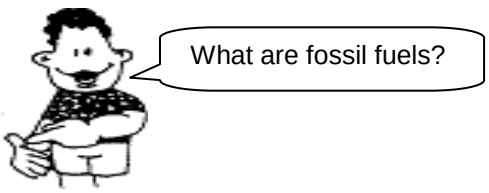
When we look around us, the Earth seems to have no limits. The land, vegetation, oceans and the air around us stretch to the horizon and beyond. They seem to be endless. However, if we looked at the Earth from a spaceship, we could easily see that there are limits to the Earth. There is a secure amount of land, water, forest and air available on this planet. In fact, planet Earth is like a spaceship moving through space. When a spaceship begins its journey, it has on board a certain amount of food, water and oxygen to support the astronauts. If the astronauts use these resources unwisely, they will not survive the journey through space. If the Earth is like a spaceship and we are the astronauts, could we face the same danger? If we cause too much disturbance to our natural surroundings, we run the risk of disrupting the essential processes that allow all life to live on this planet.

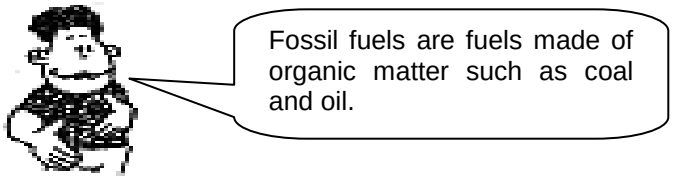
What is conservation?

Conservation is the sustainable use of natural resources, such as soils, water, plants, animals, and minerals for future generations. It is using your environment and everything around you wisely.

Identifying our resources

Natural resources are of two types, renewable and non-renewable. Renewable resources include wildlife, natural vegetation of all kinds, water, soil and air. Non-renewable resources are resources that cannot be replaced or that can be replaced only over very long periods of time. Such resources include fossil fuels, namely, coal, petroleum, natural gas, and metals.





How we can preserve these resources

1. *Why is it important to conserve forests?*

Forests are important to our survival on earth. You can refer back to Lesson 8 to refresh your memory.

2. *Why is it important to conserve soil?*

Conserving land protects habitats, forests, and natural landmarks to improve the quality of the air we breathe, water we drink, and the food we eat. The land produces most of the food people need. However, not all land is **arable**, that is, suitable for farming. Figure 10.2.12a shows arable land as a scarce resource. Only a small percentage of the world's land surface is suitable for cultivation. Already in many countries, people are using the arable land and are now clearing land that is not suitable for cultivation.

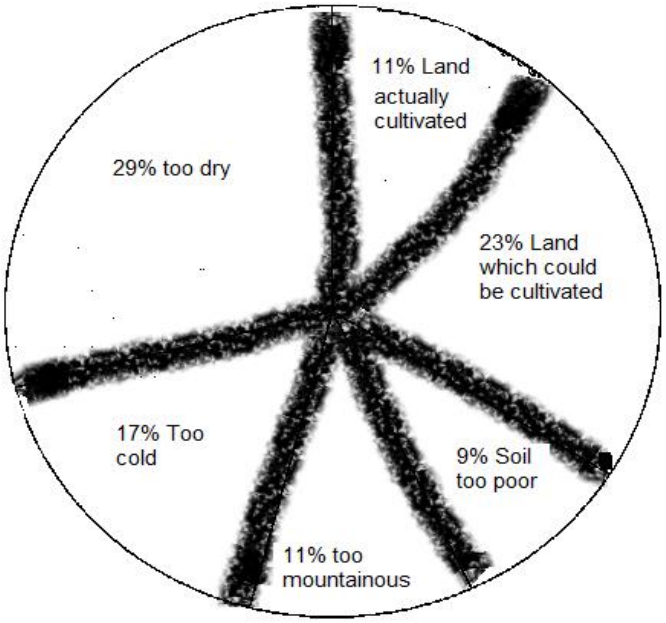


Figure 10.2.12a: Uses of land on earth.

Methods of soil conservation

- Zoning of land for specific use
- Use of soil building plants in crop rotations
- Use of strip cropping
- Use of fertilisers to get back fertile soil

If the land is not used carefully it can be completely destroyed. We must use the land in ways that do not destroy it for future use. Among the basic measures for soil conservation currently in use is the **zoning** of land by specific use. In this system the more level and stable soils are selected as suitable for annual crops, and other areas are chosen for perennials, such as grass and legumes, or for use as grazing or forest lands. Another conservation method involves the use of soil-building plants in **crop rotations**. Such crops hold and protect the soil during growth and, when ploughed under, supply much-needed organic matter to the soil. Cultivation methods that leave a layer of vegetable waste on the surface of the soil represent a major advance in land use. Another soil-conservation method is the use of **strip-cropping**, which is, alternating strips of crop and fallow land. This method is valuable for control of wind erosion on semi-arid lands that need to lie **fallow** for efficient crop production. In addition, the maintenance of soil fertility at the maximum level of production often involves the use of chemical fertilisers.

Soil is the foundation for society. Healthy soil is necessary for sustainable production of food, which allows a society to exist. Loss of soil fertility has been a contributing factor to every civilisation in history that has collapsed. It is important to think about how we have damaged the soil using modern and industrial methods in agriculture.

3. Why is it important to protect animals?

The animals and plants of our environment seem to be of little practical value to many people. Wildlife conservation is the practice of protecting endangered plant and animal species and their habitats. Among the goals of wildlife conservation are ensuring that nature will be around for future generations to enjoy and recognise its importance for humans.

Government agencies help to conserve wildlife through design of rules to protect wildlife. Conserving wildlife is an important practice. This is due to the bad effects of man's activities on wildlife and endangered species. Refer to Lesson 7 on endangered species.

4. Why is it important to conserve water?

Conserving water is important. Water covers about 70 per cent of the earth. The majority of the earth's water is saltwater. Fresh water is only 3 per cent of the planet's water, and the majority of that is frozen as glaciers and ice caps or is under ground.

In Papua New Guinea, we are lucky because water is not a scarce resource. However, in many parts of the world people suffer from water shortages because of very dry climates. Both the amount and quality of water are important because they affect people's health, their ability to stay clean, and grow crops. Diseases such as typhoid, cholera, and diarrhoea are spread through unclean water.

According to the United Nations, more than one out of six people (1.1 billion) in the world lack access to safe drinking water, and more than two out of six (2.6 billion) lack adequate sanitation. As global population continues to rise, the resulting increase in demand for clean water will put huge strain on the environment and some experts predict that the global wars of the next generation will be fought not over fossil fuels, but water.

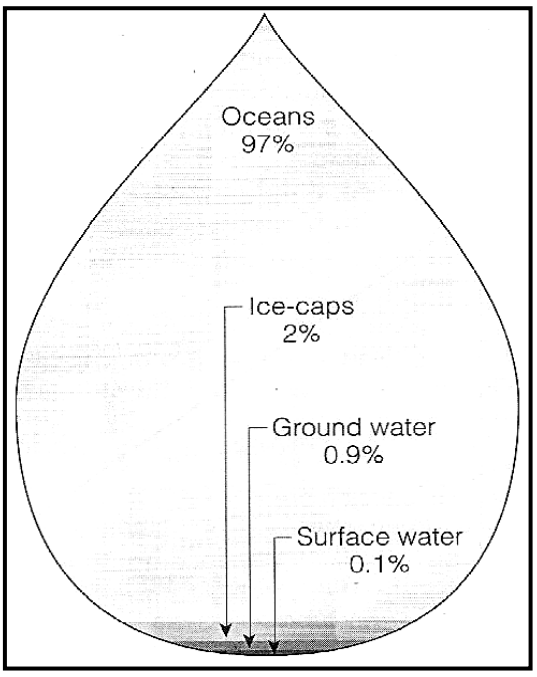


Figure 10.2.12b: Distribution of water on earth.

5. Why is it important to conserve air?

Nowadays almost everything we need or want costs money. However, there is one basic need that is free, the air we breathe. In Papua New Guinea, there is so much fresh air around us that we do not even think about it. But it is not the same everywhere. In some of the large industrialised cities of the world, the air is polluted by gases and smoke from factories and vehicle fumes that some people have breathing problems. Some even buy oxygen masks to help their breathing when air pollution levels rise too high. Polluted air can cause health problems.

To conserve air is to protect and clean the earth's air supply.

6. Why is it important to conserve energy?

To conserve energy is to reduce the total amount of energy used. When we reduce our use of energy we help to lessen the level of greenhouse gas emissions that add to climate change and global warming.
Fossil fuels are limited energy resources that will become depleted. For this reason conserving energy is important to ensure future energy delivery; at least until renewable energy industry will mature enough to replace fossil fuel fired power plants. There are various ways you can contribute to energy conservation. You can, for instance, not always using your car, instead choose either to walk or ride the bike. Also, when buying new devices for your household, make sure that they are energy efficient devices because such devices will use up less energy.
The environmental condition of our planet is getting worse with each day so do not forget that energy conservation also helps our environment.

CASE STUDY

Here are some ways to help conserve environment, plants and animals species.

Illustration 10.2.12c: Movement corridor, Toronto, Canada

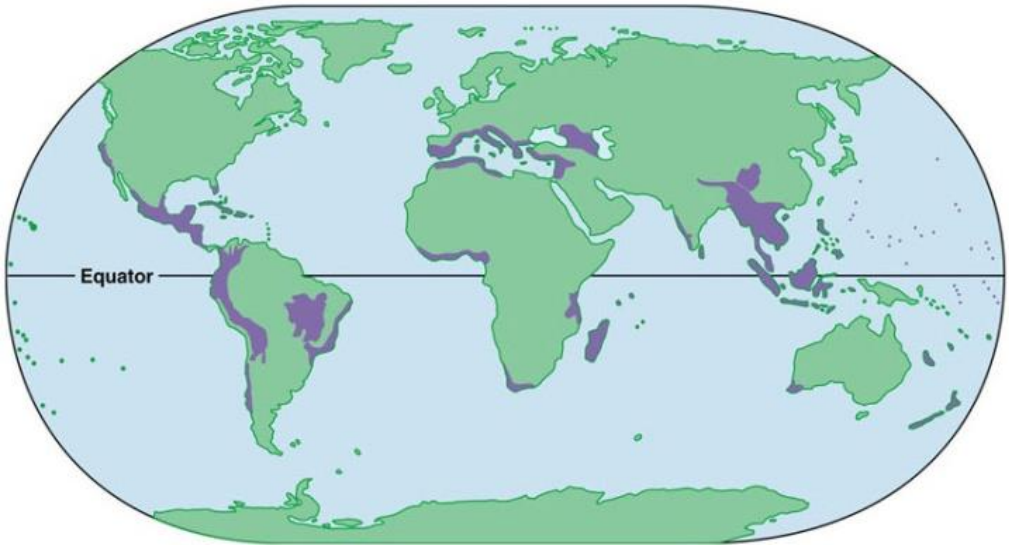
a. Landscape ecology and movement corridors

- A goal of landscape ecology is to study human land use patterns and make biodiversity conservation a priority.
- When habitats are split into parts by human development it is sometimes possible to develop **movement corridors** to connect pieces of high quality habitat. These may go for many kilometres or they may be local man-made corridors to protect wildlife.

b. Protected areas

- Not everything can be protected, so scientists are focusing on protecting biodiversity hotspots. These are small areas that have a fairly high number of species. Hotspots can be seen in purple (darker colour) on the map below; and because of their great diversity, these hotspots are also at great risk from development.
- Fisheries biologists are using NO FISH zones to protect breeding stocks, and nursery grounds.

WORLD PROTECTED AREAS



- **Protected areas on volcanoes (in Papua New Guinea)**

In late 2006, local [illegible] Map 10.2.12d: World wildlife protected areas [illegible]es of Mt Bosavi to celebrate 3 new protected areas. Covering 80,000 ha of the Kikori River Basin, these areas are home to pristine rainforests and rich wildlife such as the world's longest lizard and giant pigeons and butterflies. WWF has been heavily involved in supporting the local communities of Bosavi to declare parts of their land as Wildlife Management Areas.

c. Restoration ecology

Illustration 10.2.12e: Controlled burns

- The goal of restoration ecology is to develop ways to return degraded ecosystems to conditions as similar as possible to their natural, pre-degraded state.
- These techniques have been used to bring spawning salmon back into rivers and streams where they once bred.
- Controlled burns are sometimes used (see the Illustration 10.2.12e).
- **Bioremediation** uses plants and microbes to remove toxic chemicals for polluted areas. This has been used successfully to help clean-up oil spills.
- The on-going **Everglades Restoration Project** is one of the largest restoration projects ever attempted, and is still many years from completion.

d. Zoned Reserves

- Zoned reserves are protected areas that are surrounded by zones in which there is human habitation, but the land is protected from extensive alteration.
- Costa Rica has used the concept of zoned reserves to protect much of its biologically diverse land. The government and people of Costa Rica should be commended for their attempts to both manage their rich biological resources, and work towards a plan for sustainable development.
- Hopefully Papua New Guinea and other countries will consider this case study and consider ways to conserve plants and animal species, and the environment.

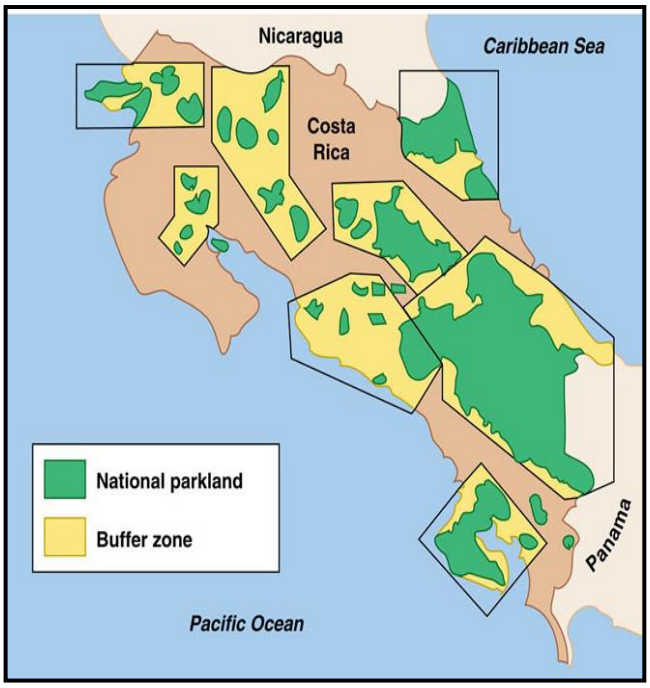


Illustration 10.2.12f: Map showing zoned reserves in Costa Rica, Central America.

Effects of our actions on resources

Look at the following photograph showing an example of man's effect on the rainforest.

Illustration 10.2.12g: Cutting of trees in the rainforest for logging has left the soil bare.

Now, you will look at three effects of our actions on our resources. These effects are:

1. Threat to biodiversity
2. Chemical pollution in the environment
3. Global warming

1.

(a) Threat to biodiversity

- Biodiversity has three components:

  -Genetic diversity. This is the pool of genetic information and variations found in the biosphere.

  -Species diversity. The number of different life-forms found on the planet. Almost 2 million species have been described to date.

  -Ecosystem diversity. The unique groupings of interact communities scattered around the globe.

- When populations are reduced or species become extinct, genetic information is lost forever without us ever knowing its potential benefit to both that species, and to mankind.
- There is a list of threatened and endangered species (both in the U.S. and worldwide). At present 24% of mammalian species are endangered and approximately 20% of freshwater fish have gone extinct or are threatened with extinction. Many plants, insects, and other invertebrates are also endangered.
- Coral reef and tropical forest ecosystems have been and are being seriously impacted by man's activities. In the late 1990's, illegal wild fires, that were set

to clear rainforest in Borneo (Indonesia), caused severe air pollution in Singapore, Malaysia, and the surrounding region that the governments of those countries called a regional conference to address the issue.

(b) Importance to Biodiversity

- Plants, microbes, and animals contain a vast genetic diversity that may in the future provide many needed products for mankind.
- About 25% of all pharmaceuticals contain chemicals derived from plants.
- Many companies are 'bio prospecting' for useful enzymes and drugs. They do this by screening for useful enzymes in microbes that live in unusual or extreme habitats, by looking for cancer fighting chemical in marine invertebrates (sponges do not get cancer), or by searching tropical forests for potential pharmaceuticals.
- Healthy ecosystems control runoff and erosion. They can absorb excess nutrients before they cause **eutrophication**. They provide the pollinators needed for agricultural crops, and provide organisms for the biological control of agricultural pests.
- We do not know what future discoveries can improve our lives, but we do know that this will not happen if we lose the biodiversity upon which it depends.

Illustration 10.2.12h: Eutrophication is a natural process that occurs in an aging lake or pond as that body of water gradually builds up its concentration of plant nutrients.

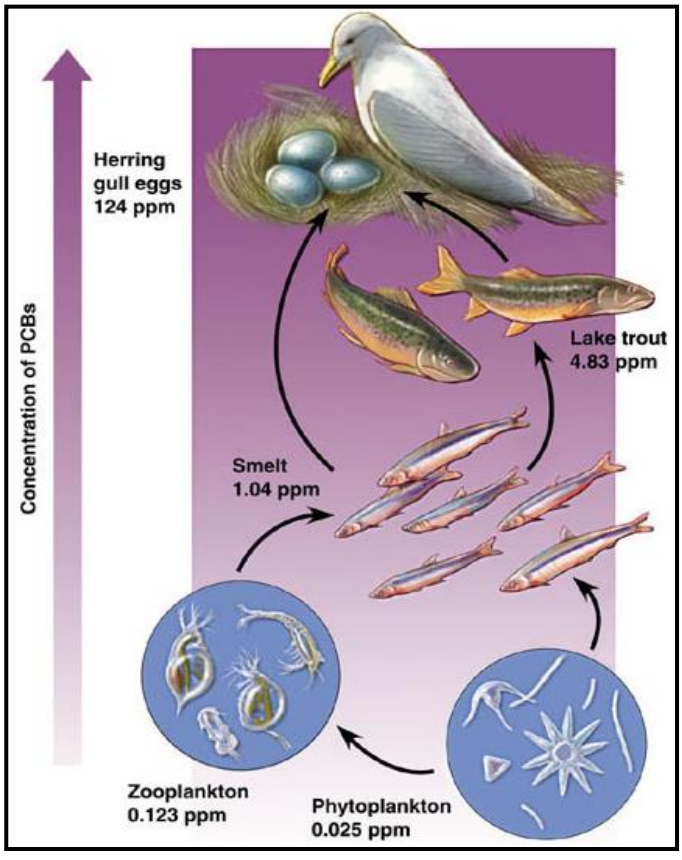
Artificial eutrophication occurs when human activity introduces increased amounts of these nutrients, which speed up plant growth, and eventually choke the lake of all of its animal life.

2. Chemical Pollution in the Environment

- **Biological magnification** is the reason that species at the top of the food chain are more toxic than those at lower trophic levels. Bio means 'life', and magnification means to increase in amount.
- Compounds, such as DDT and PCBs, have in the past and are presently causing environmental problems. Study the illustration of biological magnification in Illustration 10.2.12h. PCBs, or polychlorinated biphenyls, are industrial products or chemicals. PCBs were banned in 1979 by the US government.
- Oil spills can destroy or disrupt local coastal ecosystems and communities.
- Loss of large parts of the ozone layer has come about through the use of chlorofluorocarbons in aerosol cans. That is way these compounds have been banned in air-conditioners and refrigeration units.
- Mercury is a naturally-occurring toxic element which has a complex cycle between the Earth's crust, atmosphere and oceans. Some mercury is released by natural processes but the main emissions to the atmosphere result from human activities.

- Mercury deposited in wetlands, lakes and streams can be converted by natural bacteria into methylmercury, a toxic form that is gathered and biomagnified at each link in the food chain. In some circumstances, the result is sport fish that would be toxic if eaten by humans and prey fish that may be toxic to wildlife that eats them.
- Eutrophication that is caused by the runoff of nitrates and other nutrients from the land, has created large areas that are without oxygen. There is a major dead zone in the Gulf of Mexico off the Mississippi River Delta. (see following map)
- Sea areas starved of oxygen will soon damage fish stocks even more than unsustainable catches, as believed by the United Nations.
  BBC News Monday, 29 March, 2004

Map 10.2.12i: Map showing the 'dead zone' in the Gulf of Mexico



PPM stands for "parts per million" and is used to describe the amount of certain chemicals in a substance.

Ppm calculations also are used by government agencies to determine whether air, soil or water is, polluted enough to be hazardous to human health. For example, the Environmental Protection Agency (EPA) intervenes when the amount of copper in water exceeds 1.3 ppm.

Figure 10.2.12j: The build-up of the concentration of DDT in the body of organisms through a food chain.

3. Global warming

- Atmospheric scientists believe that the evidence for global warming is overwhelming. Something really must be done to limit greenhouse gas emissions. Part of the rise in global temperature may be due to long term atmospheric cycles; however man's activities have probably been the major contributing factor. The data on global temperatures given in the graph below was collected at Mauna Loa, Hawaii, U.S.A.

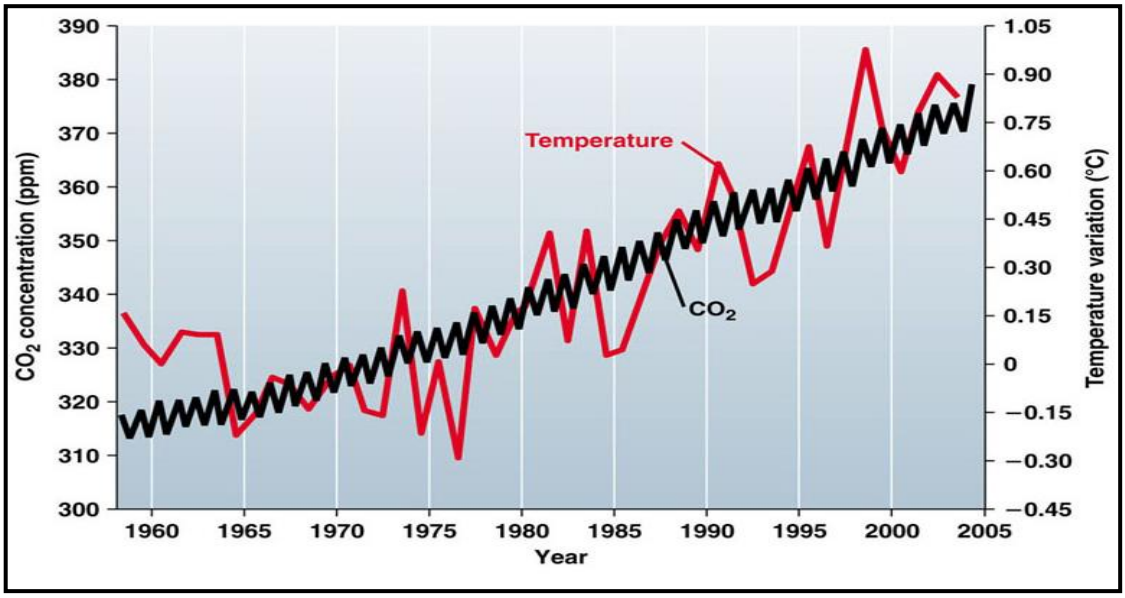


Figure 10.2.12k: CO_2 and temperature variations

- The greenhouse effect is shown in the Figure 10.2.12l. An average temperature rise of only a few degrees Celsius can lead to significant sea level rise and changed rainfall pattern. We must not wait too long to control greenhouse gases, it may take a long time to see positive change. It is like trying to stop a freight train when there is a truck on the track ahead. You can hit the brakes when the train is 200 yards away from the truck, but it will not stop for another ½ kilometre!

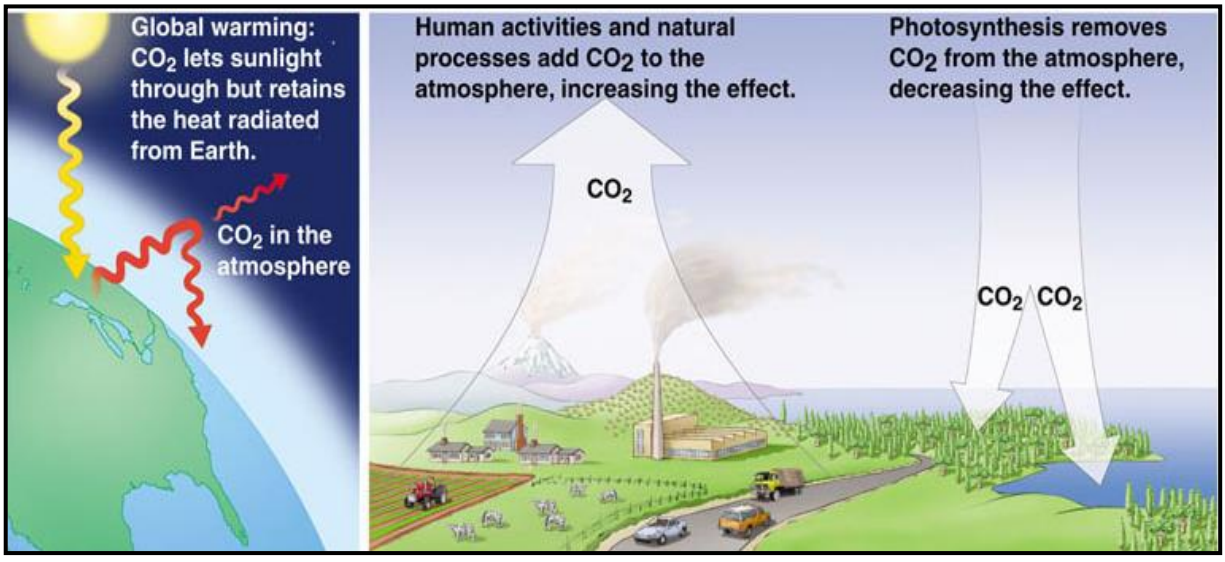


Figure 10.2.12l: Effects of global warming

Now read the summary.

Summary

You have come to the end of Lesson 12. In this lesson, you have learnt that:

- there is a secure amount of land, water, forest and air available on this planet.
- conservation is the sustainable use of natural resources, such as soils, water, plants, animals, and minerals for future generations.
- natural resources are of two types: renewable and non-renewable.
- land conservation protects habitats, forests, and natural landmarks.
- there are four methods of land conservation.
- wildlife conservation is the practice of protecting endangered plant and animal species and their habitats.
- government agencies are dedicated to wildlife conservation to help implement policies designed to protect wildlife.
- Numerous independent non-profit organisations also promote various wildlife conservation causes.
- wildlife conservation has become an important practice due to the negative effects of human activity on wildlife and endangered species.
- in many parts of the world people suffer from water shortages because of very dry climates.
- in some places people have polluted much of their water.
- a basic need that is free is the air that we breathe.
- the conservation of air is the protection and cleaning of the earth's air supply.
- air pollution is caused by a number of sources.
- there are different methods that reduce the total amount of energy used by industries, households and various other sectors.
- there are ways to improve and conserve environments, plants and animals' species.

NOW DO PRACTICE EXERCISE 12 ON THE NEXT PAGE

Practice Exercise 12

Read the lesson notes and answer questions.

1. Why is it important to conserve soil?

_____

_____

_____

_____

2. Why is it important to protect animals?

_____

_____

_____

_____

3. Why is it important to conserve energy?

_____

_____

_____

_____

4. Why is it important to conserve air?

_____

_____

_____

_____

5. Why is it important to conserve water?

_____

_____

_____

_____

_____

_____

6. How have man's activities affected biodiversity?

_____

_____

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_____

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_____

7. Explain how chemical pollution is harmful to the environment.

_____

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_____

8. What are some ways environments, plants and animals' species can be conserved?

_____

_____

_____

_____

_____

_____

9. Explain how bioremediation is useful to restoring ecology?

_____

_____

_____

_____

10. According to your notes, which country is using Zoned Reserves to protect its biological diversity?

_____

CHECK YOUR ANSWERS AT THE END OF TOPIC 4

Lesson 13: Green Revolution

In the last lesson you learnt about the conservation of the environment. In this lesson you will learn about Green Revolution, its purpose and impact on agricultural farming.

Your Aims:

- explain Green Revolution
- discuss the purpose of Green Revolution
- explain the impact of Green Revolution on Agriculture and Farming
- identify the advantages and disadvantages of Green Revolution
- discuss the effects of Green Revolution in India

What is Green Revolution?

During the latter part of the 20th century the practice of farming took on a new approach by utilising modern technologies. This movement which was pushed by governments as the answer to traditional agriculture was called the **Green Revolution**. What the supporters of the Green Revolution promised was a highly efficient method for planting and harvesting crops. This was mainly to increase the yields of farms everywhere with the goal of getting rid of starvation throughout the world and in particular developing countries.

After the Second World War, American chemical manufacturers who had been given contracts to make weapons for the war effort needed to find an outlet for their products. They soon discovered that they could create fertiliser rich in nitrates, which could be used on crops. The fertiliser itself is made from petroleum, which was refined crude oil. This was the beginning of the Green Revolution.

Illustration 10.2.13a: New varieties of wheat and other grains that was instrumental to the Green Revolution.

For some time leading up to the introduction of the petrochemical fertiliser, there had been the gradual introduction of machinery into the process of farming. What had been done in the olden days was soon being swept away by how suitable modern technology is. These new methods of cultivation are unquestionable, as farming had been very labourous. The farmer did not have to rely on horses and oxen to plow a field, but drive a tractor far easier and quick, and cultivate a large area of land in a shorter period of time.

The Green Revolution involved a series of research, development and technology transfer initiatives. This led to increased agricultural production worldwide in the late 1960s particularly in the developing countries. The Green Revolution resulted in remarkable increase in cereal-grains production in Mexico, India, Pakistan, the Philippines, and other developing countries in the 1960s and 1970s. The initiatives were led by Norman Borlaug, the "Father of the Green Revolution" who was recognised for saving over a billion people from starvation.

Purpose

The important developments were:

- the high-yielding varieties of cereal grains,
- expansion of irrigation infrastructure,
- modernisation of management techniques,
- distribution of hybridised seeds,
- synthetic fertilisers, and
- pesticides to farmers.

The illustrations below show fertiliser being sprayed on crops, and the man who founded the idea of the Green Revolution.

Illustration 10.2.13b: Increased use of various technologies such as pesticides, herbicides, and fertilisers.

Illustration 10.2.13c: Norman Ernest Borlaug, the 'Father of Green Revolution'

Impact on agriculture and farming

The Green Revolution brought about major changes in agricultural practices in many parts of the developing world. It sought to get rid of famine in many nations and greatly increased food production. This was done by effectively ending subsistence agriculture and replacing it with commercial agriculture.

The idea was to transplant many of the systems, ideas and technology of Western farming into (mainly) Asian agriculture, whilst researching and utilising the resources Asian countries had. It was largely funded by the Rockefeller Foundation, the Ford Foundation and some other major agencies. There was same-time development of new varieties of food plants and improved agricultural techniques, resulting in greatly

increased crop yields.

Illustration 10.2.13d: Highly mechanised irrigation system in the United States that helped irrigate large fields of cereal grains.

The Rockefeller and Ford Foundations established the International Rice Research Institute (IRRI) in the 1960s. This institute developed new High Yielding Varieties (HYV) of various crops, which spread through the more democratic countries of the region such as Indonesia, Pakistan, India, parts of South America and North Africa. The United States Aid (USAID) became involved by funding infrastructure developments and fertiliser shipments.

Now do Activity 1.

Activity 1

1. What did the supporters of Green Revolution promised would be the ultimate outcome of it?

_____

_____

_____

_____

_____

_____

2. State the key purpose and goal of the Green Revolution.

_____

_____

_____

_____

_____

3. What was involved in the Green Revolution?

_____

_____

_____

_____

_____

_____

Here is a list of measures adopted in the Green Revolution.

- Use of high yielding varieties (HYV) of seeds
- Irrigation
- Use of insecticides and pesticides
- Consolidation of holdings
- Land reforms
- Improved rural infrastructure
- Supply of agricultural credit
- Use of (chemical) fertilisers
- Use of Sprinklers or Drip Irrigation

In this list, you will see the positive and negative impacts of the Green Revolution.

Positive Impacts

(i) Increase in food production or yield.

(ii) Advantage to farmers was the fact that their economic situation was improving. Even small and marginal farmers (although they were late in joining) were getting better yield, control on many insects and pests and mechanizing improved working conditions.

(iii) Better land use by employing two and three crop pattern.

(iv) Better scientific methods applied as required by farms.

(v) New seeds have been developed with better yield and disease fighting capability.

(vi) Good earning by farmers.

Negative Impacts

(i) Degradation of land was due to change in land use pattern and employing two and three crop rotation every year. Land quality was reduced and yield has suffered. Also due to heavy chemical fertiliser inputs land has become hard and carbon material is reduced.

(ii) Weeds have increased due to heavy crop rotation pattern. No rest was given to the land nor were given time to pay for proper weeding removal system which has increased weeds.

(iii) Pest infestation has increased in number. Pests which were controlled by bio degradable methods have become resistant to many pesticides and these chemical pesticides have become non effective.

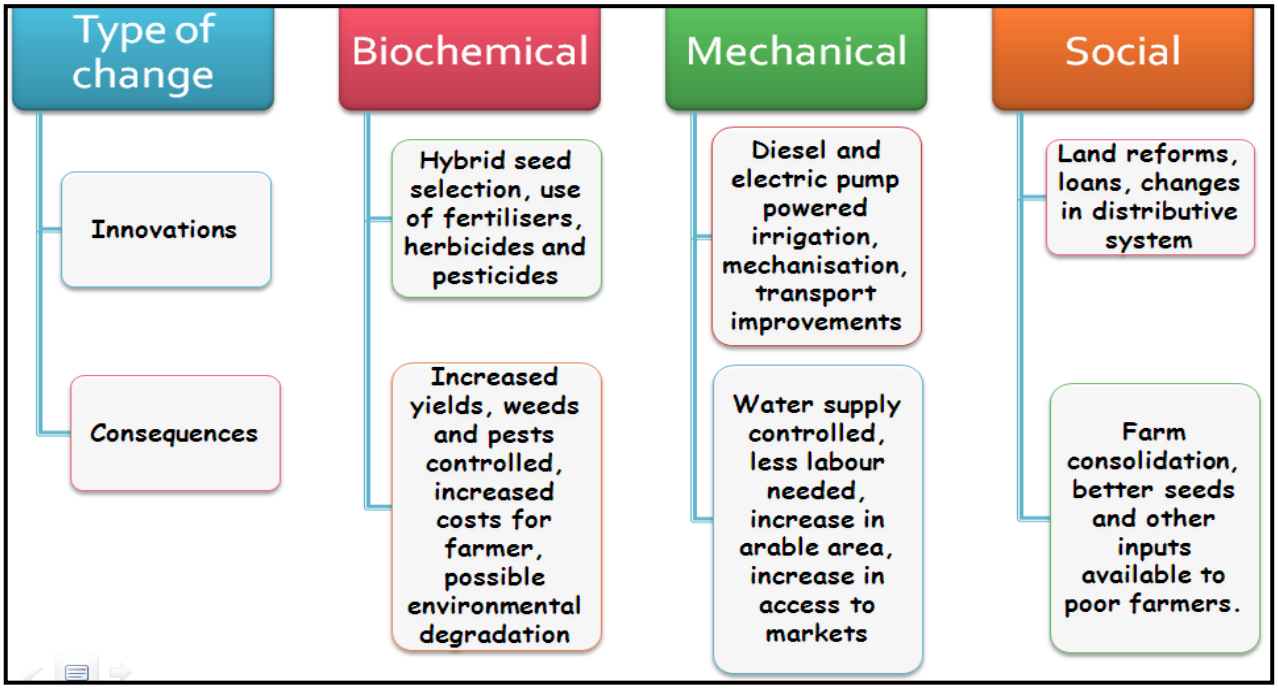
(iv) Loss of biodiversity due to heavy use of chemical pesticides, insecticides and fertilisers. Many birds and friendly insects were lost and this is a big loss in the long term.

(v) Chemicals in water came from chemicals used in the farms. They went down and contaminated ground water which affected the health of people.

(vi) Excess use of fertilisers has made the soil infertile.

Take a look at the diagram below. It shows 3 major strands in Green Revolution and its attempts to transform agriculture in terms of social, biochemical and mechanical.

Read the three strands of the Revolution shown in the table below.



The social aspect of the Green Revolution was concerned with leaving behind the cultural practices in relation to land ownership. This was done by trying to join smaller inefficient family land holdings into bigger more profitable plots. This also made facilities available to farmers to borrow money and to improve rural road infrastructure so that the farmers could better access local and world markets. The land reforms had disastrous impacts on many small famers and destroyed a culture of subsistence farming in some areas. The *Borrowing Money Facility* was also risky, because one poor harvest would mean many very poor farmers could end up bankrupt.

The Biochemical part of it involved increasing crop yields by using More Economically Developed Country's technology to raise production levels. Seed selection, fertilisers and pesticides were all used to increase yields. These biochemical changes were supported by mechanical improvements in irrigation and farm mechanisation. Farm mechanisation means that there were more machines used in farming than human labour. In this case, the richer farmers could profit from these, but poorer farmers could not and soon found themselves at

Illustration 10.2.13e (*right*): IR8 High Yielding Rice

risk of being bought out by wealthier neighbouring farms.

Genetic modification and seed selection

One of the biggest improvements made within the Green Revolution was seed selection of plants with the best properties to fit certain environments. The IR8 is a variety of rice which was promoted throughout Asia and had the following properties:

- Shorter stems
- Narrower leaves
- Standard plant length and height
- Insensitive to variations in day length and **photoperiod**
- Matures more rapidly
- Yields are higher

Let us take a look at the more common myths surrounding the Green Revolution.

Common Myths

*Myth**:** Hunger is the result of over population, and more food is needed to be produced in order to eliminate it.*

*Fact***:** Although the world population is growing and has undergone intense expansion within the past few decades, there is still enough food being produced to feed everyone. In fact, there is currently a surplus of food now since agriculture and governments are saying that there is not enough being produced.

According to calculations based on information provided by the Food and Agriculture Organisation's *1992 FAO Yearbook Vol. 46; there* is enough food to provide everyone on earth with at least 3,500 calories a day. It should also be noted that this figure does not include some foods such as nuts, fish, and grass-fed meat. What can be said about the amount of hunger in the world is that it is because of an uneven system of distribution for food resources. The desire and interest for profit and the poorly carried out government rules are seen as the main causes for global hunger. Food shortage is not the reason.

*Myth**:** Traditional methods of small farmers are primitive and inefficient, which leads to small yields in crops.*

Fact**:** Small farmers have been time and again shown to produce higher yield than larger industrialised farms. The total amount of production of large scale farms cover up for their weaknesses. The small farmer is more likely to take care in planting and harvesting their crops, as they depend on them for their incomes. There are also factors suggesting that traditional methods are inefficient. Small scale farms are capable of growing crops in combination with one another to make the most of their land.

Now do Activity 2.

Activity 2

1. State two environmental impacts brought about by the Green Revolution.

   (a) _____

   (b) _____

   _____

2. What was the primary cause of global food shortage according to the Food and Agriculture Organisation Yearbook Report of 1992?

   _____

   _____

   _____

   _____

   _____

Check your answers at after the summary.

The introduction of these high-yielding varieties of seeds and the increased use of chemical fertilisers and irrigation are known collectively as the Green Revolution.

Now read the summary.

Summary

You have come to the end of Lesson 13. In this Lesson, you have learnt that:

- the introduction of High Yielding Varieties (HYV) of seeds, increased use of chemical fertilisers and irrigation are known as Green Revolution.
- the Green Revolution involved a series of research, development and technology transfer initiatives.
- the Green Revolution brought about major changes in agricultural practices in many parts of the developing world.
- the Green Revolution resulted in remarkable increase in cereal-grains production in Mexico, India, Pakistan, the Philippines, and other developing countries in the 1960s and 1970s.

- the initiatives were led by Norman Borlaug, the "Father of the Green Revolution" who was recognised for saving over a billion people from starvation.
- the Rockefeller and Ford Foundations established the International Rice Research Institute in the 1960s.
- the IRRI developed new High Yielding Varieties of various crops, which spread through Indonesia, Pakistan, India, parts of South America and North Africa.
- the USAID became involved by funding infrastructure developments and fertiliser shipments.
- the Green Revolution involved 3 major types of change in its attempt to transform agriculture.

Answers to Activity 1

1. They promised a highly efficient method for planting and harvesting crops.
2. To increase the yields of farms everywhere with the goal of reducing hunger throughout the world and in particular developing countries.
3. The Green Revolution involved a series of research, development and technology transfer initiatives. This led to increased agricultural production worldwide in the late 1960s particularly in the developing countries.

Answers to Activity 2

1.
   (i) Loss of biodiversity due to heavy use of chemical pesticides, insecticides and fertilisers. Many birds and friendly insects were lost.
   (ii) Chemicals in water came from chemicals used in the farms. These chemicals contaminated ground water which affected the health of people.
2. The desire and interest of profit and poorly carrying out government regulations were the main causes.

NOW DO PRACTICE EXERCISE 13 ON THE NEXT PAGE

Practice Exercise 13

1. What crop is the IR8? State one of its properties.

_____

_____

_____

2. In your own words, how would you explain genetic modification of plant crops?

_____

_____

_____

_____

3. State one positive and negative impact of the Green Revolution.

(i) _____

(ii) _____

4. Which international donors funded the research for HYVs of cash crops?

_____

_____

_____

5. What does IRRI stands for, and state, its functions?

_____

_____

_____

_____

_____

6. Name 2 democratic Asian countries where Green Revolution spread to.

(a) _____

(b) _____

CHECK YOUR ANSWERS AT THE END OF TOPIC 4

Lesson 14: Conservation in Papua New Guinea

In the previous lesson you learnt about the Green Revolution. In this lesson you will learn about Conservation in Papua New Guinea. Conservation is saving and looking after the environment for the future.

Your Aims:

- define Conservation.
- identify national organisations that promote environmental conservation in Papua New Guinea.
- Identify approaches taken by Papua New Guinea to adopt conservation at both local and international levels.
- discuss alternative ways in which the government can adopt conservation

To conserve something means to take care of it for later use. Conservation means looking after, protecting and managing the natural environment. Traditionally, Papua New Guinean practices conserved resources which meant that they took care of their natural resources and in turn, these resources supported their livelihoods. Today, the rapid increase in the population puts pressure on land and other natural resources.

Before we identify some of the national organisations that promote conservation of the environment within Papua New Guinea, we need to identify reasons why it is important for Papua New Guinea to conserve our natural environment. Environmentalists are groups of people or individuals who are concerned with conserving living things and environments that are still unaffected by Man's activities.
They also try to conserve the natural environment and prevent further exploitation of these natural resources. Even though the various methods undertaken by environmentalists' promoting the idea of conservation are not always legal, these methods in many cases relay the important reasons why we should conserve the environment.

National Organisations that promote environmental conservation in PNG
The Department of Environment and Conservation (DEC) is the government agency responsible for conservation in Papua New Guinea. The government's effort to conserve biodiversity is supported by international environment conservation NGOs. The major research organisations include the Forestry Research Institute (FRI), and the National Agriculture Research Institute (NARI). Government owned universities: the University of Papua New Guinea (UPNG) and the University of Technology (UNITECH) also contribute to novel researches into the PNG biodiversity. These research organisations place emphasis on species with economic value to PNG. The NGOs are the main group behind conserving biodiversity in PNG. The major international NGOs assisting in biodiversity conservation include:

- Conservation International (CI),

- The Binatang Research Centre (BRC),
- Wildlife Conservation Society (WCS), World Wildlife Fund (WWF), and
- The Nature Conservation Society (NCS).

Some indigenous PNG NGOs include Partners with Melanesians (PwM), Research and Conservation Foundation of PNG (RCF), Tenkile Conservation Alliance in Sandaun Province, and PNG Institute of Biological Research. The other conservation organisations that have left include: Conservation Melanesia, Melanesian Environment Foundation, Village Development Trust, and Pacific Heritage Foundation.

Reasons for conserving environments

The idea of conserving the environment and its inhabitants is not a new idea in Papua New Guinea. In traditional Papua New Guinea, our ancestors have always had a special connection with the environment, showing great care and respect for the living things within it. They proved these by taking “just enough” of what they needed from their hunting or fishing trips. However, since the arrival of foreigners and the introduction of money as a medium of exchange, the environment has been overused and greatly affected. Therefore, the government needs to pass and enforce laws that will remind people about the importance of conservation.

Here are 4 reasons for conserving the environment.

(i) If we cause too much disturbance to our natural surroundings, we run the risk of disrupting the essential processes that allow all life, including humans, to live on this planet. The destruction of large areas of rainforest interrupts vital chemical cycles (the water cycle and the carbon cycle) which operate between the land, the oceans and the atmosphere.

(ii) Many plants are extremely useful. About 25 % of the chemicals found in medicines are extracted from rainforest plants. There are thought to be thousands of plants, still unknown to modern science that may be useful in medicine. If we exploit useful animals and plants to the point where they can not renew their populations, they will become extinct and will no longer be available to us. The destruction of the rainforest may cause many animals and plants to become extinct before scientists have the chance to investigate their usefulness.

(iii) Most people appreciate being able to visit different places and see the variety of living things and environments around the world. We owe it to future generations to preserve as many of today’s environments as possible, so that our children can appreciate the Earth’s beauty as we do.

(iv) Natural environments are home to a large number of plants and animals. By destroying environments people are taking away these homes. There are many animals and plants that cannot adapt to changing conditions, so they die.

See the following pictures about Fraser Island which is situated on the east coast of Australia.

Illustration 10.2.14a: Fraser Island.

Source: Wikipedia,
The Free Encyclopedia, 2016

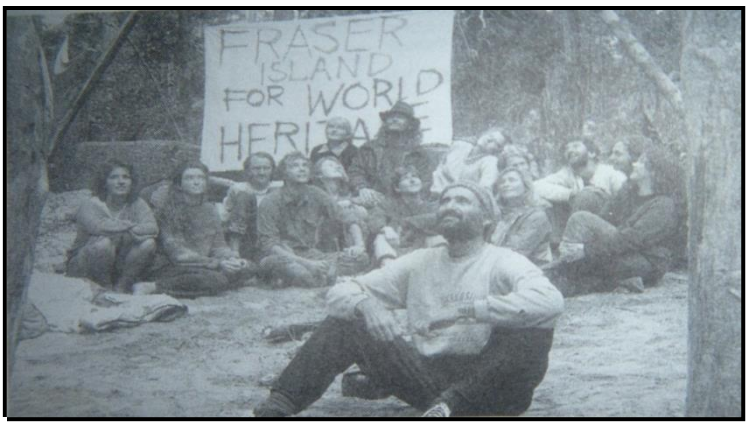


Illustration 10.2.14b: Environmentalists trying to stop logging operations on Fraser Island, Australia.

Source: *Changing World*, NDoE, p. 59

What is Extinction?

Extinction is the dying out of a particular species of plants and animals.

Now do Activity 1.

Activity 1

1. Who are environmentalists?

   _____

   _____

   _____

2. What is the difference between preserve and conserve?

   _____

   _____

   _____

   _____

Check your answers after the summary.

Approaches taken to adopt conservation at all levels

Conserving wildlife

You may feel that there is very little you can do to contribute to preventing the world wide destruction of environments. This is true, as an individual there is very little any single person can do that will make a big improvement in the environment. However, when many individuals all share the same ideas and beliefs, those ideas and beliefs must be listened to by the people in authority, such as the government. Individual people can support the preservation of the environment in these many ways.

There are a number of groups which aim to protect the world's wildlife. Two international organisations are the International Unions for the Conservation of Nature and Natural Resources (IUCN) and the Worldwide Fund for Nature (WWF). Greenpeace is another organisation that has strong links with the Pacific region. Ships owned by Greenpeace try to stop the hunting of endangered species of whales and other marine wildlife. Greenpeace also actively supports the idea of a nuclear-free Pacific. In 1985, the *Rainbow Warrior* was blown up in New Zealand killing one of the Greenpeace volunteers. The Rainbow Warrior was a ship belonging to Greenpeace which was going to demonstrate against the France nuclear-testing programme at Muroroa Atoll.

See here a picture of the *Rainbow Warrior*.

Illustration 10.2.14b: Rainbow Warrior

Source: *Changing World*, NDoE, p. 60

Now do Activity 2.

Activity 2

1. Name the international organisation that actively supports the idea of a nuclear-free Pacific.

   _____

2. Name the ship that was blown up in 1985 in New Zealand? _____

3. Which European country carried out nuclear testing on Murorua Atoll? _____

Check your answers after the summary.

Alternative ways government can adopt conservation

Conservation in Papua New Guinea

Like everywhere in the world, Papua New Guinea's population in the past was much smaller compared to the present. Back then resources were plentiful and were not seriously threatened by overuse. When resources were limited, traditional land practices were developed and put into place to prevent these resources from being destroyed. At the same time wherever and whenever there was a surplus of a harvest it was always shared amongst the clan or tribe. However, today the population of Papua New Guinea has increased rapidly within a short space of time. This puts pressure on the land to grow crops in many areas. The introduction of money has made people become more cash driven meaning they are more interested in selling the resources on their land in exchange for cash.

Papua New Guinea as an Independent nation must be able to make better informed choices and decisions about conserving the limited resources in our natural environment.

There are already several organisations in the country that are concerned with environmental issues. The Melanesian Environment Foundation (MEF) aims to promote awareness, care and concern for the environment to people of all ages. The Friends of the Earth (FOE) had an international network in thirty countries in 1990. They encouraged a safe and sensible use of the environment.

At the *grass roots* level in Papua New Guinea, people want to see their traditional hunting grounds preserved for future generations. The use of guns instead of traditional weapons and cutting of the forests for its valuable timber are both activities that change the environment.

In 1983, laws were passed in the country for Wildlife Management Areas to be created. In many areas there was great concern over the loss of marine and land resources. Crocodiles, mud crabs, prawns, shrimps, pigs, cuscus, fruit bats and several types of fish were all threatened by over hunting.

A Wildlife Management Area is an area of land, usually under traditional ownership, which is protected under the *Conservation Areas Act 1978*. Landowners can catch animals for food but must not overhunt.

Now read the summary.

Summary

You have come to the end of Lesson14. In this Lesson, you have learnt that:

- conservation means looking after, protecting and managing the natural environment. Traditionally, Papua New Guinean

- environmentalists are groups of people or individuals who are concerned with preserving and conserving living things and environments that are still unaffected by Man's activities.
- environmentalists try to conserve the natural environment and prevent further misuse of these natural resources.
- the Department of Environment and Conservation is the government agency responsible for conservation in Papua New Guinea.
- the NGOs are the driving force behind conserving biodiversity in PNG
- indigenous PNG NGOs include Partners with Melanesians, Research and Conservation Foundation of PNG, Tenkile Conservation Alliance in Sandaun Province, and PNG Institute of Biological Research.
- the government's effort to conserve biodiversity is supported by international environment conservation non-government organisations.
- individual people can support the preservation of the environment in many ways.
- there are many international and national organisations whose main interest is to preserve the environment and protect the many species of plants and animals that are threatened with extinction.
- in 1983, laws were passed in the country for Wildlife Management Areas to be created.
- a Wildlife Management Area is an area of land, usually under traditional ownership, which is protected under the Conservation Areas Act 1978.

Answers to Activity 1

1. Environmentalists are groups of people or individuals who are concerned with preserving and conserving living things and environments that are still unaffected by Man's activities.
2. Preserve means to protect living things and conserve means to prevent further exploitation of these living things.

Answers to Activity 2

1. The International organisation that actively supports the idea of a nuclear-free Pacific is Greenpeace.
2. Rainbow Warrior
3. France

NOW DO EXERCISE 14 ON THE NEXT PAGE

Practice Exercise 14

Read your notes and answer questions.

1. What effect would the destruction of large areas of rainforest have on the natural chemical processes?

_____

_____

_____

_____

2. What percentage of chemicals found in modern medicine are found in rainforests?

_____

3. Describe the incident with the *Rainbow Warrior* in New Zealand in 1985?

_____

_____

_____

_____

_____

_____

_____

4. Identify 2 main factors within PNG that has placed enormous pressure on our natural environment.

(i) _____

(ii)_____

5. What are the main aims of these two organisations that are concerned with conservation of natural resources in PNG?

(i) The Melanesian Environmental Foundation (MEF)

_____

_____

_____

_____

_____

(ii) Friends of the Earth (FOE)

6. In PNG at the grass roots level, what do people want to see?

7.

(i) What is a Wildlife Management Area?

(ii) What is the main idea behind the setting up of WMA?

CHECK YOUR ANSWERS AT THE END OF TOPIC 4

Lesson 15: Environmental Care and Protection

In the last lesson you learnt about conservation of biodiversity of plants and animals species in Papua New Guinea. In this lesson, you will learn about environmental repair and protection.

Your Aims:

- define environmental care and protection
- identify organisations and programs that promote environmental care and discuss their importance
- identify projects that promote environmental repair

Introducing the Environment

First of all, let us recall the simple definition of the word environment. The environment is made up of everything around us. It includes both the natural and the man-made features. The natural features of the environment are living and non-living things. They co-exist to maintain the natural balances and keep the ecosystems functioning. The living features include the animals and plants, fungi, bacteria and the genetic resources of the environment.

Air, land, water, soil, minerals, oceans and seas make up the non-living aspect of the natural environment. The man-made or human environment is built by man or come about as a result of man's actions. The natural environment consists of all things found in nature.

Pollution affects our environment. Pollution is contamination or undesirable changes in the physical, chemical or biological characteristics of the air, water or land affecting living things. Pollution causes **degradation** in the natural quality of the environment and offends the senses of sight, taste or smell and can cause health hazard to humans.

Environmental care and protection

In this lesson, when we say environmental care or protection, we are referring to the natural features of the environment that would need care and protection from man's activities.

Environmental protection is about looking after the natural environment at the individual, organisational or governmental levels for the benefit of the environment and everyone else.

Due to the pressures of population and technology, the biophysical environment is being degraded, sometimes permanently. This has been recognised by governments who have begun placing restraints on activities that cause environmental degradation. Since the

1960's, environmental movements have created awareness of the various environmental issues.
Academic institutions offer courses, such as environmental studies, environmental management and environmental engineering, that teach the history and methods of environment protection. Protection of the environment is needed due to various human activities. Waste production, air pollution, and loss of biodiversity (resulting from the introduction of invasive species and species extinction) are some of the issues related to environmental protection.

Environmental protection is influenced by three factors: Environmental legislation, Ethics and, Education.

Each of these factors plays a part in influencing national-level environmental decisions and personal-level environmental values and behaviours. In order for environmental protection to become a reality, it is important for societies to develop each of these areas that, together, will inform and drive environmental decisions.

Programmes promoting environmental care and protection
Let us now look at some approaches to environmental protection.

1. *Voluntary Environmental Agreements*

In industrial countries, voluntary environmental agreements often help companies to be recognised for improving beyond what is expected. In doing this, they support the development of best environmental practices.

2. *Ecosystems Approach*

An ecosystems approach is about how we can manage resources and protect the environment. It aims to look at the difficult relationships in an ecosystem. This involves sponsors across all relevant governmental departments, and representatives of industry, environmental groups and community. This method supports exchange of information, develop ways to solve conflicts and improved conservation in regions.

3. *International Environmental Agreements*

Many of the earth's resources are especially at risk because they are influenced by man's activities. As a result of this, many attempts are made by countries to develop agreements that are signed by several governments to stop damage or manage the impacts of human activity on natural resources. This can include agreements that impact factors such as climate, oceans, rivers and air pollution.

Some of the most well-known multinational agreements include: the Kyoto Protocol, Vienna Convention on the Protection of the Ozone Layer and Rio Declaration on Environment and Development.

4. *Government*

Discussion about environmental protection often focuses on the role of government and law enforcement. However, environmental protection may be seemed to be the responsibility of everyone and not only that of government. Decisions that impact the environment will involve many different sponsors; including industry, native and environmental groups, and community representatives.

Here are some international organisations that promote environmental care.

Earth Island Institute works for solutions to environmental problems by promoting citizen action and protecting a diverse network of projects.

National Wildlife Federation
The nation's largest member-supported conservation group, uniting individuals, organisations, businesses and government to protect wildlife, wild places, and the environment.

Rainforest Action Network
Rainforest Action Network works to protect the Earth's rainforests and support the rights of their inhabitants through education, *grassroots* organising, and nonviolent direct action.

Tree People
Their mission is to inspire the people of Los Angeles to take personal responsibility for the urban forest - educating, training and supporting them as they plant and care for trees and improve the neighborhoods in which they live, learn, work and play.

Trees for the Future
A nonprofit organisation established in 1989 with a mission to help communities in Burundi, Cameroon, Ethiopia, Ghana, Kenya, Mali, Senegal, Tanzania, Uganda, India, Indonesia, Philippines, Brazil, Haiti, and Honduras plant trees.

Rainforest Foundation
The mission of the Rainforest Foundation is to support indigenous people and traditional populations of the world's rainforests in their efforts to protect their environment and fulfill their rights by assisting them.

Nature Conservancy
The mission of *The Nature Conservancy* is to preserve the plants, animals and natural communities that represent the diversity of life on Earth by protecting the lands and waters they need to survive.

Trees Water People
Develops and manages continuing reforestation, preserving local trees, wetlands, watershed protection, appropriate technology, and environmental education programs in Central America, Mexico, and the American West.

World Wildlife Fund (WWF)
Their mission is to stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature, by conserving the world's biological diversity, ensuring that the use of renewable natural resources is sustainable, and promoting the reduction of pollution and wasteful consumption.

Wilderness Society
Their goal is to ensure that future generations enjoy clean air and water, wildlife, beauty and opportunities for recreation and renewal that pristine forests, rivers, deserts and mountains provide.

Sierra Club
Organisation that helps to protect & save America's Forests, Arctic refuges, Lakes, Rivers, Streams, and National Wildlife.

Stop Global Warming
A non-political effort to bring all Americans together in one place, proving there is a vast consensus that global warming is here now and it is time for our country to start addressing it.

Friends of the Earth (FOE)
Friends of the Earth International is the world's largest grassroots environmental network, uniting 71 diverse national member groups and some 5,000 local activist groups on every continent. We campaign on today's most urgent environmental and social issues. We challenge the current model of economic and corporate **globalisation**, and promote solutions that will help to create environmentally sustainable and socially just societies. Their decentralised and democratic structure allows all member groups to participate in decision-making. They strive for gender equity in all of their campaigns and structures.

Green Biz is the leading information resource on how to align environmental responsibility with business success. They provide valuable news and resources to large and small businesses through a combination of Web sites, workshops, daily news feeds, electronic newsletters, and briefing papers. Their resources are free to all users.

Ecofoot is the amount of the environment necessary to produce the goods and services necessary to support a particular lifestyle.

Trade Aid is a ‘not for profit’ organisation made of several parts reflecting the work they do as a retailer, importer, wholesaler and development agency. All of these parts form what they call the Trade Aid Movement.
It believes that the care for the environment is a global responsibility. As a trading organisation, it is responsible for the use or exploitation of the natural resources which make up its products, for any emissions or pollution resulting from their production or transportation. It is also responsible for their behaviour as a retailer in New Zealand where they are based. Therefore, when looking at their impact on the environment they must look both at their actions in New Zealand and to those of their trading partners.

The Oceania Project
Have a look at The Ocean Project in Illustration 10.2.15a. It consists of several projects that basically care for whales, dolphins and the oceans. Organisations and individuals that 'Care' for the Earth directly help save and protect whales and dolphins.

The Green Volunteers is an Australian Marine Conservation Society (AMCS) which serves as the voice for Australia's coasts and oceans. AMCS work with local communities to protect ocean life and the habitats they call home.

Illustration 10.2.15a: Logo

The Wilderness Society is a national, community-based, environmental advocacy organisation whose mission is to protect, promote and restore wilderness and natural processes across Australia for the survival and ongoing evolution of life on Earth.

Now do Activity 1.

Activity 1

1. Give 3 examples each of living and non-living aspects of the environment.

Living Aspect	Non-living Aspect
1.	
2.	
3.	

2. Explain Environmental Protection.

_____

_____

_____

_____

_____

3. Name 4 approaches to environmental care and protection.

(a) _____

(b) _____

(c) _____

(d) _____

4. Which 2 international organisations that promote environmental care and protection work in Papua New Guinea?

   (a) _____

   (b) _____

Check your answers after the summary.

Environmental protection and conservation in PNG

Illustration 10.2.15a: Matschie's Tree-kangaroo, an endangered endemic species found in Huon Peninsula.

The PNG government recognised the relationship between the people and nature at Independence. Provision was made in the constitution for "…all necessary steps to be taken to give adequate protection to all our valued birds, animals, fish, insects, plants and trees".
Currently, biodiversity is protected by the following legislation: *Fauna Act/1982*, *Conservation areas Act/1980, 1992*, the *Crocodile Trade Act/1982* and the *International Trade Act/1982*.
Source: Wikipedia, the Free Encyclopedia

Status of biodiversity protection

The effort by the PNG government to protect biodiversity has resulted in 44 existing terrestrial protected areas using the International Union for the Conservation of Nature and Natural Resources (IUCN) categories. These protected areas make up for 1.6% of the total land area. A study of biodiversity identified a further 398 areas for conservation. This would increase the total protected areas. Included in the PNG protected area list, is the **terrestrial** Wildlife Management Area (WMA). WMA is an Integrated Conservation and Development Project (ICAD), which tries to conserve biological diversity by involving landowners. The idea behind the project is to generate income activities which would encourage people living in these areas to conserve. Such projects would link the value of these resources to living standard and also access to markets.

Papua New Guinea's first conservation area, the **YUS Conservation Area**, was established in 2009 on the Huon Peninsula, Morobe Province.

Apart from local conservation efforts, PNG is also a member of international conventions and treaties. These international treaties include:

- The International Plant Protection Convention (1951),
- The Convention on the prevention of Marine Pollution by Dumping of Wastes and other matter (1972),
- The convention on the International Trade in Endangered Species of Wild Flora and Fauna;

- The RAMSAR Convention on Wetlands of International Importance (1992); Convention on Biological Diversity (1992) and
- the Convention on the Conservation of Migratory Species of Wild Animals.

PNG has two listed RAMSAR sites: Lake Kutubu and Tonda Wildlife Management Area.
Source: Wikipedia, the Free Encyclopedia, 2015

Projects promoting environmental repair
Let us now look more closely at the work of two international NGOs and what they do in PNG to promote environmental repair and care.

1. The Nature Conservancy
The Nature Conservancy is a charitable international environmental organisation in the United States. Its mission is to preserve the lands and waters on which all life depends. It was founded in 1951 and it works in more than 30 countries, including all 50 states of the United States. It is the largest environmental nonprofit organisation in the Americas.

In Papua New Guinea, native communities own the lands and control the waters that they have managed for many generations. As a result, much of the Conservancy's work in the country involves empowering local people to design sustainable futures for the lands and waters that surround them.

Nature Conservancy is working with the people of Papua New Guinea to build a greener country. As in most developing nations, Papua New Guinea does not have enough funding to protect its valuable natural resources. To address this problem, The Nature Conservancy helped set up the Papua New Guinea *Mama Graun* Conservation Trust Fund which is the first of its kind in Papua New Guinea. This was aimed to provide long-term funding for biodiversity conservation work.

The trust fund uses donations and the revenue from the investment to provide sustained funding for land owners and communities in Papua New Guinea. This would be to those who live in selected protected areas by providing grants and hands-on training. This assistance would in turn ensure the long term success in management of their conservation areas. Also, the trust fund would help the government, international donors and NGOs to work together to find and fund conservation projects that could not be started.

There were twelve priority protected areas found within Papua New Guinea that the trust fund has provided support. When these protected areas are joined together it will form **biological corridors** (refer to *movement corridors* in Lesson 12) and together, will preserve large sections of ecosystems.

See following illustration on biological corridor.

Illustration 10.2.15b: Biological corridor in a protected area in Papua New Guinea.

2. The World Wildlife Fund

WWF has been working on conservation issues in Papua New Guinea and the Solomon Islands for many years. In 2008 WWF's Pacific Office based in Fiji was divided in order to provide more effective reporting in this vast and biologically important region.

The WWF works with the vast biodiversity and the communities who live amongst it to improve sustainable livelihoods, land-use planning, and being flexible to climate change.
WWF has been working in Papua New Guinea since 1995 and has had a big influence on conservation work in the country. It is now based in Madang.

Projects and Programmes

Kikori Basin

This is one of the most iconic places in Papua New Guinea, yet also one of the most unprotected. Through the WWF Netherlands and private donors they aim to implement land-use management plans in four provincial government areas through a Kikori Basin 'blueprint'.
A 'blueprint' is an original design or plan of something.

Transfly

Transfly is one of the most remote ecological regions in Papua New Guinea. It is one of the most important, for both marine species and land ecosystems. There are coastal and marine livelihoods on low-lying reefs including savanna woodlands and forestry.

Madang Lagoon

With the Madang Lagoon and the north coast of Madang they replanted mangrove trees and restored dying trees this was an effort towards improving the climate change effect. This was set to spread up the north coast from Alexishaven to Bogia Station and beyond with support from around 15 different community groups.

Inshore Fish Aggregating Devices

Three types of fish aggregating devices were installed in Madang Lagoon. This was to improve the catch for local communities in Riwo, Krangket and Siar/Kaninam and also protect the number of fish in reefs.

Now do Activity 2.

Activity 2

1. What is the mission of The Nature Conservancy?

   _____

   _____

   _____

   _____

2. How has The Nature Conservancy in PNG addressed the problem of inadequate conservation funding to protect PNG's natural resources?

   _____

   _____

   _____

   _____

3. Who owns much of the land and waters in PNG? _____

4. What is the purpose of creating biological corridors?

   _____

   _____

   _____

Check your answers after the summary.

Now read the summary.

Summary

You have come to the end of Lesson 15. In this Lesson, you have learnt that:

- pollution causes ruin in the natural quality of the environment and can cause health hazard to humans.
- environmental protection is about looking after the natural environment at different levels for the benefit of the environment and everyone.
- protection of the environment is needed due to various human activities.
- waste production, air pollution, and loss of biodiversity are some of the issues related to environmental protection.
- there are four different approaches to environmental protection.
- international organisations that promote environmental care and conservation in PNG include the Nature Conservancy and the World Wildlife Fund.
- the Nature Conservancy is a charitable international environmental organisation based in the United States.
- WWF has been working on conservation issues in Papua New Guinea and the Solomon Islands for many years.
- the Department of Environment and Conservation is the government agency responsible for biodiversity conservation in PNG.
- Papua New Guinea's first conservation area, the YUS Conservation Area, was established in 2009 on the Huon Peninsula, Morobe Province.
- the PNG government's effort to conserve biodiversity is supported by international environment conservation and NGOs.

Answers to Activity 1

1.

Living	Non-living
1. Plants/fungi	Air/oceans/seas
2. Animals/bacteria	Land/minerals
3. Genetic resources	Soil /water

2. Environmental protection is about looking after the natural environment at the individual, organisational or governmental levels for the benefit of the environment and everyone else.

3.
   (a) Voluntary environmental agreements
   (b) Ecosystems approach
   (c) International environmental approach
   (d) Government

4.
   (a) Nature Conservancy
   (b) World Wildlife Fund (WWF)

Answers to Activity 2

1. Its mission is to preserve the land and waters on which all life depends on.
2. The Nature Conservancy helped establish the Papua New Guinea *Mama Graun* Conservation Trust Fund.
3. Native/indigenous communities
4. Protected areas were created to preserve large sections of ecosystems.

NOW DO PRACTICE EXERCISE 15 ON THE NEXT PAGE

Practice Exercise 15

1. Distinguish between the natural and man-made environment.

_____

_____

_____

_____

_____

2. What is the main aim of the ecosystems approach to resource management and environmental protection?

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

3. What year did WWF start working in PNG? _____

4. Make a list of conservation areas for projects started by the WWF?

_____

_____

_____

_____

5. Briefly explain how the PNG government has supported the conservation of biodiversity in PNG?

_____

_____

_____

_____

_____

_____

_____

_____

_____

6. What is the WMA? What is the purpose of the WMA?

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

7. Name the 2 RAMSA sites in PNG.

(i) _____

(ii) _____

8. Which 3 factors influence environmental protection?

(i) _____

(ii) _____

(iii) _____

CHECK YOUR ANSWERS AT THE END OF TOPIC 4

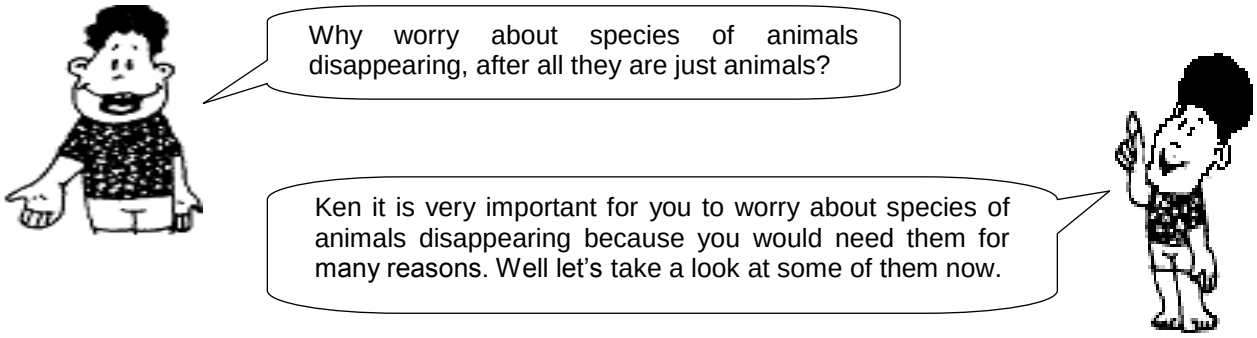
Lesson 16: Case Study: Conservation in Papua New Guinea

Welcome. Lesson 16 is the last lesson of the grade 10 Unit 2. This lesson will be based on a case study on environmental care and repair in Papua New Guinea.
You will begin by looking at what conservation means then you identify the types of conservation practices in Papua New Guinea.

Your Aims:

- discuss conservation practices taken to conserve wildlife
- compile case studies on wildlife conservation in Papua New Guinea.

The population of Papua New Guinea has dramatically increased leading to increased land pressure which has affected plants and animals. Some animal species (refer to Lesson 13) have become extinct because of changes to their environment, diseases, or other natural reasons. However the present rate of extinction is at least 100 times higher than it has ever been, mainly because of the actions of humans. But why should we worry about disappearing animals? You may ask yourself such questions as to why we are concerned about population increase, environmental overuse and plants and animals dying out.



It is important to preserve animals because they depend on each other. Animals are also beautiful to look at and provide companionship for people. Hundreds of mammals, birds, reptiles, amphibians, fish and insects are endangered, mostly because people are either killing them or destroying their habitats. When their homes are gone, they have nowhere to live and they die. The most serious threat to the environment especially in PNG is the clearance of forest for timber particularly lowland tropical rainforest, which supports the greatest variety of living things. Loss of trees means less wildlife.

Conservation practices in PNG

The best way to preserving wildlife is to educate people about the needs and the importance of animals to the environment.

Here are some ways you and I, or the national community can look at to conserve natural resources.

1. Awareness

One way of helping to preserve wildlife is to educate people through conducting awareness about the importance and needs of animals and how to live close to them in harmony.

See illustrations about resources conservation below.

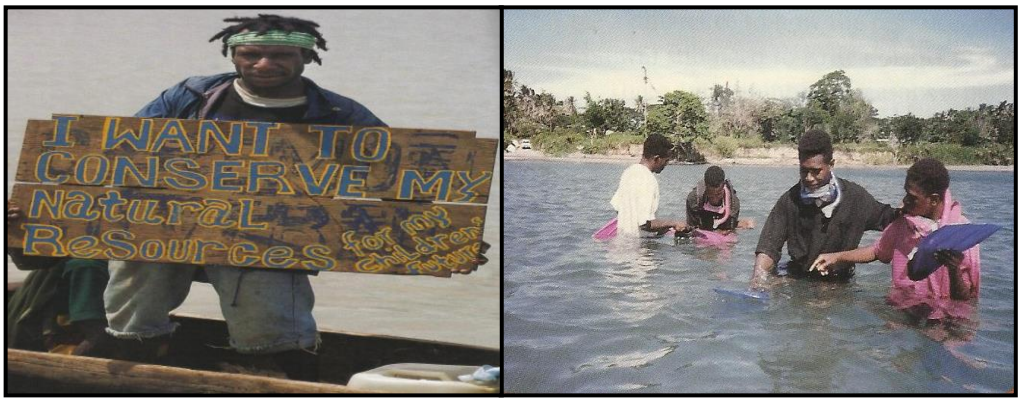


Illustration 10.2.16a: A man protesting against drift net fishing. (*Right*) Students learning how to protect the marine wildlife.

Governments could also do more to prevent wild animals from being killed for their meat, furs and tusks. For example; in PNG our cultural diversity requires the use of many wild animals for cultural obligations and responsibilities. This cultural practice has caused a near extinction of certain species of wildlife. But wild animals also continue to suffer as growing human populations take over their space by establishing farms, building houses and chopping down the forest.

See illustrations of our cultural expectations that use up a fair bit of these resources.

Illustration 10.2.16b: The Cultural decorations use a lot of wildlife resources such as the Bird of Paradise feathers.

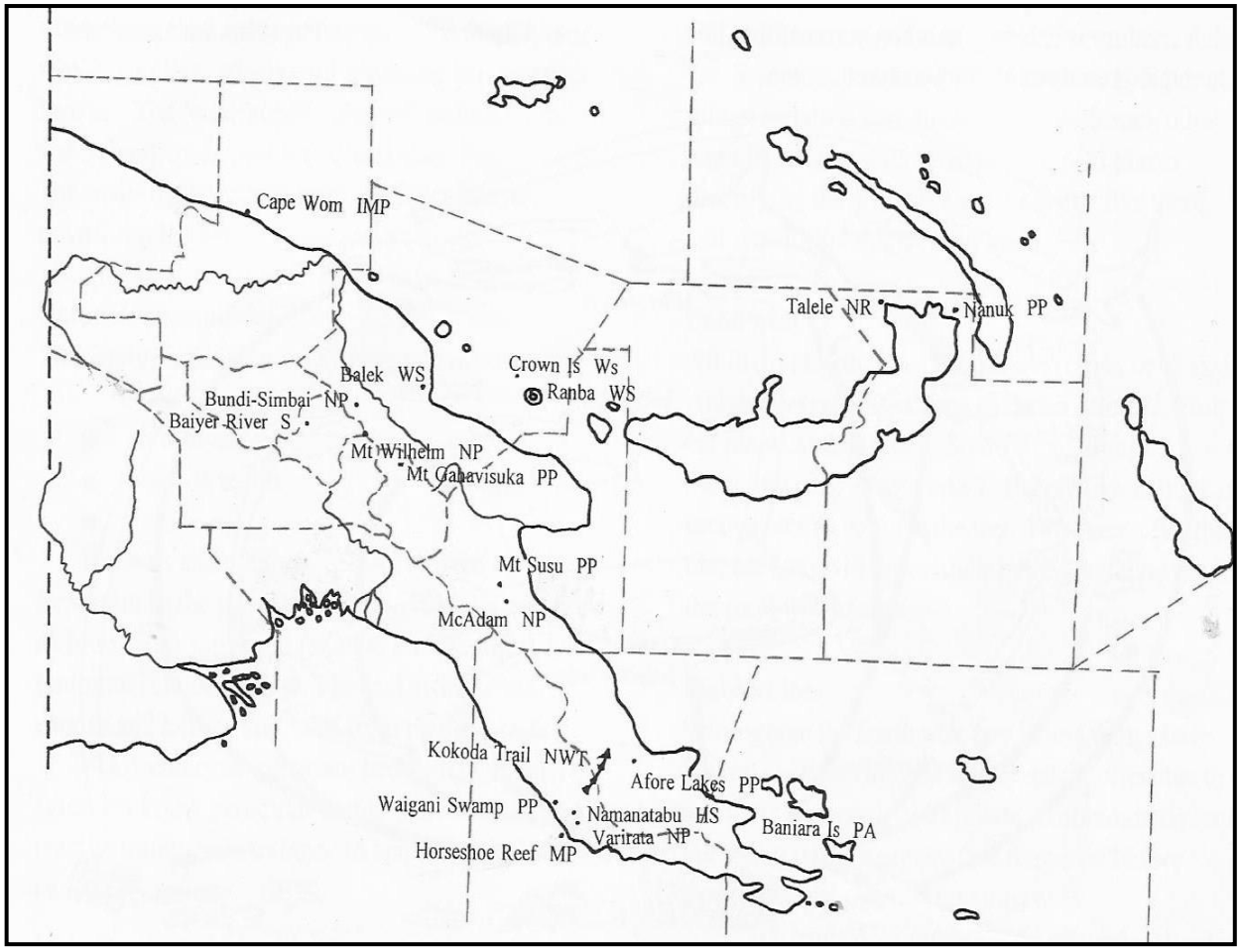
2. Parks and Wildlife Management Areas in PNG

Many organisations and governments believe that the best way to protect animals is to construct special places where they can be looked after. These special places are called Parks, Zoos and Sanctuaries or simply wildlife management areas.

In PNG, the government and landowners have declared certain areas as parks and wildlife management areas where wildlife can live without being hunted. No one is allowed to take plants or animals from these areas.

Shown on the map are some areas in Papua New Guinea that are wildlife conservation areas.

National Parks in Papua New Guinea



Apart from Parks, the Sanctuaries are often built for the purpose of saving certain animals from extinction. Sanctuaries play an important role in preserving animals while zoos are for the education and enjoyment of paying customers as well as for the protection of the animal.

There are about five sanctuaries in the country but the two largest sanctuaries in Papua New Guinea are called the Moitaka Wildlife Sanctuary in Port Moresby and the Balek Wildlife Sanctuary near Madang. At Moitaka, research is carried out on the crocodiles that are kept in the park along with the birds and many other animals. At Balek there are limestone caves filled with fish, turtles and eels.

We will now take a look at two case studies of two areas in PNG. Although these communities were not part of sanctuaries or zoos, they took on the initiative of conserving wildlife within their particular areas.

CASE STUDY 1: YUS on Huon Peninsula

In March 2009 the PNG government established the YUS Conservation Area on the Huon Peninsula, Morobe Province. It was named after the initials of its three main rivers- the Yupno, Uruwa and Som and covers 760 square kilometres of tropical rainforest stretching from the north coast to the Sarawage Mountains. The park, established in 2009 is an important conservation area. The declarations were made after twelve years of negotiations between the government and the 10,000 people who own the land and Conservation International based in the United States. Thirty-five nearby village communities put a stop to hunting, logging, mining and other developments within the conservation area and throughout the region. This agreement protected all the natural resources in the YUS conservation area including the endangered Matschie's tree kangaroo.

See the illustrations below on the YUS Conservation Area and an endangered tree kangaroo that lives in it. (See Lesson 15)

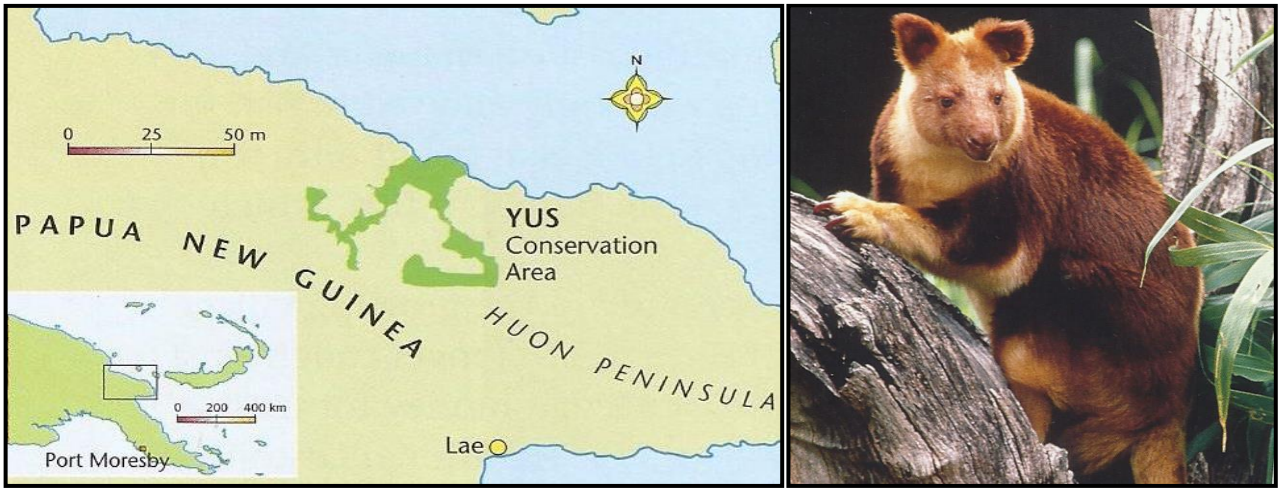


Illustration 10.2.16c: The YUS Conservation Area (*Right*) endangered Matchie's tree kangaroo also known as the Huon Tree Kangaroo.

Now do Activity.

Activity

1. List two ways wildlife can be conserved.
   (i) _____
   (ii) _____

2. What is the purpose of establishing the YUS?

_____

Check your answers after the summary.

Now, read Case Study 2.

CASE STUDY 2: Fish conservation on Manus Island

For generations the people of Pere village, on the south coast of Manus Island have depended on fishing for their livelihood. Clans were only allowed to fish for the species they were named after-for example, the Kekwa clan could only fish for Kekwa (grouper).This traditional system protected the supply of fish, which were caught with the bamboo spears and vine nets. However, in recent years fish number fell because of the growing village population and changes in the ways people lived. Fish were no longer caught just for food but also for cash they brought in.
Families needed money for their children's schooling, for clothes and for extra food supplies.

Illustration 10.2.16d: Pere villagers using the fishing net to catch fish. (*Right*) Man fishing using a traditional fishing spear.

Traditional customs were no longer followed and the reefs were open to anyone. People began fishing at night with underwater lights and spear guns and, worst of all, villagers allowed commercial fishermen onto the reefs, who paid for this right. This provided quick income for the villages, but meant that too many fish were being caught, especially on the reefs where they laid their eggs. For immediate financial gain people were allowing the destruction of the sea resources that supported them for thousands of years.

In 2004 members of a non-government organisation called the Nature Conservancy, talked to the people of Pere and other nearby villages about how they might deal with the problem. The villages then made their own rules. Commercial fishing companies and night fishing with the flashlights were banned, and between March and May people are not allowed onto the reefs when fish lay their eggs. The new rules have an effect, and fish numbers have now begun to increase.

Through education certain individuals have come to understanding the importance of preserving the wildlife in the environment. This group of individuals formed groups where they voice the same idea which is to conserving the wildlife.

There are 5 main groups with interest in conservation in Papua New Guinea.

- Communities
- Local non-government organisations (NGO)
- International non-government organisation (NGOs)
- Government
- Businesses

Now read the summary.

Summary

You have come to the end of Lesson 16. In this lesson you learnt that:

- conserving wildlife is important because everything in the environment is interdependent, that is animals depend on the plants and human beings depend on the animals.
- the most effective way of preserving wildlife is to educate the communities about the importance of the wildlife.
- different groups like the YUS communities have been formed around the country with the task of preserving the environment.
- wildlife management areas like parks, sanctuaries and zoos have been established throughout the country.

Answers to Activity

1. Some ways wildlife can be conserve is by
   (i) educating people through awareness
   (ii) setting up special places where they can be free from human activities
2. The main purpose of the YUS Management Area is to protect the wildlife from hunting, logging and mining activities.
3. The Huon tree kangaroo or the Matschies tree kangaroo

NOW DO PRACTICE EXERCISE 16 ON THE NEXT PAGE

Practice Exercise 16

1.

(a) What is the YUS?

_____

(b) What is its main purpose?

_____

2. What is the name of the endangered species that is being protected by the YUS Management Area in the Huon Peninsula?

_____

3. List 2 types of conservation measures the Pere villagers took to conserve wildlife in their area?

(a)

_____

(b)

_____

4. How can the government and NGOs protect the animals living in the wild?

_____

5.

(i) What is a sanctuary?

_____

_____

(ii) What is a zoo?

_____

_____

(iii) What is the total number of animal sanctuaries in Papua New Guinea?

_____

(iv) Which two sanctuaries are the biggest?

_____

6. Make a list of the groups of people that help conserve the environment and wildlife in Papua New Guinea, and in our local areas?

_____

_____

_____

_____

_____

NOW CHECK YOUR ANSWERS AT THE END OF TOPIC 4

ANSWERS TO PRACTICE EXERCISES 12-16

Practice Exercise 12

1. Soil is the basis for society; and healthy soil is necessary for sustainable production of food, which allows a society to exist.
2. It is important to protect endangered plant and animal species and their habitats to make sure nature will be around for future generations to enjoy.
3. There are a few energy resources left, and they are not renewable.
4. It is important to conserve air because polluted air can cause health problems.
5. Our life depends on water. Both the amount and quality of water are important because they affect people's health, their ability to stay clean, and grow crops. Many diseases such as typhoid, cholera, and diarrhoea are spread through unclean water; and good water is only 3%.
6. Man's activities have affected biodiversity in 3 ways:
   -reduced or extinct species population results in loss of genetic information without us knowing the potential benefit to both that species and man.
   -a list of threatened and endangered species worldwide
   -coral reef and tropical forest ecosystems have been and are seriously impacted by man's activities.
7. The toxins and chemicals affect plant and animal species living in the rivers and on land.
8. Through creating movement corridors, protected areas, restoration ecology and zoned reserves.
9. It uses plants and microbes to remove toxic chemicals for polluted areas. It is useful to help clean-up oil spills.
10. Costa Rica

Practice Exercise 13

1. Rice, shorter stems (or any other properties of rice are correct)
2. Genetic modification is the changing of plant DNA structure to make a plant grow and produce in large numbers.
3.
   (i) Positive impact: increase in food production (or any other positive impacts)

   (ii) Negative impact: land being ruined or degraded (or any other negative impacts)
4. Rockefeller and Ford foundations of the United States
5. IRRI= International Rice Research Institute. Its function was mainly to develop and carry out research on the HYV.
6. Pakistan, India

Practice Exercise 14

1. The destruction of large areas of rainforest interrupts vital chemical cycles (the water cycle and the carbon cycle) which operate between the land, the oceans and the atmosphere.
2. About 25 % of the chemicals found in medicines are extracted from rainforest plants.
3. The Rainbow Warrior was blown up killing one of the Greenpeace volunteers. (The France wanted to carry out nuclear testing on Murorua atolls.)
4.
   (i) the rapidly increasing population
   (ii) the idea of selling the resources on the land for money.
5.
   (i) The Melanesian Environmental Foundation aims to promote awareness, care and concern for the environment to people of all ages
   (ii) The Friends of the Earth aims to encourage a safe and sensible use of the environment.
6. At the “grass roots” level in PNG many people wish to see their traditional hunting grounds preserved for the future generations.
7. A Wildlife Management Area (WMA) is an area of land, usually under traditional ownership, which is protected under the Conservation Areas Act 1978.
8. For income generating activities; biological diversity would encourage people living in these areas to conserve their environment and resources as such projects would link the value of these resources to living standard and also access to markets.

Practice Exercise 15

1. The man-made or human environment is built by man or come about as a result of man’s actions. The natural environment consists of all things found in nature.
2. aims to consider the difficult interrelationships of an ecosystem. This involves stakeholders across all relevant governmental departments, as well as representatives of industry, environmental groups and community. This approach supports exchange of information, development of ways to solve conflicts and improved conservation in regions.
3. 1995
4. Kikori Basin, Transfly, Madang Lagoon, and Inshore fishing aggregating devices
5. The effort by the PNG government to protect biodiversity has resulted in 44 existing terrestrial protected areas using the International Union for the Conservation of Nature and Natural Resources (IUCN) categories.
6. WMA is an Integrated Conservation and Development Project (ICAD), which tries to conserve biological diversity by involving landowners. The idea behind the project is to generate income activities which would encourage people living in these areas to conserve.
7.

(i) Lake Kutubu

(ii) Tonda Wildlife Management Area

8.

(i) Environmental legislation

(ii) Ethics

(iii) Education.

Practice Exercise 16

1.

(i) The YUS stands for Yupno, Uruwa, and Som Rivers where the protected area covers

(ii) This conservation area was established to conserve animals and protect endangered species like the Matschie's tree kangaroo.

2. Matschie's Tree kangaroo

3.

(i) Commercial fishing companies were banned from fishing within their waters

(ii) night time fishing using torch light was not allowed

4. By building special places

5.

(i) A sanctuary is a special place built for the purpose of saving certain animals from extinction. Sanctuaries play an important role in preserving animals.

(ii) A zoo is also a special place for the education and enjoyment of paying customers as well as for the protection of the animal.

(iii) 5

(iv) The 2 largest sanctuaries in PNG are the Moitaka Wildlife Sanctuary in Port Moresby and the Balek Wildlife near Madang.

6. Communities, Local NGOs, International NGOs, Government, Businesses

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END OF UNIT 2. NOW DO YOUR ASSIGNMENT.

Glossary

Adapt	get used to
Aesthetics	a set of principles concerned with the nature and appreciation of beauty.
Agrochemical	a chemical used in agriculture, such as a pesticide or a fertiliser.
Aquatic	of or relating to the animals and plants that live in or near water.
Aquifer	body of spongy rock which can contain or transmit groundwater
Alter	to change (something)
Alternative	offering or expressing a choice
Arable	suitable for farming or able to produce crops.
Artificial eutrophication	occurs when human activity introduces increased amounts of plant nutrients which speed up plant growth and eventually choke the lake of all its animal life.
Bilateral	involving two groups or countries
biodiversity	the existence of many different kinds of plants and animals in an environment.
biological corridor	a geographically defined area which provides connectivity between landscapes, ecosystems and habitats, natural or modified, and ensures the maintenance of biodiversity and ecological and evolutionary processes.
Bioenergy	renewable energy produced by living organisms
Biomagnify	increasing concentration of a substance, such as a toxic chemical, in the tissues of organisms at successively higher levels in a food chain.
biologist	a scientist who studies the life of living things.
biomagnify	to increase in concentration a pollutant from one link in a food chain to another.
Bioremediation	the treatment of pollutants or waste (as in an oil spill, contaminated groundwater, or an industrial process) by the use of microorganisms (as bacteria) that break down the undesirable substances.

Bio prospect	to search for substances that are produced by living organisms and may be of medicinal or commercial value.
biosphere	the part of the Earth in which life can exist.
biota	the animal and plant life of a particular region, habitat, or geological period.
blueprint	a detailed plan of how to do something.
Bubonic Plague	a very serious disease that is spread especially by rats and that killed many people in the Middle Ages.
Chlorofluorocarbon (CFCs)	a gas that was once commonly used in various products (such as aerosols) but that is believed to cause damage to the ozone layer in the Earth's atmosphere.
Clog	something that blocks a pipe
Conservation	Conservation is looking after, protecting and managing the natural environment.
Coral polyps	tiny, soft-bodied organisms related to sea anemones and jellyfish. At their base is a hard, protective limestone skeleton which forms the structure of coral reefs.
Crop-rotation	the practice of growing different crops in succession on the same land chiefly to preserve the productive capacity of the soil.
Dichlorodiphenyl-trichloroethane (DDT)	a poisonous chemical that was used especially in the past to protect plants from insects and that is now banned in the United States.
degradation	the act or process of damaging or ruining something.
ecosystem	everything that exists in a particular environment.
effluent	flowing out (of waste matter)
El Nino	a flow of unusually warm water along the western coast of South America that causes many changes in weather in other places (such as a lot of rain in areas that are usually dry).
emission	the act of producing or sending out something (such as energy or gas) from a source
Endemic	species which is only found in a given region or location and nowhere else in the world.
environment	anything that is around us that is made up of both the natural and man-made surroundings.

Everglades Restoration Project	Comprehensive Everglades Restoration Plan (CERP) The CERP was authorised by United States government in 2000 as a plan to restore, preserve, and protect the south Florida ecosystem while providing for other water-related needs of the region, including water supply and flood protection.
Eutrophication	process by which a body of water becomes enriched in dissolved nutrients (as phosphates) that stimulate the growth of aquatic plant life usually resulting in the depletion of dissolved oxygen.
Evacuate	to leave (a dangerous place)
Evolve	to change or develop slowly often into a better, more complex, or more advanced state.
Export	(Something) to sell to overseas.
Extinct	die out
Fallow	To leave the land to rest for a few years to regain soil fertility
Fragmented	a part broken off or detached
Gene	a part of a cell that controls or influences the appearance, growth, etc., of a living thing.
Globalisation	the development of an increasingly integrated global economy marked especially by free trade, free flow of capital, and the selecting of cheaper foreign labour markets.
Genetically Modified Organism (GMO)	any organism whose genetic material has been altered using genetic engineering techniques.
Green Revolution	a change of traditional to modern farming that used technology, fertiliser and different farming techniques on crops.
Greenhouse effect	trapping of the sun's warmth in the lower atmosphere, due to the greater transparency of the atmosphere to visible radiation from the sun than to infrared radiation emitted from the planet's surface.
Hard coral	hard, calcium-based skeletons also called stony corals that consist of numerous single polyps living together in colonies.
Hazardous	involving risk or danger.
Herbicide	a chemical used to destroy plants or stop plant growth.

Industrial Revolution	the name given the movement in which machines changed people's way of life as well as their methods of manufacture.
Infra-red	producing or using rays of light that cannot be seen and that are longer than rays that produce red light
Infrastructure	structure (building), set-up of something
Inter-tropical convergence zone (ITCZ)	a narrow zone near the equator where northern and southern air masses converge, typically producing low atmospheric pressure.
Intractable	(waste) that cannot be easily removed.
Invasive species	is a plant, fungus, or animal class that is not native to a specific location and which is likely to spread to a degree believed to cause damage to the environment, human economy or human health.
La Nina	an irregular and unusually cold water to the ocean surface along the western coast of South America that often occurs following an El Niño and that disrupts typical regional and global weather patterns especially in a manner opposite to that of El Niño.
Leeward	side sheltered or away from the wind.
Lubrication	to apply oily or greasy substance to (a machine, parts of a mechanism) in order to reduce friction
mercury	a heavy silvery-white metal which is liquid at room temperature.
Meteorologist	an expert in weather forecast
Micro organism	tiny organisms that inhabit the soil, for example, bacteria.
mono-culture	growing only one type of crop.
monsoon	describe winds that reverse their direction in different seasons. It is a seasonal shift in the prevailing wind direction that usually brings with it a different kind of weather.
Mooring buoy	an anchored float serving as a navigation mark, to show reefs or other hazards, or for mooring.
Movement corridors	linear features whose main wildlife function is to connect at least two important habitat areas.
Natural eutrophication	process that occurs in an aging lake or pond as that body of water gradually builds up its concentration of plant nutrients.
Nocturnal	active mainly during the night

Obsolete	outdated
Oil spill	occur when an oil tanker (a ship that carries oil from one country or place to another) leak oil into the ocean
Overspecialise	o specialise to an extreme degree
Ozone	ozone is a gas that occurs both in the Earth's upper atmosphere and at ground level.
Ozone layer	layer in the atmosphere that contains greenhouse gases.
Paddies	a field where rice is grown
Pesticide	Any substance for destroying or controlling any pest, includes insecticides, herbicides, fungicides.
Plankton	very tiny animal and plant life in an ocean or lake.
Poacher	one who kills or takes wild animals (as game or fish) illegally.
Polychlorinated biphenyl	is known as PCB for short. It is an organic chlorine compound that were once widely used as dielectric and coolant fluids in electrical apparatus, carbonless copy paper and in heat transfer fluids
Pest	organism that is damaging to livestock, crops, humans, or land fertility
Pharmaceuticals	a compound manufactured for use as a medicinal drug
Photoperiod	the period of time each day during which an organism receives light; day length
Photosynthesis	a process by which green plants and other organisms turn carbon dioxide and water into carbohydrates and oxygen, using light energy trapped by chlorophyll
Pollution	the action or process of making land, water, air, etc., dirty and not safe or suitable to use
Prevailing wind	a wind from the direction that is leading or most usual at a particular place or season.
Rain shadow	a region having little rainfall because it is sheltered from prevailing rain-bearing winds by a range of hills.
RAMSA	The Convention on Wetlands, signed in Ramsar, Iran, in 1971, is an intergovernmental treaty which provides the framework for national

	action and international cooperation for the conservation and wise use of wetlands and their resources
Recycle	to make something new from (something that has been used before)
Runoff	is what occurs when rain is not absorbed by the ground on which it falls and so flows downhill.
Sea anemone	sea organisms that look like plants but are meat-eating animals, and come in different sizes and many different colours.
Sedated	To dose with sedatives.
Silt	sand, soil, mud, that is carried by flowing water and that sinks to the bottom of a river or pond.
Strip-cropping	is a method of farming which involves cultivating a field divided into long, narrow strips which are swapped in a crop rotation system. It is used when a slope is too steep or when there is no other method of preventing soil erosion.
Slag	stony waste matter separated from metals during the smelting or refining of ore
Salmon spawning	The salmon run is the time when salmon, which have migrated from the ocean, swim upriver where they spawn (lay eggs) on gravel beds. After spawning, all Pacific salmon and most Atlantic salmon die, and the salmon life cycle starts over again.
Soft coral	soft corals contain structures within their tissue that support their bodies. They have eight fuzzy tentacles for feeding.
Strip-cropping	the growing of a cultivated crop (as corn) in strips alternating with strips of a sod-forming crop (as hay) arranged to follow an approximate contour of the land and minimise erosion.
Subsidence	(the temperature) to become less strong or intense
Sustain	to provide what is needed for (something or someone) to exist or continue.
Sustainable	involving methods that do not completely use up or destroy natural resources.
Synthethic	made by combining different substances : not natural
Terrestrial	living or growing on land instead of in water or air.

Total Waste Management (TMW)	is a specialised environmental company that provides industrial waste management, waste water treatment, environmental engineering and spill management services within Papua New Guinea.
Tributary (river)	a river or stream flowing into a larger river or lake.
Tundra	a vast, flat, treeless Arctic region of Europe, Asia, and North America in which the subsoil is permanently frozen.
Water pollution	contamination of streams, lakes, underground water, bays or oceans by substances harmful to living things.
YUS Conservation Area	YUS stand for Yupno, Uruwa and Som Rivers located in the protected area in the Huon Peninsula.
Zoning	one of the sections in a city or town that is used for a particular purpose
Zooplankton	plankton made up of animals

Appendix 1.1

Endangered plants found in Papua New Guinea

This list combines species from several endangered species lists.

	Species Name	Scientific Name	Group	Range
1.	Acacia crassicarpa	Acacia crassicarpa	Plants	Australia, Papua New Guinea
2.	Aglaia brassii	Aglaia brassii	Plants	Australia, Indonesia, Papua New Guinea, Solomon Islands
3.	Aglaia leucoclada	Aglaia leucoclada	Plants	Papua New Guinea
4.	Aglaia barbanthera	Aglaia barbanthera	Plants	Indonesia, Papua New Guinea
5.	Aglaia lepiorrhachis	Aglaia lepiorrhachis	Plants	Indonesia, Papua New Guinea
6.	Aglaia integrifolia	Aglaia integrifolia	Plants	Papua New Guinea
7.	Aglaia rubrivenia	Aglaia rubrivenia	Plants	Papua New Guinea, Solomon Islands
8.	Aglaia flavescens	Aglaia flavescens	Plants	Indonesia, Papua New Guinea
9.	Aglaia puberulanthera	Aglaia puberulanthera	Plants	Indonesia, Papua New Guinea
10.	Aglaia cuspidata	Aglaia cuspidata	Plants	Papua New Guinea
11.	Aglaia polyneura	Aglaia polyneura	Plants	Indonesia, Papua New Guinea
12.	Aglaia cremea	Aglaia cremea	Plants	Papua New Guinea
13.	Aglaia penningtoniana	Aglaia penningtoniana	Plants	Papua New Guinea
14.	Aglaia cinnamomea	Aglaia cinnamomea	Plants	Indonesia, Papua New Guinea
15.	Aglaia parksii	Aglaia parksii	Plants	Fiji, Papua New Guinea, Solomon Islands
16.	Aglaia brownii	Aglaia brownii	Plants	Australia, Indonesia, Papua New Guinea
17.	Aglaia mackiana	Aglaia mackiana	Plants	Papua New Guinea
18.	Albizia carrii	Albizia carrii	Plants	Papua New Guinea
19.	Alectryon repandodentatus	Alectryon repandodentatus	Plants	Australia, Papua New Guinea
20.	Alloxylon brachycarpum	Alloxylon brachycarpum	Plants	Indonesia, Papua New Guinea
21.	Alstonia rubiginosa	Alstonia rubiginosa	Plants	Papua New Guinea

22.	Alstonia breviloba	Alstonia breviloba	Plants	Papua New Guinea
23.	Amboyna Wood	Pterocarpus indicus	Plants	Cambodia, China, India, Indonesia, Malaysia, Myanmar, Papua New Guinea, Philippines, Solomon Islands, Sri Lanka, Taiwan, Thailand, Vanuatu
24.	Archidendron forbesii	Archidendron forbesii	Plants	Papua New Guinea
25.	Arthrophyllum proliferum	Arthrophyllum proliferum	Plants	Papua New Guinea
26.	Beautiful Leaf	Calophyllum morobense	Plants	Papua New Guinea
27.	Beautiful Leaf	Calophyllum acutiputamen	Plants	Papua New Guinea
28.	Beautiful Leaf	Calophyllum waliense	Plants	Papua New Guinea
29.	Beautiful Leaf	Calophyllum robustum	Plants	Papua New Guinea
30.	Bleasdalea papuana	Bleasdalea papuana	Plants	Indonesia, Papua New Guinea
31.	Borneo Teak	Intsia bijuga	Plants	Africa, Asia, Australia, Europe, Oceanic
32.	Brachychiton velutinosus	Brachychiton velutinosus	Plants	Australia, Papua New Guinea
33.	Brachychiton carruthersii	Brachychiton carruthersii	Plants	Papua New Guinea
34.	Canthium suborbiculare	Canthium suborbiculare	Plants	Papua New Guinea
35.	Ceratopetalum succirubrum	Ceratopetalum succirubrum	Plants	Australia, Indonesia, Papua New Guinea
36.	Chisocheton stellatus	Chisocheton stellatus	Plants	Indonesia, Papua New Guinea
43.	Diospyros benstonei	Diospyros benstonei	Plants	Papua New Guinea
44.	Diospyros lolinopsis	Diospyros lolinopsis	Plants	Papua New Guinea
45.	Diospyros littorea	Diospyros littorea	Plants	Australia, Indonesia, Papua New Guinea
46.	Diospyros insularis	Diospyros insularis	Plants	Papua New Guinea, Solomon Islands
47.	Diospyros gillisonii	Diospyros gillisonii	Plants	Papua New Guinea
48.	Elattostachys rubrofructus	Elattostachys rubrofructus	Plants	Papua New Guinea

49.	Elattostachys goropuensis	Elattostachys goropuensis	Plants	Papua New Guinea
50.	Elattostachys aiyurensis	Elattostachys aiyurensis	Plants	Papua New Guinea
51.	Flindersia ifflaina	Flindersia ifflaina	Plants	Australia, Papua New Guinea
52.	Flindersia pimenteliana	Flindersia pimenteliana	Plants	Australia, Indonesia, Papua New Guinea
53.	Flindersia laevicarpa	Flindersia laevicarpa	Plants	Australia, Indonesia, Papua New Guinea
54.	Geniostoma umbellatum	Geniostoma umbellatum	Plants	Papua New Guinea
55.	Gluta papuana	Gluta papuana	Plants	Papua New Guinea
56.	Gonystylus macrophyllus	Gonystylus macrophyllus	Plants	Indonesia, Malaysia, Papua New Guinea, Solomon Islands
57.	Guioa molliuscula	Guioa molliuscula	Plants	Papua New Guinea
58.	Guioa hospita	Guioa hospita	Plants	Papua New Guinea
59.	Guioa unguiculata	Guioa unguiculata	Plants	Papua New Guinea
60.	Guioa grandifoliola	Guioa grandifoliola	Plants	Papua New Guinea
61.	Guioa scalariformis	Guioa scalariformis	Plants	Papua New Guinea
62.	Guioa plurinervis	Guioa plurinervis	Plants	Papua New Guinea
63.	Guioa pauciflora	Guioa pauciflora	Plants	Indonesia, Papua New Guinea
64.	Guioa oligotricha	Guioa oligotricha	Plants	Indonesia, Papua New Guinea
65.	Guioa novobritannica	Guioa novobritannica	Plants	Papua New Guinea
66.	Guioa normanbiensis	Guioa normanbiensis	Plants	Papua New Guinea
67.	Helicia acutifolia	Helicia acutifolia	Plants	Papua New Guinea
68.	Helicia retusa	Helicia retusa	Plants	Papua New Guinea
69.	Helicia polyosmoides	Helicia polyosmoides	Plants	Papua New Guinea
70.	Helicia peltata	Helicia peltata	Plants	Papua New Guinea
71.	Helicia peekelii	Helicia peekelii	Plants	Papua New Guinea
72.	Helicia neglecta	Helicia neglecta	Plants	Papua New Guinea
73.	Helicia insularis	Helicia insularis	Plants	Papua New Guinea
74.	Helicia subcordata	Helicia subcordata	Plants	Papua New Guinea
75.	Helicia calocoma	Helicia calocoma	Plants	Papua New Guinea
76.	Helicia rostrata	Helicia rostrata	Plants	Papua New Guinea

77.	Helicia australasica	Helicia australasica	Plants	Australia, Papua New Guinea
78.	Hopea inexpectata	Hopea inexpectata	Plants	Papua New Guinea
79.	Horsfieldia squamulosa	Horsfieldia squamulosa	Plants	Papua New Guinea
80.	Horsfieldia sepikensis	Horsfieldia sepikensis	Plants	Papua New Guinea
81.	Horsfieldia clavata	Horsfieldia clavata	Plants	Papua New Guinea
82.	Horsfieldia ampliformis	Horsfieldia ampliformis	Plants	Papua New Guinea
83.	Horsfieldia ampla	Horsfieldia ampla	Plants	Papua New Guinea
84.	Horsfieldia urceolata	Horsfieldia urceolata	Plants	Papua New Guinea
85.	Kayea macrophylla	Kayea macrophylla	Plants	Indonesia, Papua New Guinea
86.	Kayea coriacea	Kayea coriacea	Plants	Papua New Guinea
87.	Koompassia grandiflora	Koompassia grandiflora	Plants	Indonesia, Papua New Guinea
88.	Madhuca boerlageana	Madhuca boerlageana	Plants	Indonesia, Papua New Guinea
89.	Mammea papyracea	Mammea papyracea	Plants	Papua New Guinea
90.	Mammea papuana	Mammea papuana	Plants	Papua New Guinea
91.	Mammea grandifolia	Mammea grandifolia	Plants	Papua New Guinea
92.	Mammea veimauriensis	Mammea veimauriensis	Plants	Papua New Guinea
93.	Mangifera altissima	Mangifera altissima	Plants	Indonesia, Malaysia, Papua New Guinea, Philippines, Solomon Islands
94.	Manilkara Tree	Manilkara kanosiensis	Plants	Indonesia, Papua New Guinea
95.	Mastixiodendron stoddardii	Mastixiodendron stoddardii	Plants	Papua New Guinea, Solomon Islands
96.	Milkwood	Tabernaemontana remota	Plants	Indonesia, Papua New Guinea
97.	Nandu Wood	Pericopsis mooniana	Plants	Federated States of Micronesia, Indonesia, Malaysia, Palau, Papua New Guinea, Philippines, Sri Lanka
98.	Neuburgia tubiflora	Neuburgia tubiflora	Plants	Papua New Guinea

99.	Nutmeg Tree	Myristica atresens	Plants	Papua New Guinea
100.	Nutmeg Tree	Myristica incredibilis	Plants	Papua New Guinea
101.	Nutmeg Tree	Myristica ovicarpa	Plants	Papua New Guinea
102.	Nutmeg Tree	Myristica simulans	Plants	Papua New Guinea
103.	Nutmeg Tree	Myristica fasciculata	Plants	Papua New Guinea
104.	Nutmeg Tree	Myristica ornata	Plants	Papua New Guinea
105.	Nutmeg Tree	Myristica schlechteri	Plants	Papua New Guinea
106.	Nutmeg Tree	Myristica dasycarpa	Plants	Papua New Guinea
107.	Nutmeg Tree	Myristica olivacea	Plants	Papua New Guinea
108.	Nutmeg Tree	Myristica pygmaea	Plants	Papua New Guinea
109.	Nutmeg Tree	Myristica coacta	Plants	Papua New Guinea
110.	Nutmeg Tree	Myristica nana	Plants	Papua New Guinea
111.	Nutmeg Tree	Myristica psilocarpa	Plants	Papua New Guinea
112.	Nutmeg Tree	Myristica byssacea	Plants	Papua New Guinea
113.	Nutmeg Tree	Myristica mediterranea	Plants	Indonesia, Papua New Guinea
114.	Nutmeg Tree	Myristica polyantha	Plants	Papua New Guinea
115.	Nutmeg Tree	Myristica buchneriana	Plants	Indonesia, Papua New Guinea
116.	Nutmeg Tree	Myristica leptophylla	Plants	Papua New Guinea
117.	Nutmeg Tree	Myristica pilosella	Plants	Papua New Guinea
118.	Nutmeg Tree	Myristica brevistipes	Plants	Papua New Guinea
119.	Nutmeg Tree	Myristica lasiocarpa	Plants	Papua New Guinea
120.	Nutmeg Tree	Myristica papillatifolia	Plants	Indonesia, Papua New Guinea
121.	Nutmeg Tree	Myristica sogeriensis	Plants	Papua New Guinea
122.	Nutmeg Tree	Myristica brachypoda	Plants	Papua New Guinea
123.	Nutmeg Tree	Myristica inundata	Plants	Papua New Guinea
124.	Nutmeg Tree	Myristica pachycarpidia	Plants	Papua New Guinea
125.	Nutmeg Tree	Myristica sinclairii	Plants	Papua New Guinea
126.	Osmoxylon reburrum	Osmoxylon reburrum	Plants	Papua New Guinea
127.	Osmoxylon lanceolatum	Osmoxylon lanceolatum	Plants	Papua New Guinea

128.	Osmoxylon ellipsoideum	Osmoxylon ellipsoideum	Plants	Papua New Guinea
129.	Osmoxylon corneri	Osmoxylon corneri	Plants	Papua New Guinea
130.	Osmoxylon chrysanthum	Osmoxylon chrysanthum	Plants	Papua New Guinea
131.	Osmoxylon arrhenicum	Osmoxylon arrhenicum	Plants	Papua New Guinea
132.	Osmoxylon whitmorei	Osmoxylon whitmorei	Plants	Papua New Guinea
133.	Podocarpus atjehensis	Podocarpus atjehensis	Plants	Asia, Australia
134.	Pongamia velutina	Pongamia velutina	Plants	Papua New Guinea
135.	Ptychosperma hentyi	Ptychosperma hentyi	Plants	Papua New Guinea
136.	Ptychosperma gracile	Ptychosperma gracile	Plants	Papua New Guinea
137.	Rosselia bracteata	Rosselia bracteata	Plants	Papua New Guinea
138.	Saffronheart	Halfordia papuana	Plants	Papua New Guinea
139.	Santalum macgregorii	Santalum macgregorii	Plants	Papua New Guinea
140.	Schistochila undulatifolia	Schistochila undulatifolia	Plants	Papua New Guinea
141.	Southern Beech	Nothofagus nuda	Plants	Papua New Guinea
144.	Tuckeroo	Cupaniopsis napaensis	Plants	Papua New Guinea
145.	Tuckeroo	Cupaniopsis euneura	Plants	Papua New Guinea
146.	Tuckeroo	Cupaniopsis bullata	Plants	Papua New Guinea
147.	Tuckeroo	Cupaniopsis acuticarpa	Plants	Papua New Guinea
148.	Tuckeroo	Cupaniopsis phanerophleibia	Plants	Papua New Guinea
149.	Xanthostemon oppositifolius	Xanthostemon oppositifolius		

APPENDIX 1.2

Endangered birds found in Papua New Guinea

This list combines species from several endangered species lists. Using the total at the bottom of this page as an official count of endangered species of the world is not recommended. For more information on what creatures are listed on this site, please visit our About Us page.

	Species Name	Scientific Name	Group	Range
1.	Archbold's Bowerbird	Archboldia papuensis	Birds	Indonesia, Papua New Guinea
3.	Atoll Starling	Aplonis feadensis	Birds	Papua New Guinea, Solomon Islands
4.	Australian Bustard	Ardeotis australis	Birds	Australia, Indonesia, Papua New Guinea
5.	Beach Thick-knee	Esacus giganteus	Birds	Australia, Brunei Darussalam, India, Indonesia, Malaysia, Myanmar, New Caledonia, Papua New Guinea, Philippines, Singapore, Solomon Islands, Thailand, Timor-Leste, Vanuatu
6.	Beck's Petrel	Pseudobulweria becki	Birds	Papua New Guinea, Solomon Islands
7.	Bismarck Kingfisher	Alcedo websteri	Birds	Papua New Guinea
8.	Bismarck Masked-owl	Tyto aurantia	Birds	Papua New Guinea
9.	Bismarck Melidectes	Melidectes whitemanensis	Birds	Papua New Guinea
10.	Bismarck Thicketbird	Megalurulus grosvenori	Birds	Papua New Guinea
11.	Black Honey-buzzard	Henicopernis infuscatus	Birds	Papua New Guinea
12.	Black Munia	Lonchura stygia	Birds	Indonesia, Papua New Guinea
13.	Black Sicklebill	Epimachus fastuosus	Birds	Indonesia, Papua New Guinea
14.	Black-and-white Monarch	Monarcha barbatus	Birds	Papua New Guinea, Solomon Islands
15.	Black-faced Pitta	Pitta anerythra	Birds	Papua New Guinea, Solomon Islands
16.	Black-necked Stork	Ephippiorhynchus asiaticus	Birds	Australia, Bhutan, Cambodia, India, Indonesia, Laos, Myanmar, Nepal, Papua New Guinea, Sri Lanka
18.	Blue Bird-of-	Paradisaea	Birds	Papua New Guinea

	paradise	rudolphi		
19.	Blue-eyed Cockatoo	Cacatua ophthalmica	Birds	Papua New Guinea
20.	Bougainville Bush-warbler	Cettia haddeni	Birds	Papua New Guinea
21.	Bougainville Thicketbird	Megalurulus llaneae	Birds	Papua New Guinea
25.	Crested Cuckoo-dove	Reinwardtoena crassirostris	Birds	Papua New Guinea, Solomon Islands
26.	Doria's Goshawk	Megatriorchis doriae	Birds	Indonesia, Papua New Guinea
27.	Duchess Lorikeet	Charmosyna margarethae	Birds	Papua New Guinea, Solomon Islands
28.	Dwarf Cassowary	Casuarius bennetti	Birds	Indonesia, Papua New Guinea
29.	Emperor Bird-of-paradise	Paradisaea guilielmi	Birds	Papua New Guinea
31.	Fearful Owl	Nesasio solomonensis	Birds	Papua New Guinea, Solomon Islands
32.	Finsch's Imperial-pigeon	Ducula finschii	Birds	Papua New Guinea
33.	Fire-maned Bowerbird	Sericulus bakeri	Birds	Papua New Guinea
34.	Fly River Grassbird	Megalurus albolimbatus	Birds	Indonesia, Papua New Guinea
35.	Forest Bittern	Zonerodius heliosylus	Birds	Indonesia, Papua New Guinea
36.	Goldie's Bird-of-paradise	Paradisaea decora	Birds	Papua New Guinea
37.	Green-fronted Hanging-parrot	Loriculus tener	Birds	Papua New Guinea
38.	Gurney's Eagle	Aquila gurneyi	Birds	Indonesia, Papua New Guinea
39.	Heinroth's Shearwater	Puffinus heinrothi	Birds	Papua New Guinea, Solomon Islands
40.	Imitator Sparrowhawk	Accipiter imitator	Birds	Papua New Guinea, Solomon Islands
41.	Long-bearded Melidectes	Melidectes princeps	Birds	Papua New Guinea
42.	Manus Fantail	Rhipidura semirubra	Birds	Papua New Guinea
43.	Manus Masked-owl	Tyto manusi	Birds	Papua New Guinea

44.	Manus Monarch	Monarcha infelix	Birds	Papua New Guinea
45.	Matthias Fantail	Rhipidura matthiae	Birds	Papua New Guinea
46.	Meek's Lorikeet	Charmosyna meeki	Birds	Papua New Guinea, Solomon Islands
47.	Moustached Kingfisher	Actenoides bougainvillei	Birds	Papua New Guinea, Solomon Islands
48.	New Britain Bronzewing	Henicophaps foersteri	Birds	Papua New Guinea
49.	New Britain Goshawk	Accipiter princeps	Birds	Papua New Guinea
50.	New Britain Kingfisher	Todiramphus albonotatus	Birds	Papua New Guinea
51.	New Britain Rail	Gallirallus insignis	Birds	Papua New Guinea
52.	New Britain Sparrowhawk	Accipiter brachyurus	Birds	Papua New Guinea
53.	New Britain Thrush	Zoothera talaseae	Birds	Papua New Guinea
54.	New Guinea Eagle	Harpyopsis novaeguineae	Birds	Indonesia, Papua New Guinea
55.	New Guinea Flightless Rail	Megacrex inepta	Birds	Indonesia, Papua New Guinea
56.	Nicobar Pigeon	Caloenas nicobarica	Birds	India, Indonesia, Malaysia, Myanmar, Palau, Papua New Guinea, Philippines, Solomon Islands, Thailand, Vietnam
57.	Northern Cassowary	Casuarius unappendiculatus	Birds	Indonesia, Papua New Guinea
58.	Ochre-winged Honeyeater	Macgregoria pulchra	Birds	Indonesia, Papua New Guinea
59.	Olive-yellow Robin	Poecilodryas placens	Birds	Indonesia, Papua New Guinea
60.	Pale-billed Sicklebill	Epimachus bruijnii	Birds	Indonesia, Papua New Guinea
61.	Pesquet's Parrot	Psittrichas fulgidus	Birds	Indonesia, Papua New Guinea
62.	Pied Cuckoo-dove	Reinwardtoena browni	Birds	Papua New Guinea
63.	Red-knobbed Imperial-pigeon	Ducula rubricera	Birds	Papua New Guinea, Solomon Islands
64.	Ribbon-tailed Astrapia	Astrapia mayeri	Birds	Papua New Guinea
65.	Russet Hawk-owl	Ninox odiosa	Birds	Papua New Guinea

66.	Salvadori's Teal	Salvadorina waigiuensis	Birds	Indonesia, Papua New Guinea
67.	Sanford's Sea-eagle	Haliaeetus sanfordi	Birds	Papua New Guinea, Solomon Islands
68.	Slaty-mantled Sparrowhawk	Accipiter luteoschistaceus	Birds	Papua New Guinea
69.	Solomon Islands Cuckooshrike	Coracina holopolia	Birds	Papua New Guinea, Solomon Islands
70.	Southern Cassowary	Casuarius casuarius	Birds	Australia, Indonesia, Papua New Guinea
71.	Southern Crowned-pigeon	Goura scheepmakeri	Birds	Indonesia, Papua New Guinea
72.	Striated Lorikeet	Charmosyna multistriata	Birds	Indonesia, Papua New Guinea
73.	Superb Pitta	Pitta superba	Birds	Papua New Guinea
74.	Victoria Crowned-pigeon	Goura victoria	Birds	Indonesia, Papua New Guinea
75.	Violaceous Coucal	Centropus violaceus	Birds	Papua New Guinea
76.	Wahnes's Parotia	Parotia wahnesi	Birds	Papua New Guinea
77.	White-bellied Pitohui	Pitohui incertus	Birds	Indonesia, Papua New Guinea
78.	White-breasted Monarch	Monarcha menckei	Birds	Papua New Guinea
79.	White-eyed Starling	Aplonis brunneicapillus	Birds	Papua New Guinea, Solomon Islands
80.	White-naped Lory	Lorius albidinucha	Birds	Papua New Guinea
81.	White-winged Fantail	Rhipidura cockerelli	Birds	Papua New Guinea, Solomon Islands
82.	Woodford's Rail	Nesoclopeus woodfordi	Birds	Papua New Guinea, Solomon Islands
83.	Yellow-breasted Bird-of-paradise	Loboparadisea sericea	Birds	Indonesia, Papua New Guinea
84.	Yellow-eyed Starling	Aplonis mystacea	Birds	Indonesia, Papua New Guinea
85.	Yellow-legged Pigeon	Columba pallidiceps	Birds	Papua New Guinea, Solomon Islands
86.	Yellowish Imperial-pigeon	Ducula subflavescens	Birds	Papua New Guinea

APPENDIX 1.3

Endangered Species Associated with Mangroves

The IUCN Red List of Endangered Species lists most flora and fauna into seven categories ranging from “Least Concern” to “Extinct”. These categories are based on the current population of the species, the population trend (whether it is increasing or decreasing and how rapidly) and the threats faced by those species.

Hunting, habitat loss/degradation and climate change are the three biggest threats to the natural world and these problems are increasing the number of endangered species rapidly.

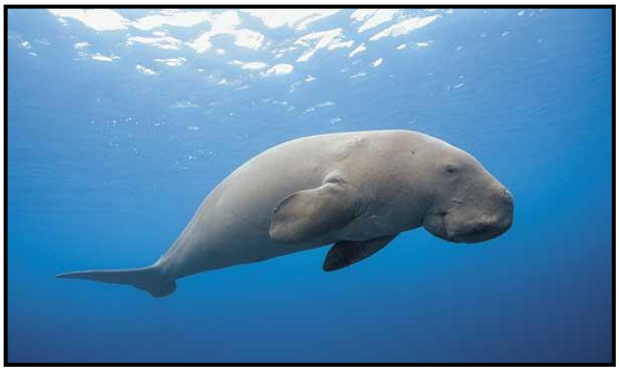
Below is a list of some of the species associated with Mangroves ranging from “Vulnerable” to “Critically Endangered”. The list covers fauna that rely on mangroves for either all or part of their lives as well as flora that are part of the Mangroves themselves. Many of these species are closely associated with each other and interlinking ecosystems, meaning the loss of one species can have devastating effects on another.

The loss of flora and fauna species and biodiversity is yet another reason why protecting mangrove habitat is so important. For more information please contact Mangrove Action Project at info@mangroveactionproject.org.

www.sms.si.edu/irlspec/Mangroves.htm
www.mangroves.godrej.com/MangroveVegetation.htm
www.nhmi.org/mangroves/flo.htm
www.fao.org/forestry/mangrove/3645/en/
www.mangrove.nus.edu.sg/guidebooks/text/flora.htm

Fauna
Mammals
Dugong, Dugong dugon

Status: Vulnerable



Range: Coastal and inland waters between East Africa and Vanuatu (Islands west of Australia). This large mammal is more closely related to the elephant than other sea mammals. It is the only fully marine mammal and is long lived and shy of humans. They are mostly herbivorous; sea grass being the main part of their diet, but have been known to eat jellyfish and squid.

The major threats to this animal come from habitat loss/degradation due to pollution and trawling, hunting for their meat and bones and fishing activities which either kill intentionally or sometimes accidentally.

More information: http://www.iucnredlist.org/details/6909/0

Pygmy Three-toed Sloth, Bradypus pygmaeus

Status: Critically endangered

Range: Only known on Isla Escudo de Veraguas, off the coast of Panama.
This is the smallest sloth in the world and it is only found in the red mangrove forests surrounding the tiny island it lives on. It is believed to only feed on mangrove leaves and it's total population is estimated to be less than 500 individuals.
It's main threat comes from loss of habitat because of indigenous peoples cutting the forest, but also from opportunistic hunters that visit the island.
More information: http://www.iucnredlist.org/details/61925/0

Bengal Tiger, Panthera tigris tigris

Status: Endangered

Range: India, Bangladesh, Nepal and Butan
This iconic species is found in tropical forests including Mangrove forests such as the Sunderbans. It's population across its entire range is estimated at less than 2500. It's diet mostly consists of large prey such as wild deer and pigs, but it will also prey on animals such as fish, elephants and primates.
The major threat to this species is poaching for its skin and of its body parts for "medicines". It is also suffering heavily from habitat loss which is leading to a decline in prey for the animal.
More information: http://www.iucnredlist.org/details/15955/0

Water mouse, Xeromys myoides

Status: Vulnerable
Range: Papua New Guinea and coastal areas of Northern Territory and Queensland, Australia

There is little known about this small, nocturnal rodent. It is carnivorous and feeds mainly on mollusks and crabs found at low tide amongst mangrove roots. Its distribution is extremely patchy along its range and it is only found in mangroves and coastal wetland associated with them. The population of this species is unknown but it is declining.
The biggest threat for this animal is loss of mangrove habitat due to coastal development and aquaculture. Development inland of mangrove ecosystems is also a major threat.
More information: http://www.iucnredlist.org/details/23141/0

No Scientific Name written

Status: Endangered
Range: Endemic to Borneo, found in Brunei, Indonesia and Malaysia

This unique primate has a declining population of only a few thousand. It is found in coastal and riverine forest such as mangroves and is limited to these specific habitats, avoiding cleared land. It is easily identified by its huge nose, pot-belly and reddish fur. Its diet consists mainly of leaves and fruit but it will also eat flowers and seeds.
Because of its association with coastal habitat, the main threat to this animal is habitat destruction. Logging, forest fires and development are encroaching rapidly on the area this monkey occupies. Hunting for Chinese “medicines” and as bush meat are also problems as it is easily caught by hunters.
More information: http://www.iucnredlist.org/details/14352/0

Smooth-coated Otter, Lutrogale perspicillata

Status: Vulnerable
Range: Wide-spread across South and Southeast Asia

This animal is secretive and diurnal (active in the morning and evening) and is rarely seen in the wild. It can grow up to 65cm and is found in large rivers, lakes and mangrove estuaries. It builds dens along river banks and prefers habitat with cover available for hiding from predators. This mammal is an opportunistic hunter and mostly eats fish, but will also eat crustaceans, insects, amphibians, birds and small rodents.
This aquatic mammal faces many threats from humans: destruction of habitat for aquaculture and hydroelectric dams, pollution of waterways by pesticides, reduction in prey and indiscriminate killing because of competition with humans and finally trapping for the fur trade.
More information: http://www.iucnredlist.org/details/12427/0

Red Colobus, Procolobus badius

Status: Endangered
Range: Senegal to Ghana, Western Africa

This primate has declining, fragmented populations along west Africa's coast one of its 3 subspecies being listed as critically endangered. It uses a variety of forest habitats, including mangroves and is vegetarian. It is preyed on regularly by Chimpanzees.
This animal is rapidly losing its habitat due to logging and clearing land for plantations. It is also suffering from hunting as it is desired for "bush meat" in the country. The logging roads through its forests are giving more access to the interior of the forest where it was once safe.
More information: http://www.iucnredlist.org/details/18240/0

Fishing Cat, Prionailurus viverrinus

Status: Endangered
Range: Patchy distribution across Asia and India

This cat is about twice the size of a domestic cat and is found in wetland habitat such as swamps, marshland and mangroves. They are good swimmers and—as their name suggests—primarily prey on fish, although they are known to eat birds, insects and rodents as well.
The main threat to this feline is wetland destruction and degradation, due to its dependence on this type of habitat. Over-fishing these areas is another significant threat and persecution by fishermen is also seen. Though considered not as valuable as other wild cats, its fur is still sold through illegal trade.
More information: http://www.iucnredlist.org/details/18150/0.

Sambar Deer, Rusa Unicolor

Status: Vulnerable, some populations classed as endangered
Range: Fragmented populations across South Asia, Southeast Asia and China

This large deer can reach up to 350 kg in weight, is highly adaptable and is the dominant species of deer in Tropical Asia. Its habitat varies widely from savannah to mangroves and it is indiscriminate with its herbivorous diet, eating many types of course vegetation.
Despite its adaptability, populations outside protected areas are at a very high risk with some having faced up to 50% declines over the last 3 generations. Hunting is the most serious threat to the animal: its antlers are used as "medicine" and it is killed for its meat. The demand for bush meat is a rapidly growing industry and for this deer the market is based in South-East Asia and China. Hunting has head to localised extinction in Vietnam, India, Thailand and Laos (amongst others), seen by a lack of this species in otherwise suitable habitat.
More information: http://www.iucnredlist.org/details/41790/0

Birds

Philippine Cockatoo, Cacatua haematuropygia

Status: Critically Endangered
Range: Endemic to the Philippines

Trapping for the caged bird trade is the biggest threat to this bird. It is valued at around $400 per bird. Habitat loss, hunting, changing weather and introduced predators are also adding to the decline of this species.
More information: http://www.iucnredlist.org/details/106001403/0

Mangrove Finch, Camarhynchus heliobates

Status: Critically Endangered
Range: Restricted to the Galapagos Islands

This bird is thought to only have a maximum of 200 mature individuals left in the wild, restricted to the North-West coast of Isabela Island. It inhabits dense mangrove swamps and has a diet of insects, larvae, spiders and some vegetable matter.
The biggest threat to this bird is predation and disease from invasive species such as the common rat (Rattus rattus).
More information: http://www.iucnredlist.org/details/106009612/0

Madagascar Teal, Anas bernieri

Status: Endangered
Range: Endemic to western coast of Madagascar

This bird has a total population of 1500-2500 individuals but this is decreasing. The species prefers coastal mangroves usually, but only breeds in seasonally flooded, non-tidal areas dominated by Black Mangrove Avicennia marina. It feeds mainly on aquatic and terrestrial insects and vegetation.
Habitat loss and disturbance by agriculture and development are threatening this species and isolating its populations. Hunting and trapping are also a problem as it is considered a delicacy.
More information: http://www.iucnredlist.org/details/100600449/0

Mangrove Hummingbird, Amazilia boucardi

Status: Endangered
Range: Endemic to the Pacific coast of Costa Rica

A maximum of 7000 mature individuals are found spaced along the stretch of coast but numbers are decreasing. It has very a specific habitat and feeds mostly on the flowers of the mangrove species Pelliciera rhizophorae.

The biggest threat is habitat loss due to construction of shrimp ponds and salt farms, but pollution and road construction (destroying hydrology) are also threats.
More information: http://www.iucnredlist.org/details/106001941/0

Insects

Illidge's Ant Blue Butterfly, Acrodipsas illidgei

Status: Vulnerable
Range: Endemic to Australia

This rare insect is a classic example of the interlinking web mangrove ecosystems maintain. The female butterfly lays her eggs in the stubs of Grey Mangrove (Avicennia marina) where there are colonies of Crematogastor ants. It has a symbiotic relationship with the ants: the ants carry the larvae into their nests and feed on the excrement and the larvae feed on developing ants.
Loss of habitat is the biggest threat to this insect as it is only found in mangroves.
More information: http://www.iucnredlist.org/details/313/0

Mangrove Skimmer, Orthetrum poecilops

Status: Vulnerable
Range: Very localised in China, Hong Kong and Japan

This species is a marine dragon fly, restricted to coastal habitats and can only be found either in mangrove forests or on the mud flats near them. The males are territorial and the females will visit in mornings and evenings.
Coastal development and aquaculture are the biggest threats to this insect, resulting in habitat loss and degradation.
More information: http://www.iucnredlist.org/details/60302/0

Reptiles

Hawksbill Turtle, Eretmochelys imbricate

Status: Critically Endangered
Range: Tropical and subtropical waters of the Atlantic, Indian and Pacific oceans

This animal is migratory and occupies many different habitats during its lifetime. Mangroves are an essential habitat for older juveniles and adults, offering protection and food. One sub-population in Central America nests and lives in mangrove estuaries all year round. Hawksbills are long-lived animals which can take between 20-40 years to reach maturity. There has been an 80% decrease in the number of turtles over the last 3 generations and the population is still decreasing.
The major threats to this species are the Tortoiseshell trade, egg collection, destruction of nesting and foraging habitat, hunting for meat and entanglement in fishing equipment.
More information: http://www.iucnredlist.org/details/8005/0

King Cobra, Ophiophagus Hannah

Status: Vulnerable
Range: Southeast Asia and parts of India

Although this species is widespread, it is not common in any of the areas it occurs. It is venomous and can reach almost 6m in length. It can be found in mangrove forests but has a range of habitats. It's diet consists mostly of other snakes but it will also eat birds, rodents and lizards.
Deforestation and agriculture development are leading to habitat loss which is the biggest threat. However this reptile is also hunted for its skin and body parts for traditional Chinese medicine.
More information: http://www.iucnredlist.org/details/177540/0

American Crocodile, Crocodylus acutus

Status: Vulnerable
Range: Atlantic coast of South and Central America up to Florida and Pacific Coast of Mexico to Peru

This reptile is the most widespread of the New World Crocodiles. They are mostly found in coastal habitats such as lagoons and mangroves but also inhabit freshwater. Their main prey is fish but adults have been known to hunt animals as large as cattle. A male adult can grow to nearly 4.5m long. Over the last 75 years the population has declined by 30%.
Coastal development is leading to a loss of nesting ground and loss of mangrove habitat for this species. Despite a ban, illegal hunting for this crocodile's skin is an on-going threat. This species is also hybridizing with other Crocodylus spp. but it is unclear yet whether this will have a long-term detrimental affect on the population.
More information: http://www.iucnredlist.org/details/5659/0

Four-Toed Terrapin, Batagur baska

Status: Critically Endangered
Range: 5 countries in Southeast Asia

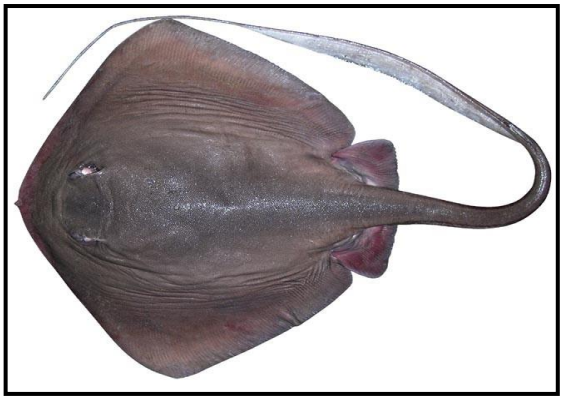
Found in tidal areas of estuaries, this turtle lays its eggs in riverbanks and sandbars. This animal is listed under CITED appendix I which is meant to be the highest level of protection from trade, yet it's population is declining rapidly and has become extinct in 4 countries over the last 15 years.
The biggest threat comes from illegal trade of the animal, especially in China.
More information: http://www.iucnredlist.org/details/2614/0

Sharptooth Lemon Shark, Negaprion acutidens

Status: Vulnerable
Range: Indian ocean and western, Central Pacific

Found in tropical waters including coral reefs and mangrove estuaries, this fish dwells on the bottom of the ocean and has a limited movement range. It feeds on bony fish and can grow up to 3m as an adult but its threat to humans is relatively low.
The major threat to this fish is habitat loss through coral reef destruction by pollution and dynamite fishing, along with deforestation of mangroves throughout Southeast Asia. It is very susceptible to heavy localized fishing and has become extinct in local areas in Thailand and India because of this.
More information: http://www.iucnredlist.org/details/41836/0

Roughnose Stingray, Pastinachus solocirostris



Status: Endangered
Range: Western-central Pacific: Malaysia, Brunei, Singapore and Indonesia.

Little is really known about this stingray an its population size is unknown. It mainly occupies mangrove estuaries and coastal areas in very shallow waters. It has a very restricted range and habitat and dwells on the sea bed.
The rapid destruction of mangroves for aquaculture is a serious threat for this animal. It is also exploited by for its shallow water habitat and over-fishing are the main threats to this animal.
More information: http://www.iucnredlist.org/details/161465/0

Tiger Tail Seahorse, Hippocampus comes

Status: Vulnerable
Range: Primarily Philippines

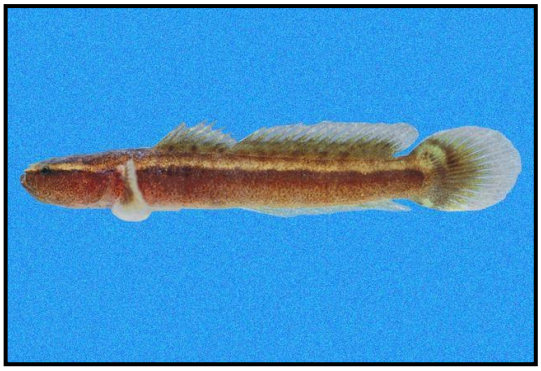
These fish are found in coral reefs, seagrass beds and mangroves. They are nocturnal and are ambush predators, eating anything small enough to swallow from tiny invertebrates to fish fry. It uses its tail to grasp onto coral, sponge and sea grass and its habitat is very localized. These seahorse mate for life and it is the male that gives birth rather than the female.
They are under threat for use in traditional “medicines” and the aquarium trade. It is also affected through by-catch and habitat degradation from fishing techniques and development. The unique behavior of fidelity towards a partner means the sea horse may never reproduce is one partner is lost.
More information: http://www.iucnredlist.org/details/41008/0

Mangrove Whipray, Himantura granulate

Status: Near Threatened but close to vulnerable
Range: Eastern Indian and Western Pacific Oceans, coastal.

This is a large (141cm across) stingray that prefers shallow, coastal waters including mangroves. Its population across its range is unknown but it is much less common than other Himantura spp.
Threats mostly come from industrial fishing across its range, but habitat loss and pollution are also affecting numbers.
More information: http://www.iucnredlist.org/details/161431/0

Fin-joined Goby, Gobulus birdsong



Status: Critically Endangered
Range: Only in 2 mangrove streams leading to the Panama Canal, Gulf of Panama

This little fish—up to 7.2cm—is endemic to this part of Panama and is incredibly rare. It depends on the mangrove forests it lives in and is only found in their shallow, fresh waters. It is carnivorous and feeds on invertebrates found on the bottom of the sea, such as mollusks, crabs and worms.
The biggest threat to this fish is habitat loss due to coastal development in Panama.
More information: http://www.iucnredlist.org/details/183832/0

Flora
Pelliciera rhizophorae

Status: Vulnerable
Range: Caribbean coast of Central and South America

This rare mangrove species has 5 small and separate populations along its range. It is restricted in its distribution and these populations are declining. It is a relatively small tree that has specific salinity needs and is the main habitat for the endangered Mangrove hummingbird.
The main threat to this mangrove is deforestation. Due to its localized populations, it is also at risk from unpredictable storms. Rise in sea level is also a threat.
More information: http://www.iucnredlist.org/details/178833/0

Bruguiera hainesii

Status: Critically Endangered
Range: Singapore, Malaysia and Papa New Guinea

This is an extremely rare species and only has around 200 known individual trees left. It has low propagation and germination rates, but can grow 30m tall with the right conditions.
The main threats are coastal development and deforestation. Because of the slow growth and production of this species it does not have time for recovery in the same way others that are faster would.
More information: http://www.iucnredlist.org/details/178834/0

Sonneratia griffithii

Status: Critically Endangered
Range: North-East coast of Bay of Bengal, Andaman Coast and coasts of Andaman Islands

There are less than 500 mature individuals left spread out in a patchy distribution and this population is decreasing with an overall decline of 80% since 1950.
Coastal development for shrimp farms and agriculture continue to be a threat to this species, despite it being fast-growing and colonizing.
More information: http://www.iucnredlist.org/details/178799/0

Avicennia bicolor

Status: Vulnerable
Range: Eastern Tropical Pacific from Mexico to Columbia

This species population has declined by around 30% over the last 30 years. It is a canopy tree reaching up to 15m and can withstand relatively high salinity levels compared to other mangrove species.
The major threat to this species is cattle grazing: either the land is cleared or the cattle graze under the mangroves and damage/destroy the undergrowth and any potential regeneration. It is also under threat from aquaculture and urban development.
More information: http://www.iucnredlist.org/details/178847/0

Camptostemon philippinense

Status: Endangered
Range: Indonesia and the Philippines

There are estimate to be less than 1200 mature species across its range in a restricted and patchy distribution with this number decreasing. It is found on the edge of mangrove forests along tidal creeks.
Fish and shrimp aquaculture is a severe threat to this species, especially in the Philippines. It is targeted locally as a source of wood for various uses and pollution is also a problem.
More information: http://www.iucnredlist.org/details/178808/0

Heritiera fomes

Status: Endangered
Range: From the Sundarbans in India spreading down the coast to Northern Malaysia

This species can be common in local populations but has a limited overall distribution. The population in India and Bangladesh is rapidly declining. It prefers fresh water and can grow rapidly in such conditions, up to 25m tall.
This species is quickly disappearing in many parts of its range due to coastal development (urban, agricultural and industrial), disease, typhoons, aquaculture and selective cutting for charcoal.

Heritiera globosa

Status: Endangered
Range: Endemic to Borneo

There is little information about this extremely rare species. It is only found in freshwater-dominated riverine areas and can grow to more than 25m but this is a slow process.
Logging to create timber and palm oil plantations are destroying the habitat for this mangrove species.

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3	CENTRAL	C/- FODE HQ	3419228	72228110	The Coordinator	Senior Clerk	72229050
4	ALOTAU	P. O. Box 822, Alotau	6411343 / 6419195	72228130	The Coordinator	Senior Clerk	72229051
5	POPONDETTA	P. O. Box 71, Popondetta	6297160 / 6297678	72228138	The Coordinator	Senior Clerk	72229052
6	MENDI	P. O. Box 237, Mendi	5491264 / 72895095	72228142	The Coordinator	Senior Clerk	72229053
7	GOROKA	P. O. Box 990, Goroka	5322085 / 5322321	72228116	The Coordinator	Senior Clerk	72229054
8	KUNDIAWA	P. O. Box 95, Kundiawa	5351612	72228144	The Coordinator	Senior Clerk	72229056
9	MT HAGEN	P. O. Box 418, Mt. Hagen	5421194 / 5423332	72228148	The Coordinator	Senior Clerk	72229057
10	VANIMO	P. O. Box 38, Vanimo	4571175 / 4571438	72228140	The Coordinator	Senior Clerk	72229060
11	WEWAK	P. O. Box 583, Wewak	4562231/ 4561114	72228122	The Coordinator	Senior Clerk	72229062
12	MADANG	P. O. Box 2071, Madang	4222418	72228126	The Coordinator	Senior Clerk	72229063
13	LAE	P. O. Box 4969, Lae	4725508 / 4721162	72228132	The Coordinator	Senior Clerk	72229064
14	KIMBE	P. O. Box 328, Kimbe	9835110	72228150	The Coordinator	Senior Clerk	72229065
15	RABAUL	P. O. Box 83, Kokopo	9400314	72228118	The Coordinator	Senior Clerk	72229067
16	KAVIENG	P. O. Box 284, Kavieng	9842183	72228136	The Coordinator	Senior Clerk	72229069
17	BUKA	P. O. Box 154, Buka	9739838	72228108	The Coordinator	Senior Clerk	72229073
18	MANUS	P. O. Box 41, Lorengau	9709251	72228128	The Coordinator	Senior Clerk	72229080
19	NCD	C/- FODE HQ	3230299 Ext 26	72228134	The Coordinator	Senior Clerk	72229081
20	WABAG	P. O. Box 259, Wabag	5471114	72228120	The Coordinator	Senior Clerk	72229082
21	HELA	P. O. Box 63, Tari	73197115	72228141	The Coordinator	Senior Clerk	72229083
22	JIWAKA	c/- FODE Hagen		72228143	The Coordinator	Senior Clerk	72229085

SUBJECT AND GRADE TO STUDY

GRADE LEVELS	SUBJECTS/COURSES
Grades 7 and 8	1. English
	2. Mathematics
	3. Personal Development
	4. Social Science
	5. Science
	6. Making a Living
Grades 9 and 10	1. English
	2. Mathematics
	3. Personal Development
	4. Science
	5. Social Science
	6. Business Studies
	7. Design and Technology- Computing
Grades 11 and 12	1. English – Applied English/Language& Literature
	2. Mathematics - Mathematics A / Mathematics B
	3. Science – Biology/Chemistry/Physics
	4. Social Science – History/Geography/Economics
	5. Personal Development
	6. Business Studies
	7. Information & Communication Technology

REMEMBER:

- For Grades 7 and 8, you are required to do all six (6) courses.
- For Grades 9 and 10, you must study English, Mathematics, Science, Personal Development, Social Science and Commerce. Design and Technology-Computing is optional.
- For Grades 11 and 12, you are required to complete seven (7) out of thirteen (13) courses to be certified.

GRADES 11 & 12 COURSE PROGRAMMES

No	Science	Humanities	Business
1	Applied English	Language & Literature	Language & Literature/Applied English
2	Mathematics A/B	Mathematics A/B	Mathematics A/B
3	Personal Development	Personal Development	Personal Development
4	Biology	Biology/Physics/Chemistry	Biology/Physics/Chemistry
5	Chemistry/ Physics	Geography	Economics/Geography/History
6	Geography/History/Economics	History / Economics	Business Studies
7	ICT	ICT	ICT

Notes: You must seek advice from your Provincial Coordinator regarding the recommended courses in each stream. Options should be discussed carefully before choosing the stream when enrolling into Grade 11. FODE will certify for the successful completion of seven subjects in Grade 12.

CERTIFICATE IN MATRICULATION STUDIES		
No	**Compulsory Courses**	**Optional Courses**
1	English 1	**Science Stream:** Biology, Chemistry, Physics
2	English 2	**Social Science Stream:** Geography, Intro to Economics and Asia and the Modern World
3	Mathematics 1	
4	Mathematics 2	
5	History of Science & Technology	

REMEMBER:
You must successfully complete 8 courses: 5 compulsory and 3 optional.