GRADE 12

GEOGRAPHY

COURSE MODULE

UNIT MODULE 1: RESOURCE USE AND MANAGEMENT

UNIT MODULE 2: URBANISATION AND INDUSTRILISATION

UNIT MODULE 3: COMPARATIVE STUDIES

Acknowledgments

We acknowledge the contributions of all Secondary Teachers who in one way or another helped to develop this course book.

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DEMAS TONGOGO
PRINCIPAL

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Papua New Guinea

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SECRETARY'S MESSAGE

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

This course is part and parcel of the new reformed curriculum. Its learning outcomes are student centred and written in terms that allow them to be demonstrated, assessed and measured.

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

This is a provision of 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, Government policies and reports. It is developed in line with the National Education Plan (2005 – 2014) and addresses an increase in the number of school leavers which has been coupled with a limited access to secondary and higher educational institutions.

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

- to facilitate and promote integral development of every individual
- to develop and encourage an education system which 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 education accessible to the physically, mentally and socially handicapped as well as to those who are educationally disadvantaged

The College is enhanced to provide alternative and comparable path ways for students and adults to complete their education, through one system, many path ways and same learning outcomes.

It is our vision that Papua New Guineans harness all appropriate and affordable technologies to pursue this program.

I commend all those teachers, curriculum writers and instructional designers, who have contributed so much in developing this course.

DR. UKE KOMBRA, PhD
Acting Secretary for Education.

Dear Student,

Welcome to the Grade 12 Geography Course Module. This Module consists of three unit modules:

UNIT MODULE 12.1 : RESOURCE USE AND MANAGEMENT
UNIT MODULE 12.2 : URBANISATION AND INDUSTRIALISATION
UNIT MODULE 12.3 : COMPARATIVE STUDIES

The Grade 12 Geography Course is a follow up from what students have studied in Grade 11. It has been designed using learning outcomes that identify the knowledge, skills, attitude and values that all students achieve or demonstrate by the end of Grade 12.

12.1 Resource Use and Management students will covers topics on the availability of resources and how they are used and managed.

12.2 Urbanisation and Industrialisation students will cover topics including distribution of world cities, industrial growth and impact of Industrial growth.

12.3 Comparative Case Studies, will engage students to compare and contrast between developed and developing countries with Papua New Guinea.

Grade 12 Geography course modules are focused on the Physical and Human Environment both in PNG and around the world. These modules aim to develop students' awareness of the natural environment and its processes and the interaction that exist between the natural and human environment.

Assessments

- **Activities**
  Each Unit Module has activities for you to do. Answers to the activities will be found at the end of each Unit after the Unit Summary
- **Assignments**
  Each Unit has an Assignment which you will do and then send to FODE Provincial Center for marking. The marked Assignment will be returned to you with comments and advice from your tutor. A mark will be given which will be counted towards your final internal mark.
- **Examinations**
  After the completion of the course, you will sit for an internal exam which will make up 70 % of your total internal mark. You will now be ready for the Grade 12 National Examination which is held in October each year.

For more information refer to the **Study Guide**.

Below are the steps to guide you in your course study.

STUDY GUIDE

Step 1: Start with Heading 12.1.1, study the first sub-heading notes and do the Learning Activities as you go along. Turn to the back of your module to correct the answers of your learning activities.

Step 2: When you have completed the first sub-heading notes, then, you can move on to the next sub-heading. Continue to do the Learning Activities as you go along. Turn to the back of your module to correct the answers of your learning activities.

Step 3: If you make any mistake, go back to the notes in your module and revise the notes well and try to understand why you gave an incorrect answer.

Step 4: Go to Topic 12.1.2 and repeat the same process in step 2 and step 3 until you complete the five headings.

Step 5: After completing your five headings, go to your Assessment Book and complete each Assessment Task in the Assessment Book.

Step 7: Check your answers in the Assessment Book again, and when you are satisfied, submit your Assessment Book to your Provincial Centre for marking.

Study Schedule

Here is a sample study schedule that you can follow. It is just a guide to help you plan your work.

WEEKS	HEADING	ASSESSMENT NUMBER	ASSESSMENT TYPE	MARK
1-2	1	Assessment Task 1	Test	20 marks
3- 4	2	Assessment Task 2	Test	20 marks
5- 6	3	Assessment Task 3	Test	20 marks
7-8	4	Assessment Task 4	Test	20 marks
9-10	5	Assessment Task 5	Assignment	20 marks
THE COMPLETED ASSESSMENT BOOK MUST BE SUBMITTED TO YOUR PROVINCIAL COODINATOR FOR MARKING.				**TOTAL: 100 marks**

All the best and enjoy your studies with FODE.

12.1 RESOURCE USE AND MANAGEMENT

UNIT MODULE INTRODUCTION

Resource use and environmental issues have been concerns of all countries, including Papua New Guinea. This unit enables students to appreciate and acknowledge the availability of the earth's resources, both locally and globally, and to consider how the resources should be used sustainability for future generation. Students develop an understanding of the impact of sustainable use of resources on the environment and develop an awareness of the need to make well-informed decisions about resource use and management. Students also develop an understanding of the negative effects of energy use on global climatic patterns.

Objectives or aims

On successful completion of this module, students will be able to:

- Identify the different ways in which fossil fuel and energy resources are used or abused.
- Identify the impacts of resource abuse on the environment and the climate.
- Identify traditional Melanesian knowledge of wildlife utilization
- Demonstrate an understanding of appropriate farming methods and sustainable ways of food production.
- Examine and present issues relating to logging in Papua New Guinea.

Time Frame

This unit should be completed within 10 weeks.

If you set an average of 3 hours per day, you should be able to complete the unit module comfortably by the end of the assigned week.

Try to do all the learning activities and compare your answers with the ones provided at the end of the unit. If you do not get a particular exercise right in the first attempt, you should not get discouraged but instead, go back and attempt it again. If you still do not get it right after several attempts then you should seek help from your friend or even your tutor. Do not pass any question without solving it first.

12.1.1 CLIMATE CHANGE AND ENERGY USE

Introduction

Welcome to topic 12.1.1 of the Grade 12 Unit 1 Module. This topic comprises of five sub-headings. They include:

12.1.1.1: What is Climate Change?
12.1.1.2: Fossil fuels, types and Uses
12.1.1.3: Effects of Global Warming
12.1.1.4: Alternative Sources of Energy
12.1.1.5: PNG REDD Initiative

Objectives/Aims

On successful completion of this topic you will:

- define Climate Change
- identify different types of fossil fuels and their uses
- enumerate the effects of Global Warming
- identify alternative sources of energy
- discuss the PNG REDD Initiative

This heading should be completed within 2 weeks.

If you set an average of 3 hours per day, you should be able to complete the topic comfortably by the end of the assigned week.

12.1.1.1: What Is Climate Change?

When looking at climates, one begins to wonder whether climates around the world have always remained the same over centuries. Well the answer to that question is climates are constantly changing and that brings us to our topic of discussion which is **climate change**. Significant change has occurred on Earth in the past and most certainly will occur in the future. So what is climate change? Let's begin by looking at what Climate change means.

Climate change is a change in global or regional climate patterns, in particular a change from the mid to late 20th century onwards as a result of increased levels of atmospheric carbon dioxide produced by the use of fossil fuels.

The climate of the planet is constantly changing. Climate change is in large part caused by human activities which cause an increase in the concentration of greenhouse gases. These gases include carbon dioxide, methane, and nitrogen dioxide and are released by modern industry, agriculture and by the burning of coal, petroleum and natural gas. This greenhouse gases cause *global warming*.

What is Global Warming?

Global warming is a gradual increase in the overall temperature of the earth's atmosphere generally attributed to the greenhouse effect caused by increased levels of carbon dioxide, CFCs, and other pollutants

Then, what really causes these climates to change? Let us take a closer look at the different factors that cause climate change.

The Causes of Climate Change

Several suggestions have been made to try and explain this change but the three main ones are;

1. **Changes in oceanic circulation:** Changes in oceanic circulation affect the exchange of heat between oceans and the atmosphere.
2. **Volcanic activity:** Volcanic activity has influenced climate in the past and continues to do so. World temperatures are lowered after any large single eruption. This is due to the increase in dust particles in the lower atmosphere which will absorb and scatter more of the incoming radiation. Precipitation also increases due to the greatest number of dust particles in the atmosphere.
3. **Plate Tectonics:** Plate tectonics have led to redistributions of land masses and to long term effects on climate. These effects may result from land mass drifting into different latitudes or from seabed being pushed upward to form high fold mountains. The presence of Fold Mountains can lead to a colder climate.

Global Warming and the Greenhouse Effect

In the atmosphere, there are various gases that allow sunlight to pass through to the surface of the earth. The main one is the heat radiation that is normally given off from the ground, and stops it from going back out into space. This process actually protects and keeps the earth warm and is known as the **greenhouse effect**. The term is based on the principle that in a green house, or plant hothouse or glass or plastic roofing, allows sunlight in but does not allow heat radiation out. It actually stops hot air from rising and getting away. Have you ever noticed how hot it is when you get in a car on a sunny day with the windows closed?

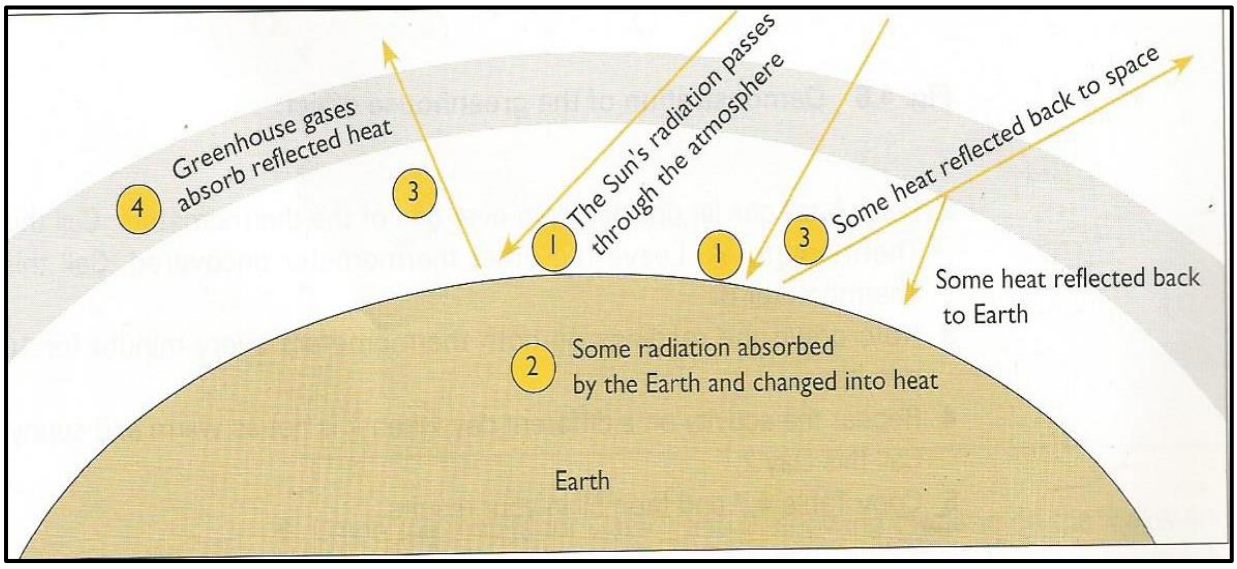


Figure 1.1 The greenhouse effect and global warming

Since the mid-1980s, scientists have become increasingly concerned about a build-up of these greenhouse gases (mainly carbon dioxide). This has been caused by the burning of fossil fuels (coal, oil and natural gas). The increase in the greenhouse gases reduce the amount of heat that escape into space. The result is that the earth's surface warms up that leads to global warming. The result is enhanced **greenhouse effect**, caused by human activities.

Greenhouse effect is simply the way the gases in the atmosphere keep warmth escaping from the earth's surface.

Apart from destroying the ozone layer, CFC's together with the gases such as carbon dioxide, methane and nitrogen dioxide are harmful in another way. These gases trap heat on the earth and can cause the earth to warm up. We call them the greenhouse gases. Scientist are certain that this greenhouse gases are increasing, for there is more and more methane and carbon dioxide found in the air than hundreds of years ago.

Methane comes from rice fields and is also released from cows. As human population increase, so too do in the areas of rice fields, the number of cows and the amount of methane released into the air.

When fossil fuel such as coal, oil and gases are burnt, carbon dioxide is produced. With the growth of industries, we are burning more and more fossil fuels, and releasing more and more carbon dioxide into the air. When living things respire, they release carbon dioxide as one of the products. Respiration is important to all living things because energy is released from the process. This energy is needed for the movement, growth, repair and many of the activities that are vital to the release of carbon dioxide and some other gases, according to the scientists, has caused the greenhouse effect which leads to a rise in the earth's temperature or global warming. As carbon dioxide is one of the major causes of the greenhouse effect, it is important for us to study it, so that we can find ways to control it level in the air.

We need plants to absorb the large amount of carbon dioxide produced from the burning of fossil fuels. But because too many trees have been cut down from the forests, the carbon dioxide level in the air cannot be brought down to safe enough level.

But how does this increased carbon dioxide affect our environment?

1. The sun's radiation passes through the atmosphere and warms the earth.
2. The radiation which is absorbed by the earth is changed to heat radiation.
3. Some of the heat is reflected back to space off the earth's surface.
4. Gases in the atmosphere (carbon dioxide, CFC's, methane and nitrogen dioxide) absorb this reflected heat and keep it within our atmosphere.
5. The trapped heat causes a gradual rise in the earth's temperature. This is call global warming.

Effect of greenhouse gases

A rise in sea levels together with the retreat of glaciers and a shrinkage in ice cover in polar and high altitude regions have been some of the most obvious effects of climate change so far, but the wider range of consequences is becoming evident.

Different regions of the world are experiencing warmer days and nights as well as increases in the frequency and intensity of storms, droughts, floods, heat waves, and high sea levels. These weather extremes will in turn have potentially devastating impacts on agriculture, forestry, ecosystems, water resources, human health, industry, and society.

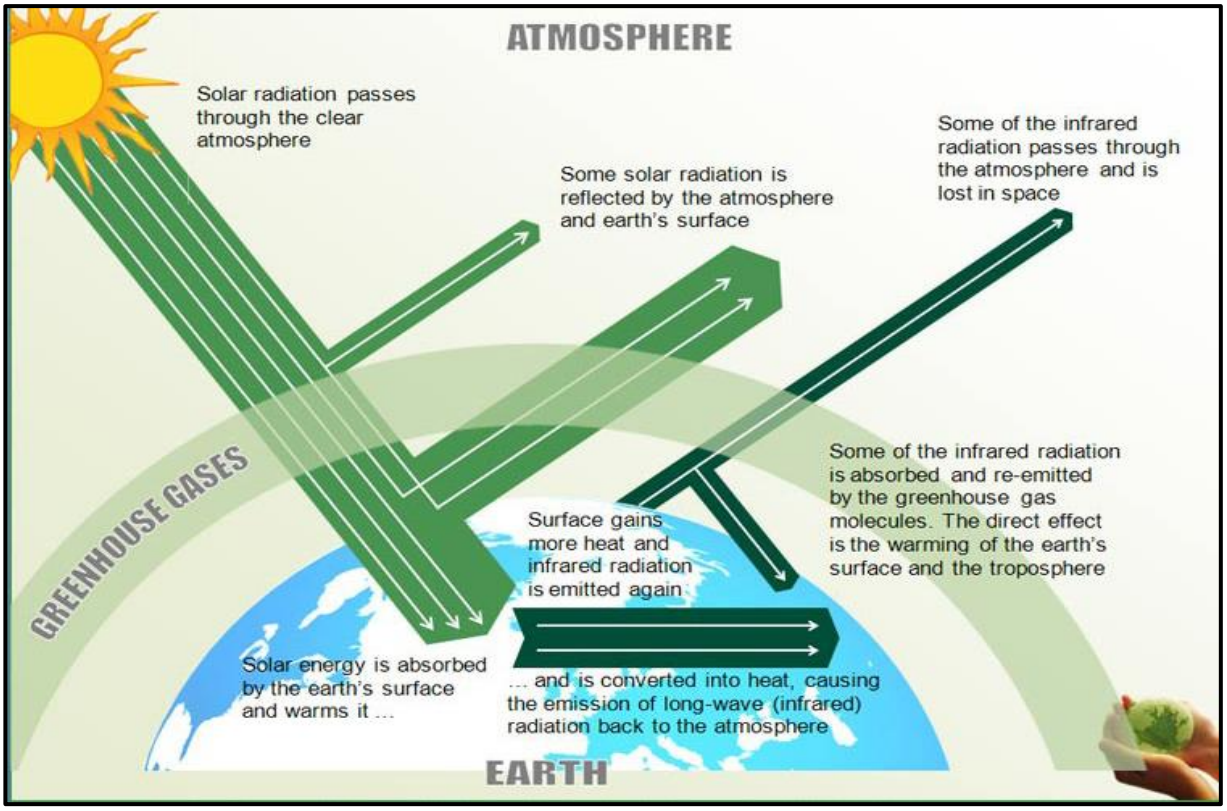


Figure 1.2 Climate change: The science of climate

Higher Concentration Of Greenhouse Gases

The earth is warmed by gases in our atmosphere that trap heat escaping from the earth's surface. These greenhouse gases (GHG) have increased significantly especially over the last 50 years due to human activities, such as deforestation, agriculture, and the burning of fossil fuels for power. The increasing concentration of GHGs in the atmosphere is trapping more and more heat, raising the average temperature of the planet's air and oceans and so altering climate patterns.

Greenhouse Gases and Temperature

Greenhouse gases have always occurred naturally in the atmosphere, but human activity is leading to increase concentration above the natural level. Since industrialization began, CO2 levels have risen sharply from 280 ppm to about 389 ppm and are largely responsible for the 0.7°C increase in average global temperatures over the last 100 years. (Sources: CDIAC, IPCC AR4, Petit et al, 2001 (Vostok ice core).

The main greenhouse gases generated by human activity are carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O); there are also minor amounts of synthetic gases such as chlorofluorocarbons (CFCs) that contribute to the warming effect.

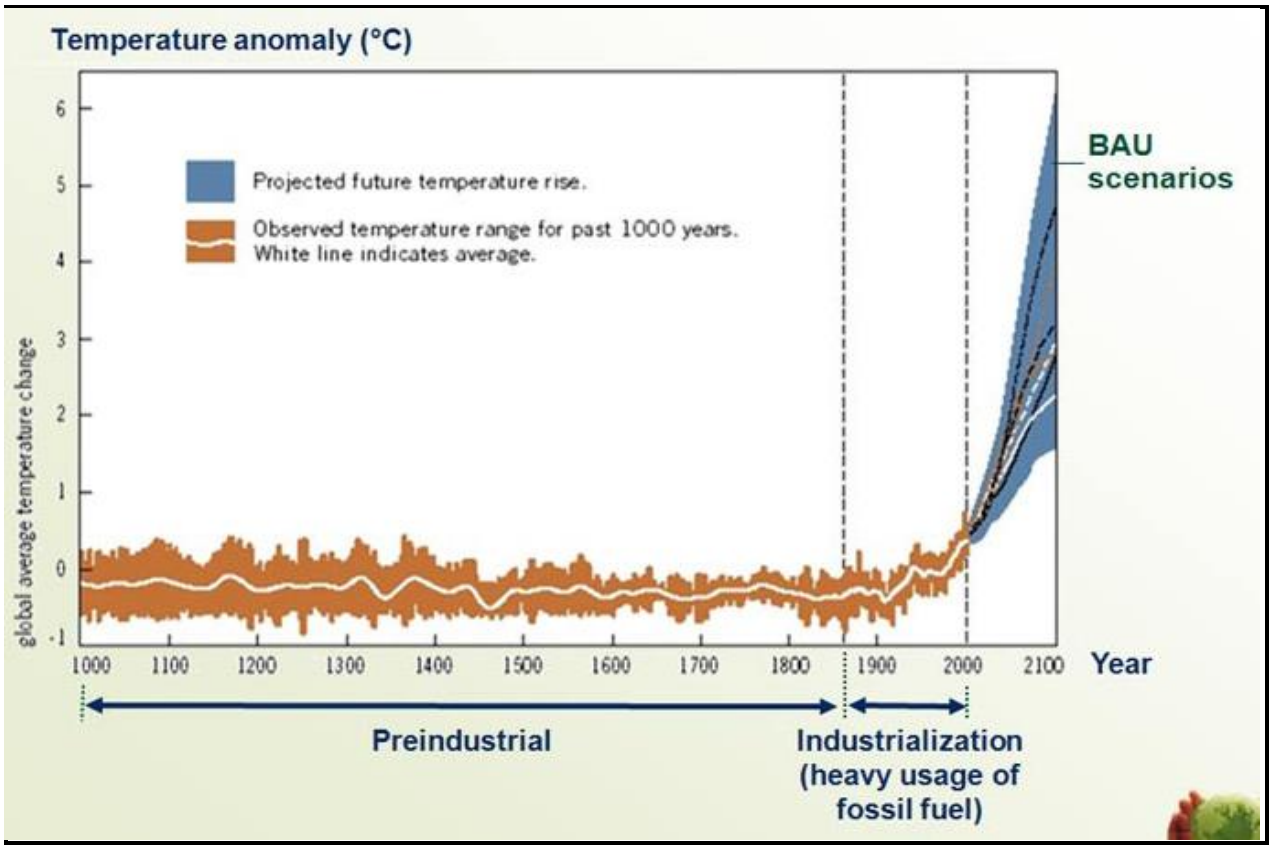


Figure 1.3 Gases in the atmosphere

The main greenhouse gases generated by human activity are carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O); there are also minor amounts of synthetic gases such as chlorofluorocarbons (CFCs) that contribute to the warming effect.

Carbon dioxide is produced in large amounts by deforestation and burning fossil fuels for energy; it is estimated to account for 50% of warming related to human activity. Methane and nitrous oxide are produced mainly from agriculture and contribute approximately 18% and 6% respectively of warming related to human activity

NOW TURN TO THE NEXT PAGE TO DO ACTIVITY 12.1.1.1

STUDENT LEARNING ACTIVITY 1

1. a) What is the greenhouse effect? Explain in your own words.

_____

_____

_____

b) Which gases contribute to the greenhouse effect?

_____

_____

2. Complete the table below by identifying how the factors listed under solution will help solve or minimize the problem or the things we can do to help minimize the problems caused by greenhouse effect. The first one has been done as an example.

Table 1: Controlling Greenhouse Gases.

SOLUTION	HOW IT HELPS	THINGS WE CAN DO
1. Control population growth	With fewer people there is less burning and industrial activity so less greenhouse gases are released.	Birth control
2. Regrowing of forest		
3. Energy conservation		

NOW CHECK YOUR ANSWERS AT THE END OF THE UNIT SUMMARY

12.1.1.2 : Fossil Fuel and Their Uses

Fossil fuels are organic chemicals created by living organisms millions of years ago and buried in sediments, where high pressure and temperatures concentrated and transformed them into high energy rich compounds. Coal is solid, petroleum (crude oil) is liquid, oil shales and tar sands are semisolid tars trapped in rock and natural gas (methane and other gaseous hydrocarbons) is as its name suggest, is a gas. Most of these fuels were laid down during the Carboniferous period (286 million to 360 million years ago) when the earth's climate was warmer and wetter than it is now, but some are thought to date as far back as Precambrian times, perhaps a billion years ago. Because fossil fuels take so long to form, they are essentially **nonrenewable resources**.

Developed countries and developing countries differ greatly in their sources of energy. The types of energy we use, are the major factors determining our quality of life and have harmful environmental effects. Our current dependence on nonrenewable fossil fuels is the primary cause of air and water pollution, land disruption and projected global warming.

Will our energy sources ever run out? Energy is vital to life and from it we get light and heat and it is what allows economic growth. Most of the energy we use comes from fossil fuels such as petroleum, coal and natural gas. We burn these fuels in power stations to make electricity and to power cars and other transport. So what are fossil fuels?

Fossil fuel is a term that refers to resources such as petroleum, coal and natural gas that found buried within sedimentary rocks and contains high percentage of carbon.

This reliance on fossil fuels creates two major problems. Firstly, these energy sources are non-renewable. Much of the easily accessible oil will be gone in 50 years times and coal will be scares in 200 years times. Secondly, and perhaps more critically, burning these fossil fuels releases gases into the atmosphere that are responsible for global warming.

Types of Fossil Fuels

Fossil fuels are often referred to as non-renewable resources because they take millions of years to form and they are the result of the sedimentation of plants and animals that lived millions of years ago whose remains were deposited at the bottom of estuaries and swamps. Their combustion releases into the atmosphere most of the gases that cause acid rain and the enhanced greenhouse effect.

We will now take a closer look at the three types of fossil fuels and taking into consideration their effects on the environment and their advantages and disadvantages.

1. Natural Gas

What is Natural Gas?

In its underground gaseous state, natural gas is a mixture of 50-90% by volume of methane, the simplest hydrocarbons**.** Most natural gas deposits occur at or near hot spots, where high temperatures and pressures. It is the cleanest of all fossil fuels and the first to run out.

Natural Gas Formation

Formed by the breakdown of organic matter, it can be found in isolation or deposited together with petroleum. Natural gas requires the same conditions as oil for accumulation. Gas can exist at greater depth than oil, however, variations in source rock, depth of burial and thermal history of organic matter probable control whether oil or gas both accumulate in that region.

How is Natural Gas Extracted?

When a natural gas field is tapped, propane and butane gases are liquefied and removed as liquefied petroleum gas (LPG). LPG is stored in pressurized tanks for use mostly in rural areas not served by natural gas pipelines. The rest of the gas (mostly methane) is dried to remove water vapor, cleansed of poisonous hydrogen sulfide and other impurities and pumped in to pressurized pipelines for distributions. At a very low temperature of -184 0 C, natural gas can be converted to liquefied natural gas (LNG). This highly flammable liquid can then be shipped to other counties in refrigerated tanker ships. One way of transporting it to places of consumption is through gas pipelines.

Natural gas is difficult to store and ship. In remote locations, offshore platform it is often flared off.

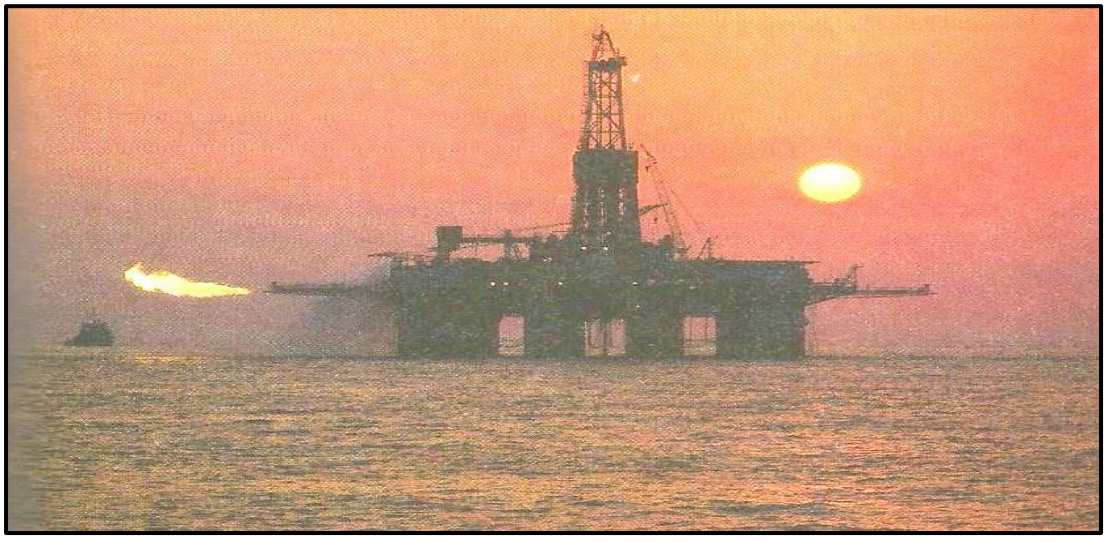


Figure 1.4 An offshore platform

2. Crude Oil

What is Crude Oil?

Petroleum or crude oil (oil as it comes out of the ground) is a fossil fuel produced by the decomposition of deeply buried dead organic matter from plants and animals under high temperatures and pressures over millions of years.

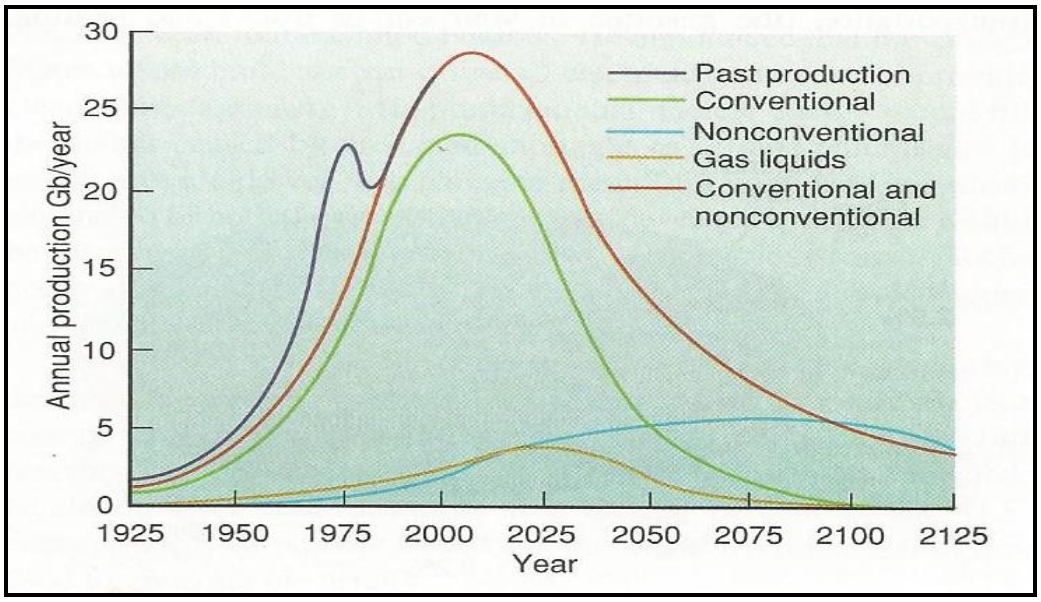


Figure 1.5 Worldwide production of crude oil

Crude Oil Formation

Typically, this smelly liquid consists mostly of hydrocarbons, with small amounts of sulfur, oxygen, and nitrogen impurities.

Crude Oil and Natural Gas are often trapped together under a dome deep within the earth's crust. The crude oil is dispersed in pores and cracks in underground rock formations, like water in a sponse. If there is enough pressure from natural gas and water under the dome of oil- containing rock, some of the crude oil is pushed to the surface when a well is drilled (known as gusher).

How it is extracted?

Primary Oil recovery involves drilling a well and pumping out the oil that flows by gravity into the bottom of the well. After the flowing oil has been removed, water can be injected into nearby wells to force some of the remaining heavy oil to the surface, a process known as secondary oil recovery.

On average, producers get only about 35% of the oil out of a reservoir by primary and secondary recovery before they abandon it because the heavy oil that remains is too difficult or expensive to recover. As oil prices increases, it may become economical to remove about

10-25% of this heavy oil by enhanced or tertiary, oil recovery. Steam or CO_2 gas can be used to force some of the heavy oil into the well cavity for pumping to the surface. However, enhanced oil recovery is expensive. Most crude oil travels by pipeline to a refinery, where it is heated and distilled.

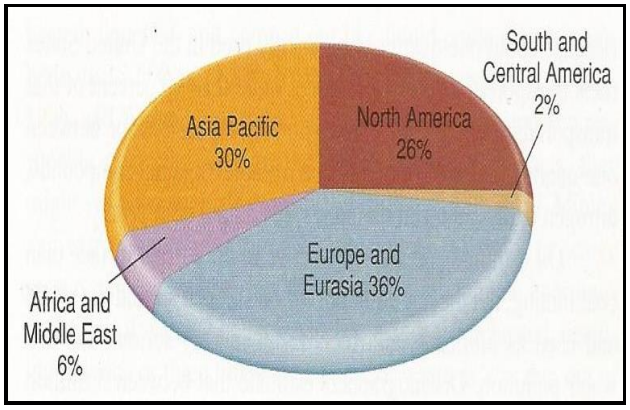


Figure 1.6 Coal proven reserve by region

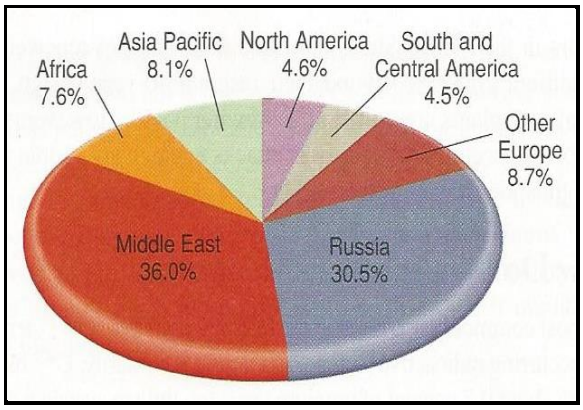


Figure 1.7 Natural gas proven reserve by region

Uses of Petroleum

- Is the base for many industrial products such as heavy fuel oils, lubricating oils, diesel oils, paraffin and petrol.
- Also used in the manufacture of detergents, synthetic textiles, plastic, paints, insecticides, fertilizers, toiletries and synthetic rubber.

Environmental Effects:

- Pipelines carrying oil can be broken by faulting, landslides, acts of war-causing an oil spill.
- Tanker spillage from collisions or groundings can create oil slicks at sea.
- Oil slicks can drift ashore, fouling the beaches.
- The refining and burning of petroleum can cause air pollution.

3. Coal

Coal is a solid, rock like fuel, it formed in several stages as the buried remains of ancient swamp plants that died during the Carboniferous period (a geologic era that ended 286 million years ago) were subjected to intense pressure and heat over many millions of years. Coal is mostly carbon. As coal ages, its carbon content increases and its water content decreases. Coal is by far the dirtiest fossil fuel to burn, releasing carbon monoxide, carbon dioxide and sulphur.

How Is Coal Extracted?

Some coal is extracted underground by miners working in tunnels and shafts. Such mining is one of the world's most dangerous occupations because of accidents and black lung disease.

When coal lies close to the earth's surface, it is extracted by area strip mining, on flat terrain. Bulldozers and huge earthmoving machines remove soil and rock, known as overburden to recover underlying coal deposits. Thick beds of coal fairly near the surface are removed by digging a deep pit to remove the coal.

After coal is removed it is transported (usually by train) to a processing plant, where it is broken up, crushed, and then washed to remove impurities. The coal is then dried and shipped(again usually by train) to users, mostly power plants and industrial plants.

Uses of Coal:

- used for generating electricity.
- used to make coke which is also used in steel making.
- can be burned as liquid fuel. (powered and mixed with water).
- used to produce a variety of products such as ammonia, dyes, perfumes, disinfectants, plastics and artificial fibres.

Table 2: Common Varieties / Types (Rank) of Coal

TYPE OF COAL	CHARACTERISTICS
1. Peat	• not coal but represents the initial stage of coal development. • When dry can be burned as fuel. • Burns with a lot of smoke but gives rather poor flame.
2. Lignite (Brown Coal)	• Represents the next stage where more carbon is added • Is dark brown in colour and burn better than peat. • has only less than 70% carbon and burns with a smoky flame
3. Bituminous Coal	• it is fairly hard, has a shiny black colour but burns well • has 70% to 90% carbon, burns freely but leaves ash behind • used for producing coke, coal gas or steam

Environmental Effects

- presence of mine usually lowers the local water table as ground water is pumped out of the mine.
- the drainage out of the mines tends to be highly acid, polluting surface streams and water supplies.
- When coal is burned ash and sulfur gases pollute the air.

NOW TURN TO THE NEXT PAGE AND DO ACTIVITY 2

LEARNING ACTIVITY 2

1. Of the three fossil fuels, which two are formed using the same conditions?

   a)_____

   b)_____

2. Which one of the three fossil fuels is the cleanest?

   _____

3. What is one similarity that exists amongst all three (3) fossil fuels?

   _____

4. Explain how fossil fuels contribute to greenhouse effect.

   _____

   _____

5. Burning releases carbon dioxide, but plans can help lower the level. Which process is occurring in plants when carbon dioxide is being absorbed from the air? _____

NOW CHECK YOUR ANSWERS AT THE END OF THE UNIT SUMMARY

12.1.1.1.3: Effects of Global Warming

Global warming refers to temperature increase in the troposphere which in turn can cause climate change. Natural Change or human activities can either cause such warming.

Global climate change is a broader term that refers to changes in any aspects of the earth's climate, including temperature, precipitation and storm intensity and patterns.

Effects of Global Warming

A warmer global climate could have a number of harmful and beneficial effects for humans, other species and ecosystems depending mostly on where they are located and how rapidly the temperature changes.

Some areas will benefit because of less severe winters, less precipitation in wet areas, more precipitation in dry areas and increased food production. Other areas will suffer harm from excessive heat, lack of water and decreased food production. Poor people and wildlife species in the tropics will suffer the most harm.

1. Melting Ice and Snow

As the atmosphere warms, it causes convection that transfers surplus heat from the equatorial to polar areas. Thus temperature increases tend to be much greater in Polar Regions. Measurements from the Arctic Ocean, Greenland (an enormous frozen island) and the northwestern shores of Alaska show that floating sea ice around the North Pole and Greenland is melting and getting thinner faster than it is being formed.

Why should we care if there is less ice in the Artic?

One reason is that light surfaces of ice and snow help cool the earth by reflecting 80 to 90% of incoming sunlight back into space. Much less sunlight is reflected by much darker surfaces such as forest, grass, cities and oceans. Ocean water for example absorbs 80 -90% of energy it receives. Thus the earth's poles and mountaintop glaciers are the planets air conditioning system.

Melting of some of the earth's ice caps, floating ice, and mountain glaciers would expose darker and much reflective surfaces of water and land, resulting in a warmer troposphere. As more ice melts, the troposphere would become even warmer, which would melt more ice and raise the temperature in the troposphere. Because it is floating ice, large scale melting of Artic Ocean ice will not add to the rising global sea levels.

During the last 25 years many of the world's mountaintop glaciers have been melting and shrinking at accelerating rates. As mountain glaciers disappear, regions such as parts of Peru, Bolivia, and Ecuador that rely on glacial runoff for water could face sever water shortages. If Nepal Himalayas glaciers disappear by the end of this century, water flows in India's Ganges River system would drop by 90% leaving many millions of people without enough water.

A major concern is partial melting of Greenland's ice sheet. Unlike the melting of floating Artic Ice, melting of the land based Greenland ice sheet will raise sea levels as much as 7 meters (23 feet) if it all melts. This could take centuries but even partial melting will accelerate the projected average sea level rise during this century.

2. Rising Sea Levels

One of the greatest concerns about the increase in global temperature is the fear of the sea level rising because of the melting of the polar ice caps. The sea ice around the poles is already melting and could add a significant amount of water to the oceans. In addition water expands as it warms, forcing sea levels higher still.

The areas that are at most risk from a rise in sea level are the low-lying areas of the Pacific Ocean and the Indian Ocean. The Maldives, Cocos, Tuvalu, Kiribati and Marshall Islands are all composed of **coral atolls**, many of which are only about 3 meters above the present sea level. The earth's sea level has risen and fallen as its climate has changed over the last
A major concern is partial melting of Greenland ice sheet. Unlike the melting of floating Arctic ice melting of the land based Greenland ice sheet will raise sea levels as much as 7 meters (23 feet) if it all melts.

A rising sea level would have the following effects;

- Threaten half of the world's coastal estuaries, wetlands (one thirds of those in the USA) and coral reefs
- Disrupt many of the world's coastal fisheries
- Flood low-lying barrier islands and cause gently sloping coastlines to erode and retreat inland by 1.5 kilometers.
- Submerge some low-lying barrier islands in the Pacific Ocean (Marshall Islands), the Caribbean Sea and the Indian Ocean (the Maldives)
- Contaminate fresh water coastal aquifers with saltwater

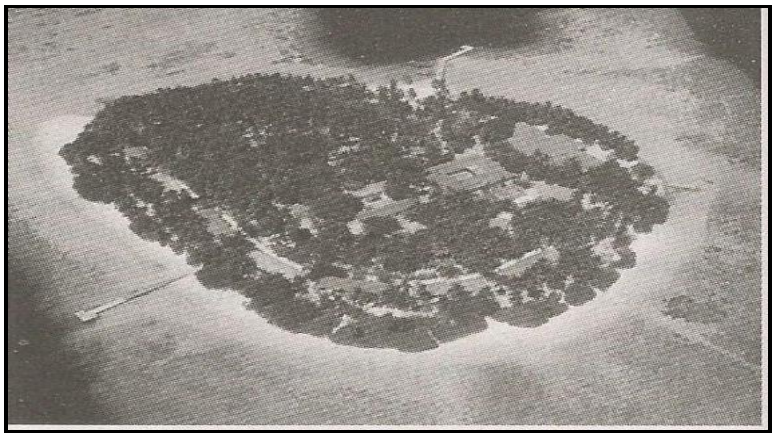


Figure 1.8 Sea Level rise in the Maldives

However, if glaciers in Greenland continues melting at their current or higher rates as the troposphere warms, the average sea level could rise more rapidly and at a higher level during this century.

3. Changing Ocean Currents

Global warming could also alter ocean currents which on the surface and deep down that are connected. These currents act like a gigantic conveyor belt moving $CO_2$and heat to and from the deep sea and transferring hot and cold water between the tropics and the poles. This cycle works great as long as water in the North Atlantic remains salty and dense enough and is not diluted by freshwater from the melting ice.

Scientist are concerned that in a warmer world, an influx of freshwater from increased rain in the North Atlantic and thawing ice in the Arctic region might slow or disrupt this conveyor belt. In other words global warming can lead to significant global cooling in some parts of the world.

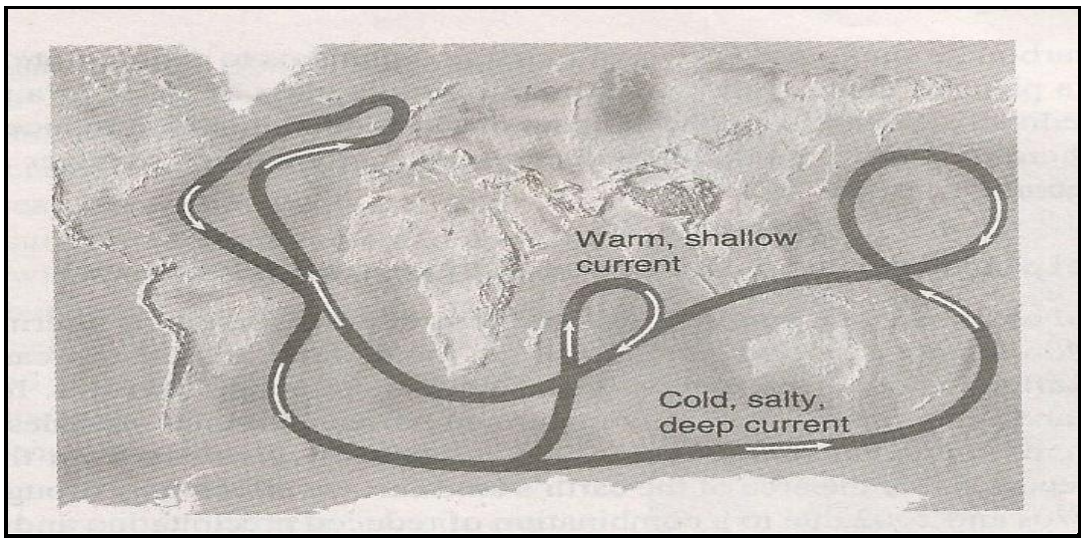


Figure 1.9 Conveyor belt of changing ocean currents

4. Impact on Agriculture

Farming probably depends on a stable climate more than any other human endeavor. Global warming upset this stability by shifting climates and speeding up the hydrological cycle. On a global basis this means changes in precipitation and water, and more crop pests and diseases. There will be winners and losers.

In warmer world, agricultural productivity may increase in some areas and decrease in others. For example, models project that warmer temperatures and increased precipitation at northern latitudes may lead to a northward shift of some agricultural production from the Mid-western United States to Canada. But overall food production could decrease because soils in Midwestern Canada are generally less fertile than those in the Midwestern United States. Crop production could also increase in Russia and Ukraine.

Models project a decline in agricultural productivity in tropical and subtropical regions, especially in Southeast Asia and Central America, where many of the world's poorest people live. In South East Asia there are predictions that rice yields in Malaysia could fall by about

20 per cent because of higher temperatures and less rainfall. In Vietnam, the Mekong Delta would be less productive because of drought, while parts of Indonesia extra rainfall would cause higher erosion and damage to the soil. In Australia changes to the climate could mean more tropical crops in the south, but also more arid conditions over much of the continent.

5. Impact on People

According to research, heat stress in some areas will be more frequent and prolonged and increase death and illness, especially among older people, those with poor health, and the urban poor. On the other hand, fewer people will die from cold weather.
Incidences of tropical infectious disease such as Dengue fever, yellow fever, and malaria are likely to increase if mosquitoes that carry them spread to temperate areas that are getting warmer. In 2006, United Nations data project that disease caused by global warming could kill as many as 185 million people in sub Saharan Africa by the end of this century. And hunger and malnutrition will increase in areas where agricultural production drops.
Flooding and drought will lead to forced migrations by tens of millions of environmental refugees

6. Effects on Biodiversity

A warmer climate could expand ranges and population of some plants and animal species that can adapt to warmer climates. But this would include certain weeds, insect pests, and disease carrying organisms. Other species will not fare so well. A 2004 report by the UN Environmental Programme estimated that at least 1 million species could face premature extinction by 2050 from global warming unless greenhouse gas emissions are drastically reduced. Changes in the structure and location of wildlife habitats could cause extinction of plant and animal species that could migrate to new areas, and those with specialised niches or a narrow tolerance for temperature change would be threatened. Polar bears may be an early casualty as the floating ice they depend on for getting their food disappears and many of them drown or starve to death. The ecosystems most likely to suffer disruptions and species loss are coral reefs, polar seas, coastal wetlands, artic and alpine tundra, and high elevation mountaintops. Some types of forest unable to migrate fast enough will decrease and others such as oak pine and oak hickory in the United States may expand northward.

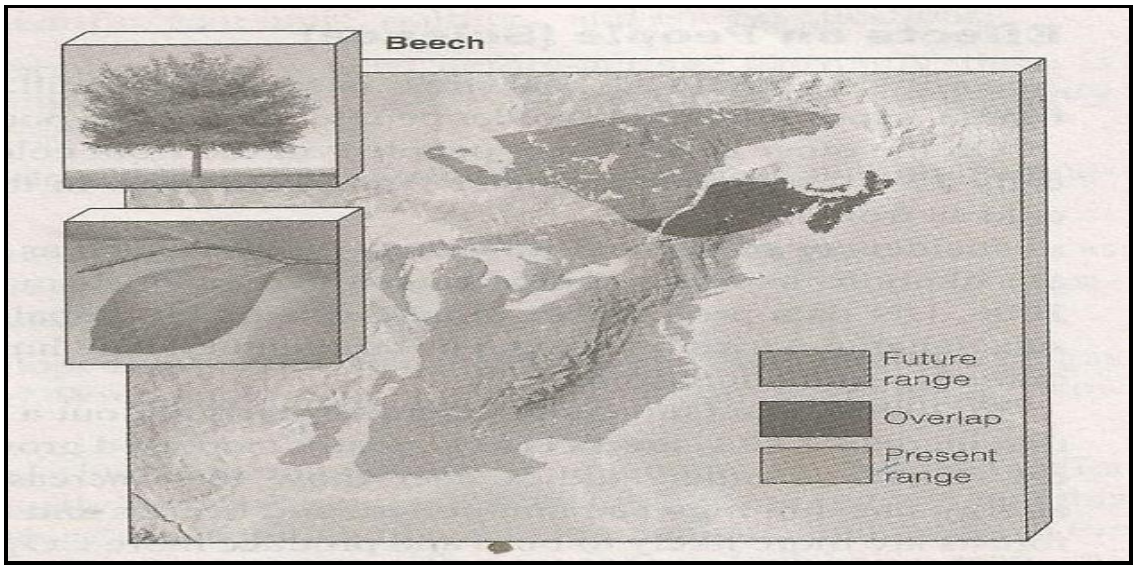


Figure 1.10 Effects of biodiversity in the world

Dealing with Global Warming

Why is climate Change such a difficult problem to deal with?

Several characteristics of global warming and the resulting climate change make it difficult to deal with its very likely harmful ecological and economic effects**.**

- The problem is global. Dealing with this threat will require unprecedented international cooperation.
- The effects will last a long time. Once climate change is set into motion its effect will last hundreds to thousands of years.
- The problem is long term political issue. People and elected officials generally respond well to short term problems, but have difficulty acknowledging and coping with long term threats.
- The harmful and beneficial impacts of climate change are not spread evenly. There will be winners and losers. Winning nations are less likely to bring about controversial changes or spends large sums of money to slow down something that will benefit them. *The catch is* we will not know who wins and who loses until it is too late to avoid harmful effects.
- Many actions that might reduce the threat of climate change, such as phasing out fossil fuels are controversial because they can disrupt economies and lifestyles. This characteristic confronts us with difficult scientific, economic, political and ethical questions.

Solutions: What are our options?

There are two basic ways to deal with global warming.

1. One is mitigation that reduces greenhouse gas emissions to slow down the rate of temperature increase and buy time to learn more about how the earth's climate system works and to shift to other non- carbon energy options.

2. The other is adaptation, in which we recognize that some warming is unavoidable and devise strategies to reduce its harmful effects. Most analysts believe we need a mix of both approaches.

There are two major schools of thoughts concerning what we should do now to reduce or mitigate the effects of global warming.

- The first group calls for a *wait and see strategy*, with some scientist and economists calling for more research and a better understanding of the earth's climate system before we make far reaching and controversial economic and political decisions such as phasing out fossil fuels. The U.S. government currently advocates this approach.
- A second and rapidly growing group of scientist and economists, business leaders, and political leaders believe that we should act now to reduce the risks from climate change brought about by global warming. They argue that potential for harmful economic, ecological, and social consequences is so great that action to slow the rate of change should not be delayed.

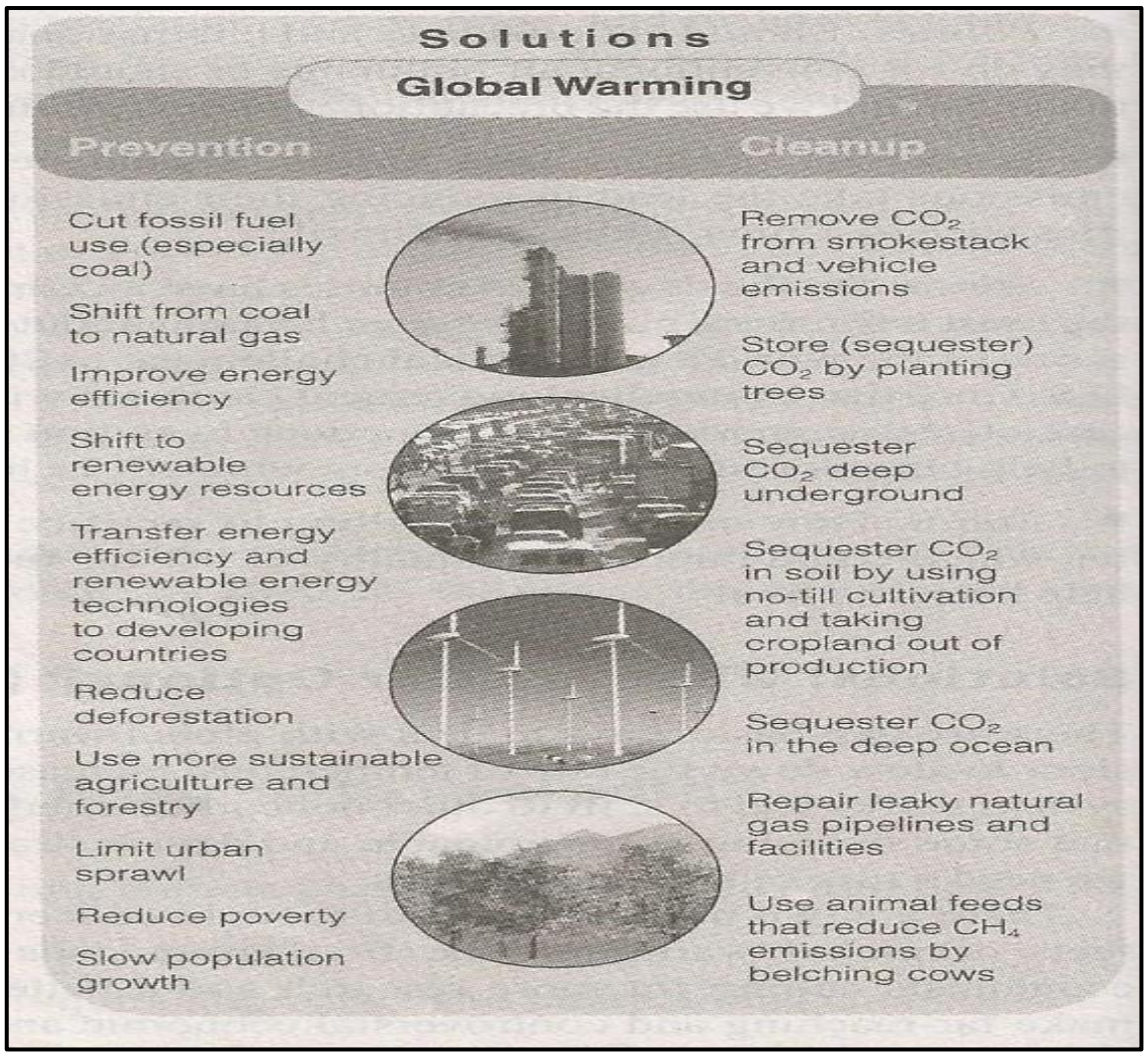


Figure 1.11 Solution to global warming

Solutions: Reducing the threat.

The mitigation solutions come down to three major strategies;

- improve energy efficiency to reduce fossil fuel use,
- shift from carbon based fossil fuels to carbon free renewable energy resources
- store as much CO2 as possible in soil, vegetation, the underground, and the deep ocean.

The effectiveness of these strategies would be enhanced by reducing population, which would decrease the number of fossil fuel consumers and CO2 emitters, and by reducing poverty, which would decrease the need of the poor to clear more land for crops and fuelwood.

NOW TURN TO THE NEXT PAGE TO DO ACTIVITY 3

STUDENT LEARNING ACTIVITIES 3

1. The table 3 below lists the effects of global warming. Identify whether these effect is felt locally or globally, by indicating with a tick or and x under the correct heading.

Table 3: Effects of Global Warming

EFFECTS OF GLOBAL WARMING	LOCALLY FELT AND SEEN	GLOBALLY FELT AND SEEN
1.Beach Erosion	✓	✓
2.Melting Ice	×	✓
3. Heat waves		
4. Sea level rising		
5.. Coral bleaching		
6..Variability in rainfall patterns		

2. Identify 2 ways that reduces effects of global warming.
For example; you can decompose grass on your lawn instead of burning it which will release carbon dioxide in to the atmosphere.

i)_____

_____

ii)_____

_____

_____

NOW CHECK YOUR ANSWERS AT THE END OF THE UNIT SUMMARY

12.1.1.4 : Alternative Sources of Energy

Energy is vital to life, from it we get light and heat and it is what allows economic growth. Most of the energy we use comes from fossil fuels such as petroleum, coal and natural gas.

Renewable Energy Resources

Renewable energy resources are not used up or exhausted through use. As long as they are used wisely these resources are unlimited because they can be recovered or regenerated.

Non-Fossil Sources

Most of our sources of energy are found in nature. The sun is our principal source of energy life.

Now let us take a closer look at some of these Renewable energy sources or non-fossil fuels sources.

1. Geothermal Energy

Geothermal energy is energy extracted from the earth's internal heat. Under the earth's crust, there is a layer of hot and molten rock called magma in the earth's mantle. Because it is less dense than the surrounding rock, magma rises slowly toward the earth's crust, carrying heat from below.

Sometimes the hot magma reaches the earth's surface as lava. However, most magma remains below the earth's crust, heating nearby rocks and groundwater. Some of this hot geothermal water travels up through geysers. However, most of it remains deep underground, trapped in cracks and porous rock. This collection of hot water is called a geothermal reservoir. Heat, mostly from the radioactive decay of naturally radioactive elements, is continually transferred to underground reservoirs of dry steam (steam with no water droplets), wet steam (a mixture of steam and water droplets), and hot water trapped in fractured or porous rock at various places in earth's crust.

If such geothermal reservoirs are close to the surface, wells can be drilled to extract the dry steam, wet steam, or hot water. This thermal energy can be used to heat homes and buildings and to produce electricity. However, the geothermal reservoirs can be depleted if heat is removed faster than natural processes renew it. Thus, geothermal resources can be nonrenewable on a human time scale, but the potential supply is so vast that it is usually classified as a renewable energy resource. The world's largest operating geothermal system called the Geysers, extracts energy from a dry steam reservoir.

The earth's internal temperature can provide a useful source of energy in some places. High-pressure, high temperature steam fields exist below the earth's surface. Around the edges of the continental plates or where the earth's crust overlays magma (molten rock) pools close to the surface, this energy is expressed in the form of hot springs, geysers, and fumaroles.

Yellowstone National Park is the largest geothermal region in the United States. Iceland, Japan and New Zealand also have high concentration of geothermal springs and vents. Depending on the shape, heat content, and access to groundwater, these sources produce wet steam, dry steam or hot water.

While few places have geothermal steam, the earth's warmth can help reduce energy costs everywhere. Pumping water through deeply buried pipes can extract enough heat so that a heat pump will operate more efficiently. Volcanoes, hot springs and geysers allow the escape of hot substances from the inside of the earth. The natural heat energy trapped underground is called geothermal energy.

Most of the world's geothermal steam reservoirs are close to plate margins because plate margins are where most recent volcanic activities have occurred. The Water within the earth's interior is heated by volcanic action which then provides steam for geothermal stations. The geothermal plants then generate electricity from the heat /steam.

Table 4: ADVANTAGES AND DISADVANTAGES OF GEOTHERMAL ENERGY

Advantage	Disadvantage	Environmental problem
1.one of the cleanest and most promising source of energy	Number of volcanic areas where geothermal steam is available is small. (must be constructed in regions with high volcanic activity	hot water often contains dissolved ions and metals such as lead and mercury that can kill fish and plants if discharged on the surface.
2. Geothermal energy production needs no fuel therefore many of the pollution problems of convectional plants are eliminated	Life of a steam well is also limited or geothermal fields can be depleted.	hot water often contains dissolved ions and metals such as lead and mercury that can kill fish and plants if discharged on the surface.
		Geothermal fluids are highly corrosive to equipment and their extraction can cause land subsidence. Example: USA and Philippines

2. Tidal Energy

Responding to the moons gravitational pull on the earth, the oceans tides fall and rise twice a day. This energy source is one of the newer forms of producing electrical energy. It harnesses the energy released by the oceans as it rises and falls. Waves in the ocean can create a tremendous amount of energy. This energy is harnessed through the use of specially designed devices that make use of the up and down movements of waves.

Disadvantages

- Limited sites -the outlet needs to located in a river outlet to the sea (estuary)
- tidal time dependency-(12 hrs,25 minutes -the average tidal amplitude, approximate time between two high tides or low tides)

3. **Hydroelectric / Hydropower Energy**

Water flowing from higher to lower elevations in rivers and streams can be controlled by dams and reservoirs and used to produce electricity. This is called hydropower. most popular approach is to build a high dam across a large river to create a reservoir. Some of the water stored in the reservoir is allowed to flow through huge pipes at controlled rates, spinning turbines and producing electricity.

Hydropower is the leading renewable energy source used to produce electricity and is the second cheapest way to produce electricity when operating and environmental costs are included. About 20 percent of the world's electricity is generated by the force of rivers through the use of hydroelectric power plants. This technology used in the 19th century employs a renewable, non-polluting resource although the technology's impact on the environment is high.

Example: China is the world's largest producer of hydroelectricity followed by USA and Canada and Brazil.

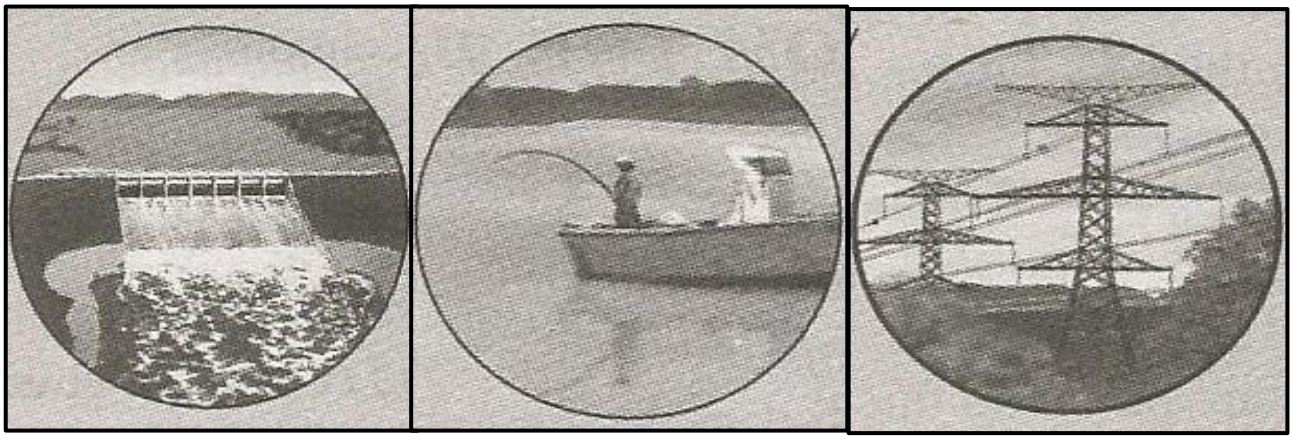


Figure 1.12 Cycles of Hydropower

Table 5: ADVANTAGES AND DISADVANTAGES OF HYDROPOWER ENERGY

Advantage	Disadvantage
Moderate to high net energy	High construction cost
Low cost electricity	High environmental impact from flooding land to form a reservoir
Long life span	Floods natural areas behind dams
No CO_2 emissions during operation in temperate areas	Decreases flow of natural fertilizers
Reservoir is useful for fishing and recreation	High CO2 emissions from biomass decay in shallow tropical reservoir

4. Wind Energy

Wind energy is not new. Human beings have been using it to propel ships and boats, pump irrigation water and grind grain for nearly 7000 years. Today wind turbines have sensors and computers that allow them to turn into the wind to capture the winds energy as efficiently as possible. A wind farm can be built fairly quickly and can be controlled by a single laptop computer. Wind energy is now the cheapest and most non-polluting way to produce electricity when its low environmental costs are included.

One of the most promising renewable resources is the use of the wind to produce electricity by driving enormous wind turbines (windmills).Wind is moving air. It is caused by the sun heating different parts of the earth unevenly. As warm air rises, Cooler air flows in as wind to take its place. Traditional windmills convert kinetic energy of wind into mechanical energy for grinding corn or pumping water.

Modern windmills or wind turbines harness wind energy to drive generators which produce electricity. For windmills to work efficiently, they have to be built in large numbers at locations with strong and steady winds. Today wind turbines can be as tall as 30 stories which allow them to tap into stronger, more reliable, and less turbulent winds found at higher elevations.

The table on the next page shows the advantages and disadvantages of wind energy.

Table 6: ADVANTAGES AND DISADVANTAGES OF WIND ENERGY

Advantage	Disadvantage
Moderate to high net energy	Steady winds needed
High efficiency	dependency on sufficient wind strength
Moderate capital cost	Backup systems needed when winds are low
Low electricity cost	High land use for wind farm
Very low environmental impact	Visual pollution
No CO_2 emissions	Noise when located near populated areas
Quick construction	May interfere in flights of migratory birds and kill birds of prey

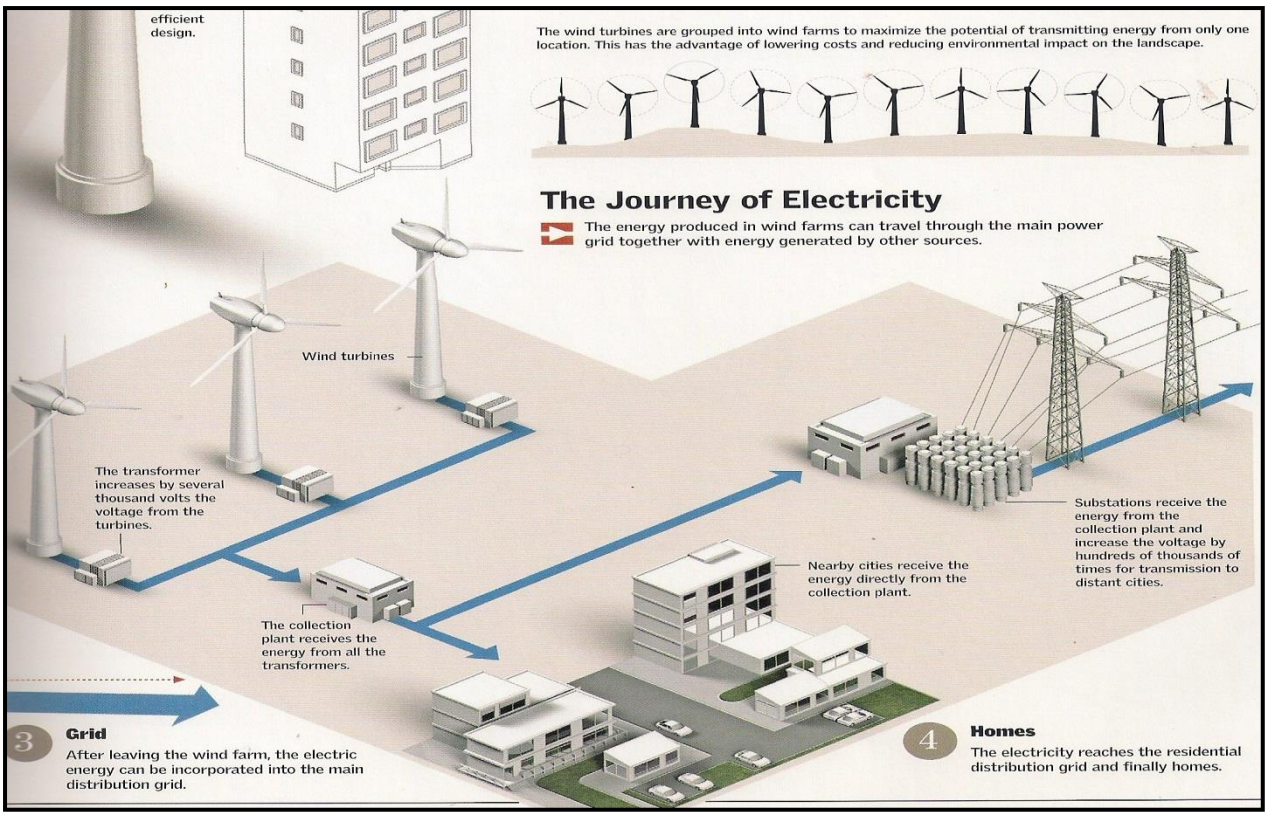


Figure 1.13 Wind energy systems

5. Solar Energy

The sun provides us with large amount of solar energy in the forms of light and heat. Solar panel, solar cells and solar furnaces convert solar energy into other forms of energy to do work or to be stored for future use.

- The harnessing of solar energy to produce electricity and heat for everyday use is gaining popularity.
- Application of this clean unlimited form of energy rang from charging batteries in transportation, all the way to the solar household being built in greater numbers throughout the world.

Advantage

- Solar energy is free, available whenever sunlight falls
- Does not cause pollution or damage the environment

Disadvantages

- Rate of supply is not fixed but depends on the weather, hours of the day and seasons.
- Devices like solar cells to trap solar energy are expensive.
- Harnessing of solar energy is expensive (Trapping of solar energy requires a large number of solar cells and large surfaces of flat land).

6. Hydrogen Energy

When oil is gone (or what's left cost too much to use) what will we use to fuel vehicles, industry, and buildings. Many scientists believe and executives of major oil companies and automobile companies say the fuel of the future is hydrogen gas. When Hydrogen gas burns in air, it combines with oxygen gas in the air and produces non-polluting water vapour and some nitrogen oxides (produced because air, which is 78% nitrogen is used to burn hydrogen). This eliminates most of the air pollution problems we face today and greatly reduces the threats from global warming by emitting no carbon dioxide.

There is very little Hydrogen (H_2) gas around. Instead, it is combined with other elements in compounds such as water, most organic compounds such as methane (CH_4) and Methanol (CH_3OH), and those found in oil and gasoline. Methods for producing Hydrogen include the following:

- Reforming, in which chemical processes are used to separate hydrogen from carbon atoms in organic compounds such as methane or methanol.
- Electrolysis of water, in which direct electrical current is passed through water to convert its molecules into gaseous hydrogen and oxygen.
- Biomass gasification, in which wood chips and agricultural waste are superheated to turn them into hydrogen and other gases.
- Thermolysis, in which high temperatures are used to split water molecules into H_2 and O_2.

If you think using Hydrogen as an energy source sounds too good to be true, you're right. Several problems must be solved to make hydrogen one of our primary energy resources, but scientists are making rapid progress in finding solutions to these problems. One problem is that it takes energy (and thus money) to produce this fuel. We could burn coal to produce high temperature heat or use electricity from coal burning and nuclear power plants to split water and produce hydrogen. However, this subjects us to the harmful environmental effects associated with using these fuels, and it costs more than the hydrogen fuel is worth.

Table 7: ADVANTAGES AND DISADVANTAGES OF HYDROGEN ENERGY

Advantages	**Disadvantages**
Can be produced from water	Not found in nature
Low environmental impact	Energy is needed to produce fuel
No CO2 emission/ pollution	High cost
Good substitute for oil	Short driving range for current fuel cell cars
Safer than natural gas and gasoline	

7. Biomass & Biofuel

Biomass is plant materials and animal waste used as sources of energy. Biomass comes in many forms and can be burned directly as a solid fuel or converted into gaseous or liquid biofuels**.** Most Biomass is burned directly for heating, cooking and industrial processes or indirectly to drive turbines and produce electricity. Burning wood and manure for heating and cooking supplies about 12% of the world's energy and about 30% of the energy is used in developing countries. One way to produce biomass fuel is to plant, harvest, and burn large numbers of fast growing trees (especially cotton woods, poplars, willows) shrubs, perennial grasses and water hyacinths.

In agricultural areas, crop residues (such as sugarcane residues, rice, husk, cotton stalks, and coconut shells) and animal manure can be collected and burned or converted into biofuels. Burning *bagasse*, the residue left after sugarcane harvesting and processing, supplies about 10% of the electricity in Hawaii and in Brazil.

Bacteria and various chemical processes can convert some forms of biomass into gaseous and liquid biofuels. Examples include *Biogass*, a mixture of 60% methane and 40% carbon dioxide, *liquid ethanol and liquid methanol*. *Ethanol* can be made from sugar and grain crops (sugarcane, sugar beets, sorghum, sunflower and corn) by fermentation and distillation. Another alcohol, methanol, is made mostly from natural gas but also can be produced at a higher cost from wood, wood wastes (such as corn cobs), sewage sludge, garbage, and coal.

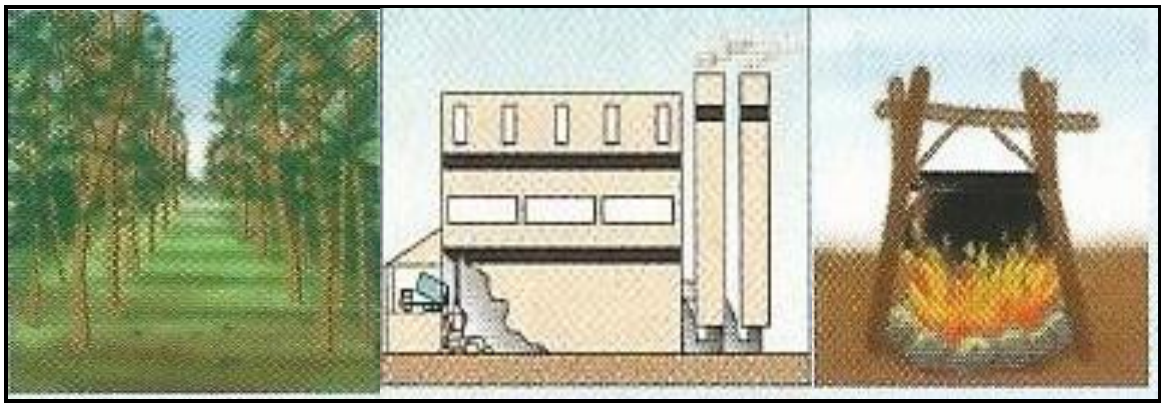


Figure 1.14 The Biofuel process

The most common biofuels are ethanol and biodiesel which are produced from agricultural products such as oilseeds, sugarcanes or cereals. Gasoline or Diesel with added alcohol (ethanol) produced from crops such as corn. Sugarcane, beets, yucca, potatoes and even wood can be used with varying efficiency to produce ethanol. Example: highest ethanol production is in Brazil (sugarcane) and USA (corn).

Uses

Ethanol is added to gasoline in different proportions to be used in vehicles.

Table 8: Advantages and Disadvantages of Biomass

Advantages	**Disadvantages**
Large potential supply	Nonrenewable if harvested unsustainably
Moderate cost	Moderate to high environmental impact
No net CO_2 increase if harvested and burned sustainably.	CO_2 emissions if harvested and burned unsustainably
Plantation can be located on semiarid land not needed for crops	Soil erosion water pollution and loss of wildlife habitat
Plantation can help restore degraded lands.	Plantations could compete with cropland

NOW TURN TO THE NEXT PAGE AND DO ACTIVITY 4

STUDENT LEARNING ACTIVITY 4

1. Which one of these renewable energy resources has noise as one of its main disadvantage?

   _____

   _____

2. To use this energy source, a large piece of land is required for installation of the device to harnessing it?

   _____

3. Two countries in the world have the largest plantations of sugarcane and corn to use as means of sourcing which type of energy resource? _____

_____

NOW CHECK YOUR ANSWERS AT THE END OF THE UNIT SUMMARY

12.1.1.1.5 : PNG REDD Initiative

What is REDD?

REDD stands for Reduction in Emission in Degradation and Deforestation

REDD is a mechanism being developed by Parties to the United Nations Framework. It covers Convention on Climate Change to reward developing countries for reducing emissions from deforestation and forest degradation. It will create an incentive for developing countries to protect, better manage and wisely use their forest resources, and in so doing contribute to conserving biodiversity and to the global fight against climate change. In addition to the environmental benefits, REDD also offers social and economic benefits.

There is no domestic policy or legislation on carbon trading in PNG. The office for climate change and Environmental Sustainability (OCCES) was created in 2008 under thePrime Minister's Office, to manage the REDD funds. In March, 2008, PNG signed an agreement with Australia to cooperate on REDD.In 2009 the OCCES issued certificates for at least 40 future REDD credits for 1 million tonnes of carbon each.

Reducing emissions from deforestation and forest degradation (**REDD**) is a mechanism that has been under negotiation by the United Nations Framework Convention on Climate Change (UNFCCC) since 2005, with the twin objectives of mitigating climate change through reducing emissions of greenhouse gases and removing greenhouse gases through enhanced forest management in developing countries.Reducing Emissions from Deforestation and Forest Degradation (REDD) is an effort to create a financial value for the carbon stored in forests, offering incentives for developing countries to reduce emissions from forested lands and invest in low-carbon paths to sustainable development. "REDD+" goes beyond deforestation and forest degradation, and includes the role of conservation, sustainable management of forests and enhancement of forest carbon stocks.

REDD as a climate change mitigation measure

In the last two decades, various studies estimate that Land Use Change, including Deforestation and Forest Degradation, accounts for 17-29% of global greenhouse gas emissions. For this reason the inclusion of reducing emissions from land use change is considered essential to achieve the objectives of the UNFCCC. Regeneration of forest on degraded or deforested lands can remove CO_2 from the atmosphere through the build-up of biomass, making forest lands a sink of greenhouse gases.

REDD was first discussed in 2005 by the UNFCCC Conference of the Parties to the Convention (COP) at the request of Costa Rica and Papua New Guinea, on behalf of the Coalition for

Rainforest Nations, when they submitted the document "Reducing Emissions from Deforestation in Developing Countries:

Eligible activities; The decisions on REDD enumerate five "eligible activities" that developing countries may implement to reduce emissions and enhance removals of greenhouse gases:

1. Reducing emissions from deforestation.
2. Reducing emissions from forest degradation.
3. Conservation of forest carbon stocks.
4. Sustainable management of forests.
5. Enhancement of forest carbon stocks.

Readiness activities

Most REDD+ activities or projects implemented since the call for demonstration activities in Decision 2/CP.13 of December 2007 are focused on readiness, which is not surprising given that REDD+ and its requirements were completely new to all developing countries.

UN-REDD Programme UNDP, UNEP and FAO jointly established the UN-REDD Programme in 2007, a partnership aimed at assisting developing countries in addressing certain measures needed in order to effectively participate in the REDD+ mechanism. These measures include capacity development, governance, engagement of Indigenous Peoples and technical needs.

The initial set of supported countries was Bolivia, Democratic Republic of Congo, Indonesia, Panama, Papua New Guinea, Paraguay, Tanzania, Vietnam, and Zambia. By March 2014 the Programme counted 49 participants, 18 of which are receiving financial support to kick start or complement a variety of national REDD+ readiness activities. The Programme operates in six work areas:

1. MRV and Monitoring (led by FAO)
2. National REDD+ Governance (UNDP)
3. Engagement of Indigenous Peoples, Local Communities and Other Relevant Stakeholders (UNDP)
4. Ensuring multiple benefits of forests and REDD+ (UNEP)
5. Transparent, Equitable and Accountable Management of REDD+ Payments (UNDP)
6. REDD+ as a Catalyst for Transformations to a Green Economy (UNEP)

Australia established a A$200 million International Forest Carbon Initiative, focused on developing REDD activities in its vicinity, i.e., in areas like Indonesia, and Papua New Guinea. Deforestation and forest degradation, through agricultural expansion, conversion to pastureland, infrastructure development, destructive logging, fires etc., account for nearly 20% of global greenhouse gas emissions, more than the entire global transportation sector and second only to the energy sector. It is now clear that in order to constrain the impacts of climate change within limits that society will reasonably be able to tolerate, the global average temperatures must be stabilized within two degrees Celsius. This will be practically

impossible to achieve without reducing emissions from the forest sector, in addition to other mitigation actions

Figure 1.15 Forest degradation

Climate Change

An Office of Climate Change & Development (OCCD) was established in 2010 to co-ordinate and focus its efforts on drawing up the country's Climate Compatible Development Strategy that:

- Promote economic development through low-carbon growth.
- Mitigate carbon emissions through participation in a global REDD+ scheme.
- Draft a National Climate Change Policy for NEC's approval
- Adaptation to climate-related hazards.
- Assist in aligning all sector policies and actions with the National Development Strategies and in particular Pillar five of the PNG
- Vision 2050, concerning Climate Change and Environment Sustainability

The Papua New Guinea's Office of Climate Change and Development (OCCD) is the co-ordinating body for all climate change related policies and actions in Papua New Guinea. The OCCD is tasked with ensuring Papua New Guinea follows a path of climate-compatible growth, that its economy develops while simultaneously mitigating greenhouse gas emissions and reducing vulnerability to climate change related risk. To this end the Office works closely with a range of stakeholders from Government, NGOs, development agencies and the private sector entities, local communities and the wider public.

What is Climate Change?

Climate has always varied naturally over long periods, but mounting evidence has made it clear that human activity has begun to alter the earth's climate at an unprecedented rate, posing a grave threat to the environment, people, and economies.

How will Climate Change Affect PNG?

Developing countries are likely to suffer disproportionately from climate change given they have less resources to cope with major disasters. Economic growth is essential to improving both the socio-economic conditions of people in developing countries and the capacity of such countries to adapt to the negative impacts of climate change. Historically economic development has led to an increase in energy and resource consumption and thus the emission of GHGs. It is imperative that future development is climate compatible and does not go hand in hand with increased GHG emissions. How will climate change affect Papua New Guinea? The effects of climate change can already been seen in PNG especially those of coastal flooding, increased prevalence of malaria, damage to coral reefs, and the migration of people who are fleeing serious effects of climate change.

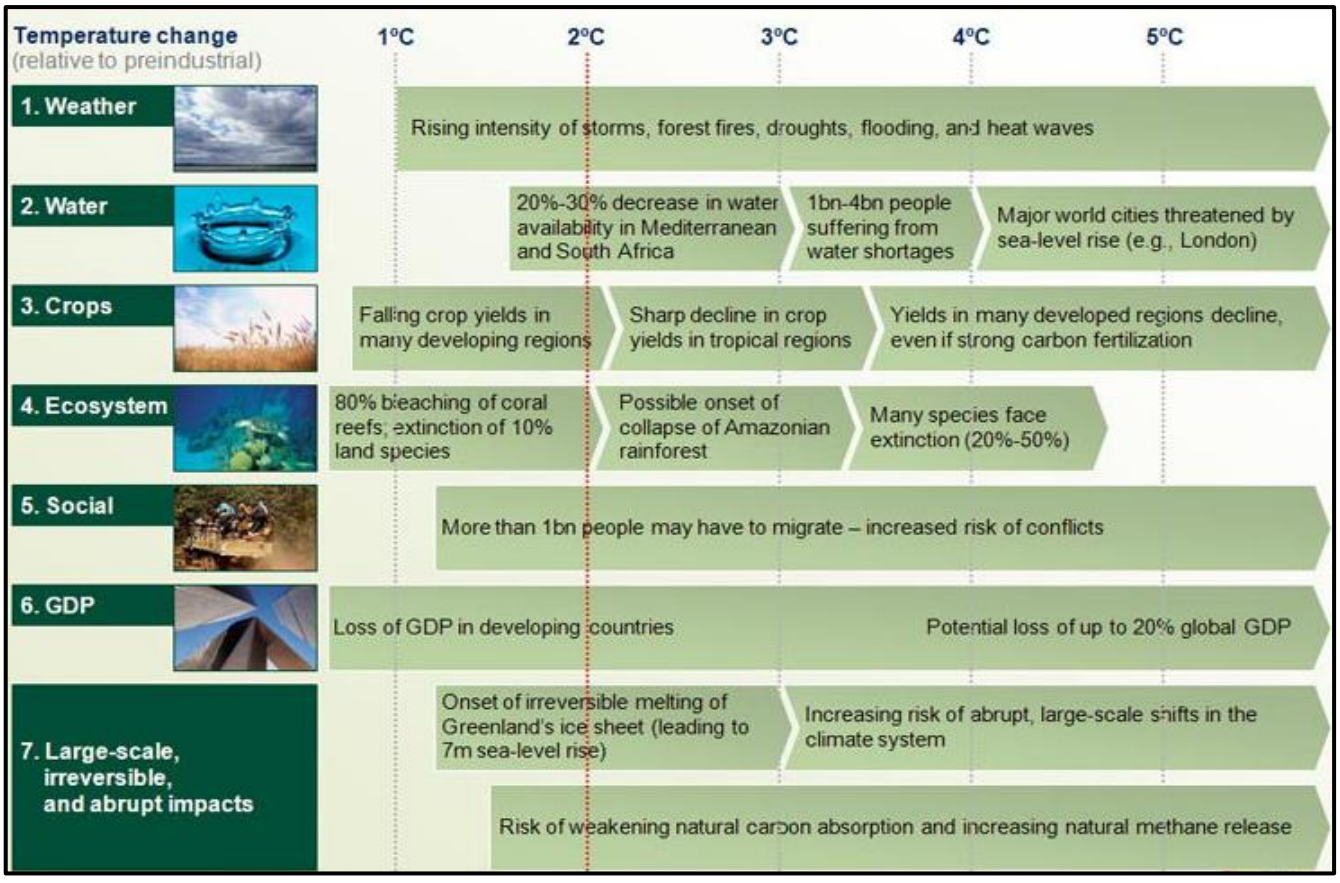


Figure 1.16 Climate change in PNG

Major Threats to Papua New Guinea

1. **Coastal flooding:** Coastal flooding is already a serious problem for PNG, affecting thousands of people every year. Climate change is causing sea levels to rise, which will result in inundation of low-lying areas and more frequent, more damaging floods due to king tides and storms

2. **Inland flooding and landslides:** Although the effect on rainfall frequency is unclear, rainfall intensity is likely to increase, resulting in more inland flooding and more landslides as soils get saturated.

3. **Malaria:** Malaria is already becoming a greater problem in PNG. Historically limited to the coastal regions of the country, the warmer climate enables mosquitoes to spread and survive in the highlands, endangering the lives of over 2 million people previously not at risk from the disease.

4. **Agricultural yield change :** As weather patterns and temperatures change, crop productivity will be affected. Just how yields of crops in PNG will change is not clear at the moment, but the OCCD plans to do further study. It is likely that some regions will have to modify their farming methods and in some cases change which crops they grow.

5. **Coral reef damage:** Coral reefs in PNG are already suffering from the effects of climate change, with several bleaching events in the last decade due to rising ocean temperatures. In addition to bleaching, coral is also under threat from ocean acidification due to increased carbonic acid, and drowning due to rising ocean levels reducing the amount of light reaching corals.

6. **Migration:** Climate change related migration is a secondary threat likely to pose severe challenges to PNG. As threats from climate change take effect, populations will move to areas that are less affected or where alternative livelihoods are available, such as urban areas. Large-scale migration will increase socio-economic pressures and the government will have to prepare policies and infrastructure. Migration of people poses unique social challenges in PNG as indigenous communities own 97% percent of PNG's land.

Minor Threats to Papua New Guinea

Tropical storms : Tropical storms are not a great threat to PNG as the country is between the first and twelfth parallels (latitudes), whereas tropical storms typically range between the tenth and the thirtieth parallels. Anecdotal evidence suggests that the frequency of occasional tropical storms that do hit the southern provinces has increased in the last 50 years, albeit from once every several decades to once every several years.

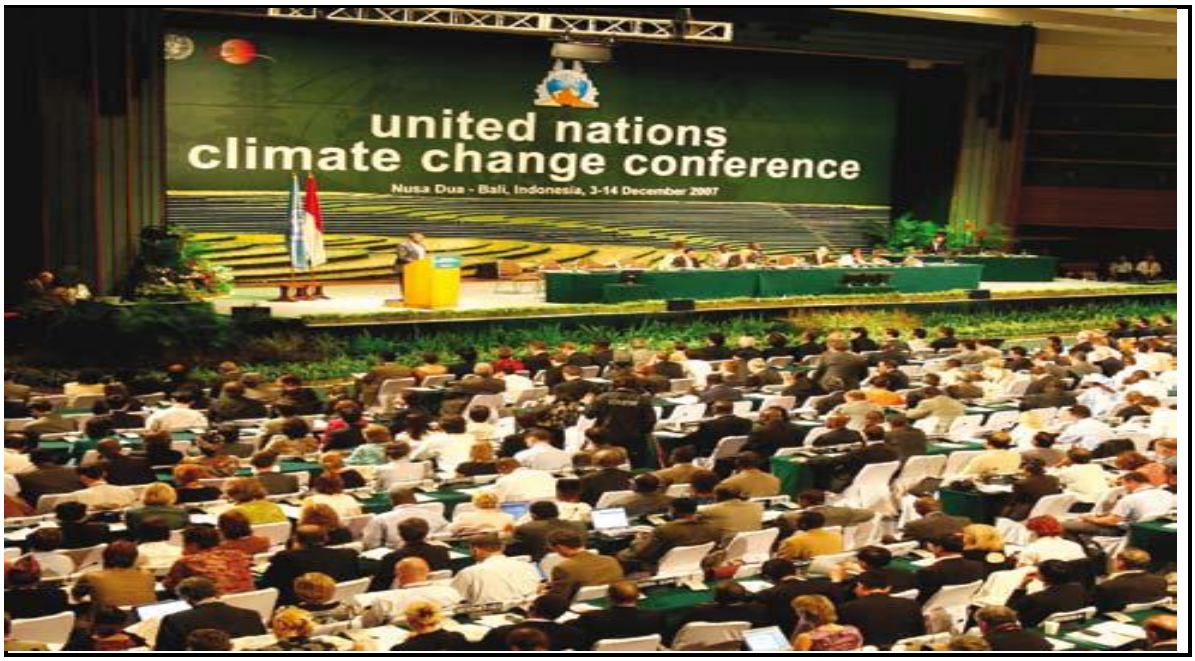


Figure 1.17 United Nations Climate change conference

OCCD completes baseline survey on community-based solar farm pilot project

While negotiations are still ongoing under the United Nations Framework Convention on Climate Change (UNFCCC) to develop a framework for REDD (*or Reducing Emission from Deforestation and Forest Degradation* under the compliance carbon trading market, opportunities for Papua New Guinea to move towards a greener economy through low carbon intensive development programme are equal opportunities that the country can capitalize on to promote green economy and climate-compatible development. such opportunities are there especially in the energy and resource efficiency sector through renewable energy projects. However, these are all new community initiatives or concepts that require testing. The OCCD has taken the lead in piloting a Solar Farm in Paramana 1 and 2 villages within the Aroma Coast of the Central Province to provide electricity for the villagers.

The farm was established at the cost of K100 thousand in February, 2014. The solar farm currently produces 15 kilo volts amps (KVA) of electricity equal to a 15 KVA generator and currently provides street lighting only for the Paramana 1 and 2 villages. A team from the Mitigation section of the REDD+ and Mitigation Division just recently completed a baseline survey to collect data and inspect the solar farm. According to Mitigation Manager Mr. Danny Nekitel, the visit was also to establish the possibility of up-grading the project in order to provide electricity direct to homes of the families living within the farm vicinity.

Other pilot provinces include Sandaun, Manus, East Sepik, and one Highlands Province yet to be identified. The Aroma Solar Farm is the first Clean Development Mechanism (CDM) initiative in the country. Solar Farming in the country has the potential to reduce greenhouse

gas emissions in the energy sector and this can contribute towards the country's emission reduction commitments (voluntarily) under the Kyoto Protocol. If solar harnessed energy is developed properly, PNG has a big potential as the country is located geographically closest to the equator with a maximum of 12 hours of sunlight.

What is Carbon Trade?

Carbon trade can be defined as an exchange of credits between nations designed to reduce emission of carbon dioxide.

The carbon trade allows countries that have higher carbon emissions to purchase the right to release more carbon dioxide into the atmosphere from countries that have lower carbon emissions. The carbon trade came about in response to the Kyoto Protocol. Signed in Kyoto, Japan, by some 180 countries in December 1997, the Kyoto Protocol calls for 38 industrialized countries to reduce their greenhouse gas emissions between the years 2008 to 2012 to levels that are 5.2% lower than those of 1990.

The carbon trade also refers to the ability of individual companies to trade polluting rights through a regulatory system known as **cap and trade**. Companies that pollute less can sell their unused pollution rights to companies that pollute more. The goal is to ensure that companies in the aggregate do not exceed a baseline level of pollution and to provide a financial incentive for companies to pollute less. Carbon is an element stored in fossil fuels such as coal and oil. When these fuels are burnt, carbon dioxide is released and acts as what we term a "greenhouse gas".

The idea behind carbon trading is quite similar to the trading of securities or commodities in a market place. Carbon would be given an economic value, allowing people, companies or nations to trade it. If a nation bought carbon, it would be buying the rights to burn it, and a nation selling carbon would be giving up its rights to burn it. The value of the carbon would be based on the ability of the country owning the carbon to store it or to prevent it from being released into the atmosphere. (The better you are at storing it, the more you can charge for it.)

A carbon tax

One way of limiting greenhouse gases is to place a tax on carbon emissions. This would increase power bills for electricity generated by coal-burning power stations, making alternative power sources more affordable and attractive. In the future there could be a carbon tax built into tickets for air travel.

Carbon emissions trading

This is a method of limiting carbon emissions by issuing permits to industries. These permits grant them the right to emit a limited amount of carbon dioxide over a time period. Industries are then permitted to trade these **carbon credits** in a free market. The aim is to limit greenhouse gas emissions but does not guarantee reduction in absolute terms. Carbon emissions trading systems now operate in Europe and North America. Australia is also considering a carbon emissions trading system.

Figure 1.18 The carbon process

International action on climate change

There have been a number of world conferences on climate change aimed at trying to solve the problems of global warming.

Figure 1.19 The climate change summit

Kyoto Protocol

Kyoto, Japan, was the host city for the Climatic Change Convention Conference in December 1997. The environment ministers of 159 nations met to discuss the enhanced greenhouse effect and global warming. A treaty, known as the **Kyoto Protocol**, was signed in which

Japan, the United States and the European Union (EU)—representing the three regions with the highest levels of greenhouse gas emissions, agreed to cut their emissions by 6, 7 and 8 per cent respectively. Although Australia and the United States did originally sign, they later refused to **ratify** the Kyoto Protocol, meaning they refused to give formal approval that would lock them into action. Twenty-one other countries agreed to meet the targets listed in by 2012. Less industrialised countries were given more time to reduce their emissions as they were seen as being disadvantaged. Many of them are still developing their manufacturing industries as a means of achieving economic growth

The Conference of the Parties

The United Nations has taken responsibility for a series of conferences on climate change, known as the Conference of the Parties (COP). The COP is responsible for keeping international efforts to address climate change on track. It reviews the commitments of parties to the conference, and examines new scientific findings and experience gained in implementing climate change policies. The COP meets every year, unless the parties decide otherwise.

NOW TURN TO THE NEXT PAGE TO DO ACTIVITY 5.

STUDENT LEARNING ACTIVITY 5

1. Explain what the initials REDD stand for?

_____

2. Discuss the main purpose of the United Nations' REDD initiative.

_____

_____

3. Define carbon trade.

_____

_____

4. What is the carbon sink? Explain

_____

_____

5. Which two countries signed the Kyoto Protocol and later refused?

_____

_____

NOW CHECK YOUR ANSWERS AT THE END OF THE UNIT SUMMARY

12.1.2 : FARMING AND FOOD SECURITY

Introduction

Welcome to heading 12.1.2 of Grade 12 Unit 1. This heading comprises of six sub-headings. They include:

12.1.2.1 What is Agriculture?
12.1.2.2 Types of Farming
12.1.2.3 Dry Farming and Irrigation
12.1.2.4 Factors Affecting Farming
12.1.2.5 Green Revolution and Genetic Modification of Crops
12.1.2.6 Inequality in Food Production and Distribution of Food

Objectives or aims

On successful completion of this heading, you will be able to:

- define and list the different types of farming.
- identify factors that affect farming.
- demonstrate an understanding of appropriate farming methods and sustainable ways of food production.
- define green revolution and discuss genetic modification of crops.

Time Frame

This heading should be completed within 2 weeks.

If you set an average of 3 hours per day, you should be able to complete the unit comfortably by the end of the assigned week.

12.1.2.1 : What Is Agriculture?

Agriculture is really a way of life and there is more to agriculture than just information in a textbook. In countries located between Tropic of Cancer and Tropic of Capricorn, 70^0 to 80^0 per cent of the population live in rural areas and farm for a living. In Papua New Guinea, approximately 70 per cent of the people live in rural areas and depend on farming.

So what is agriculture? Well the term can be defined in various ways but the simplest explanation would be;

Agriculture is the science or practice of farming, including cultivation of the soil for the growing of crops and the rearing of animals to provide food, wool, and other products.

Agriculture in a broad sense includes cultivation of the soil, growing and harvesting crops, breeding and raising livestock, dairying, and forestry. Modern agriculture depends heavily on engineering and technology. Plant breeding and genetics contribute immeasurably to farm productivity. Genetics has also made a science of livestock breeding. **Hydroponics**, a method of soilless gardening in which plants are grown in chemical nutrient solutions, may help meet the need for greater food production as the world's population increases.

The packing, processing, and marketing of agricultural products are closely related activities also influenced by science. Methods of quick-freezing and dehydration have increased the markets for farm products (*see* Food Processing and Preservation; Meat Packing Industry).

Mechanization, the outstanding characteristic of late 19th- and 20th-century agriculture, has eased much of the backbreaking toil of the farmer. More significantly, mechanization has enormously increased farm efficiency and productivity (*see* Agricultural Machinery). Animals including horses, oxen, llamas, alpacas, and dogs, however, are still used to cultivate fields, harvest crops, and transport farm products to markets in many parts of the world.

Airplanes and helicopters are employed in agriculture for seeding, spraying operations for insect and disease control, transporting perishable products, and fighting forest fires. Increasingly satellites are being used to monitor crop yields. Radio and television disseminate vital weather reports and other information such as market reports that concern farmers. Computers have become an essential tool for farm management.

Subsistence- Agriculture: Is the provision of food by farmers only for their own families and local community, there is no surplus main priority is self- survival

Agricultural practises can be grouped into three main groups which includes;

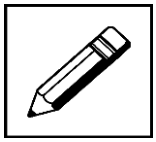
1. **Arable**: Is the growing of crops usually on flatter land where soils are of a higher quality.

2. **Pastoral:** is the raising of animal usually on land which is less favourable to arable farming (i.e. colder, wetter, steeper and higher land).
3. **Mixed**: is the growing of crops and the rearing of animals together. It is practised on a commercial scale in developed countries.

But before we start you need to know the meaning of the terms below. You will come across them frequently in this unit.

Subsistence- Agriculture: Is the provision of food by farmers only for their own families and local community, there is no surplus main priority is self- survival.
Commercial Agriculture: takes place on a large profit making scale.
Sedentary Farming: Is farming practised by a settled farmer in one place.
Shifting Cultivation: Involves farming at one place for a few years before moving on to a new site. Farming that is done on a small scale and
Extensive Farming- is usually done on large scale
Intensive Farming is done on small scale but input of labour is low.

NOW TURN TO THE NEXT PAGE AND DO STUDENT ACTIVITY 6



STUDENT LEARNING ACTIVITY 6

1. Explain the different between shifting cultivation and sedentary agriculture?

   _____

   _____

2. Agricultural practices will always be different because of three factors, what are this main factors that affect agriculture.

   _____

   _____

3. What are mixed farms?

   _____

   _____

4. Distinguish between intensive and extensive forms of agriculture?

   _____

   _____

   _____

NOW CHECK YOUR ANSWERS AT THE END OF THE UNIT SUMMARY

12.1.2.2 : Types of Farming

This sub-unit looks at the different Types of Farming around the world.

1. **Hunters and Gatherers**

Societies had to rely upon hunting of birds and animals, catching fish, collecting berries and nuts and fruits in order to survive. Nowadays there are few hunters and gatherers societies still in existence; The Kalahari Bushman, Pigmies of Central Africa, Amerindians Tribes of the Brazilian rainforest and Australian Aborigines. Each needs an extensive area from which to obtain their basic needs.

2. **Shifting Cultivation (extensive subsistence agriculture)**

This was the traditional type of agriculture in most tropical countries/under developed regions of the world. Inputs into the system, is very limited, technology is limited, capital is limited, labourers limited and outputs to system is very low with only sufficient crops grown for family consumption.

Shifting cultivation has two distinguishing factors:

a) Farmers clear the land for planting by slash and burn agriculture.

b) Farmers grow crops on a cleared field for only a few years until soil nutrients are depleted and leave it fallow (nothing planted) for many years so the soil can recover.

The most extensive form of agriculture is still practised in and known by different terms in various parts of the world;

a) tropical rainforest
- Milpa-Rhodesia Latin America
- Ladang-Malaysia South East Asia
- Taungya in Burma
- Caingin in Philippines

b) wooded savanna-The Chitimene-Central Africa

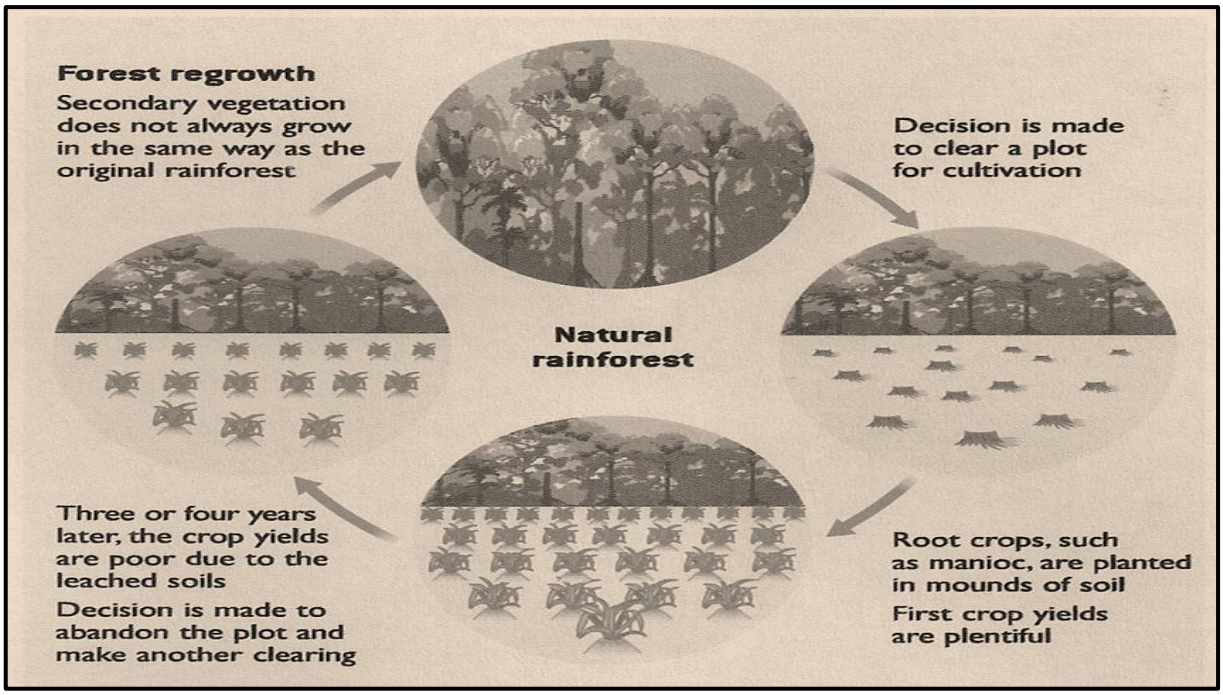


Figure 2.1 The cycle of shifting cultivation

3. Nomadic Herding

In areas where the climate is too extreme to support permanent settled agriculture, farmers become nomadic pastoralist. This is a form of subsistence agriculture based on the herding of domesticated animals, the word pastoral refers to sheep herding. Pastoral nomadism is practised in dry lands of less developed countries. They live primarily in large belts of arid and semi-arid lands that include:

- Bedouins of Saudi Arabia, Masai of (Kenya) East Africa rear cattle
- Fulani in Western Africa (migrate to avoid the Tse-tse fly) rear camels, sheep and goats.
- Lapps of Northern Finland rear herds of reindeer.

There are two forms of nomadism;

a) Total nomadism-is where the nomad has no permanent home
b) Semi-nomads- may live seasonally in a village

Some of the Characteristics of nomadic herding includes;

- animals are source of life
- there is no ownership of land
- is adapted to dry climates where planting crops is impossible

Nomadic Animal Farming

- Is practiced by wandering groups of people in the remote areas, particularly in the semi- deserts and desert regions of the world
- its main aim is to increase their herds because a man's social status among nomadic herders is determined by the number of animals he owns irrespective of their condition.
- Some pastoral nomad practice transhumance-which is a seasonal migration of livestock between mountains and lowland pastures (which is grass)

4. **Intensive Subsistence Agriculture**

Is maximum use of the land with neither fallow nor any wasted space for farming. Despite high yields, there is little surplus of crops for sale due to;

- High population density
- Rapid population growth
- Large family size

There are two types of this type of farming;

a) Intensive Subsistence with WET RICE-dominant
b) Intensive Subsistence with WET RICE-not dominant (resort to other crops)

The term wet rice refers to the practise of planting rice on a dry land in a nursery then moving the seedlings to a flooded field to promote growth.

5. Tropical Commercial (Plantation) Agriculture

- Plantations are found mostly in tropical areas where there is a lot of rainfall.
- It is a form of commercial agriculture found in the tropics and subtropics, especially in Latin America, Africa, and Asia. Though situated in less developed countries, plantations are owned or operated by Europeans.
- A Plantation is a large farm that specializes in one or two crops
- Large areas became cleared and single tree crop is planted in rows resulting in what is called monoculture or mono-cropping. This is called cash crop.
- This cash crop is grown for exporting and is not used or consumed locally.
- Crops grown on plantations include; cotton, sugarcane, coffee, rubber, tobacco, cocoa, coconut, tea, palm oil, rubber and many more.

Table 8: Advantages and Disadvantages of Plantation agriculture

Advantages	Disadvantages
Higher standards of living for the local workforce	Exploitation of local workforce, minimal wages
Capital for machines, fertiliser and transport provided initially by colonial power, now the multinational corporations	Cash crops grown instead of food crops: local population have to import foodstuffs
Use of fertilisers and pesticides improves output	Most produce is sent overseas to the parent country
Increases local employment	Most profit returns to Europe and North America
Housing, schools, health service and transport provided, also often electricity and a water supply	Dangers of relying on monoculture: fluctuations in world prices and demand
	Overuse of land has led, in places, to soil exhaustion and erosion

6. **Intensive Commercial (Mixed) Farming** (mixed crop and livestock farming)

This type of farming involves the integration of both crops and livestock, which includes dairying, market gardening, and fruit farming.

I) Market Gardening and Fruit Farming

Market Gardening and fruit farming involves the intensive cultivation of vegetables and fruits.

- Farms are usually small but the return per hectare is high.
- In the USA it is called Truck farming.
- Most of the crops grown on market gardens are perishable. They are often sited near to large towns.

Ii) Dairy Farming

- This type of farming involves milk products and should be located near to large urban centres. Efficient transport system is necessary for easy access to urban centres.
- Efficient transport linking the consumer to the producer is the refrigerated cargo ship.
- Dairy farming for the production of butter and cheese may be remote from towns.
- Most of the crops are fed to animals rather than consumed directly by humans and the livestock supply manure to improve soil fertility to grow more crops.

7. **Extensive Commercial Grain Farming**

- Grain is the seed from various grasses, like wheat corn oats barley rice millet and others.
- Cereals are farmed in lands that are closer to the urban market than commercial ranching.

- Grain is grown commercial on the American Prairies, Russian Steppes parts of Argentina and North West Europe.

8. **Extensive Commercial Pastoralism (livestock ranching)**

- Livestock ranching takes place in remote areas where other forms of land use are limited (with large areas of cheap land to support large numbers of animals)
- Ranching is the commercial grazing livestock over an extensive area. This form of agriculture is adapted to semi-arid or arid land.
- It is developed in more developed countries where the vegetation is too sparse and the soil is too poor to support crops.

9. **Mediterranean Agriculture**

- A distinctive type of farming which exists primarily in the lands that borders the Mediterranean Sea, in Southern Europe, North Africa and Western Asia.
- Mediterranean areas are on the west coast of continents.
- Winters are mild and wet allowing the growth of cereals and production of early spring vegetables. Olives are grown in most Mediterranean countries along with grapes and citrus fruits (lime, orange, lemon)

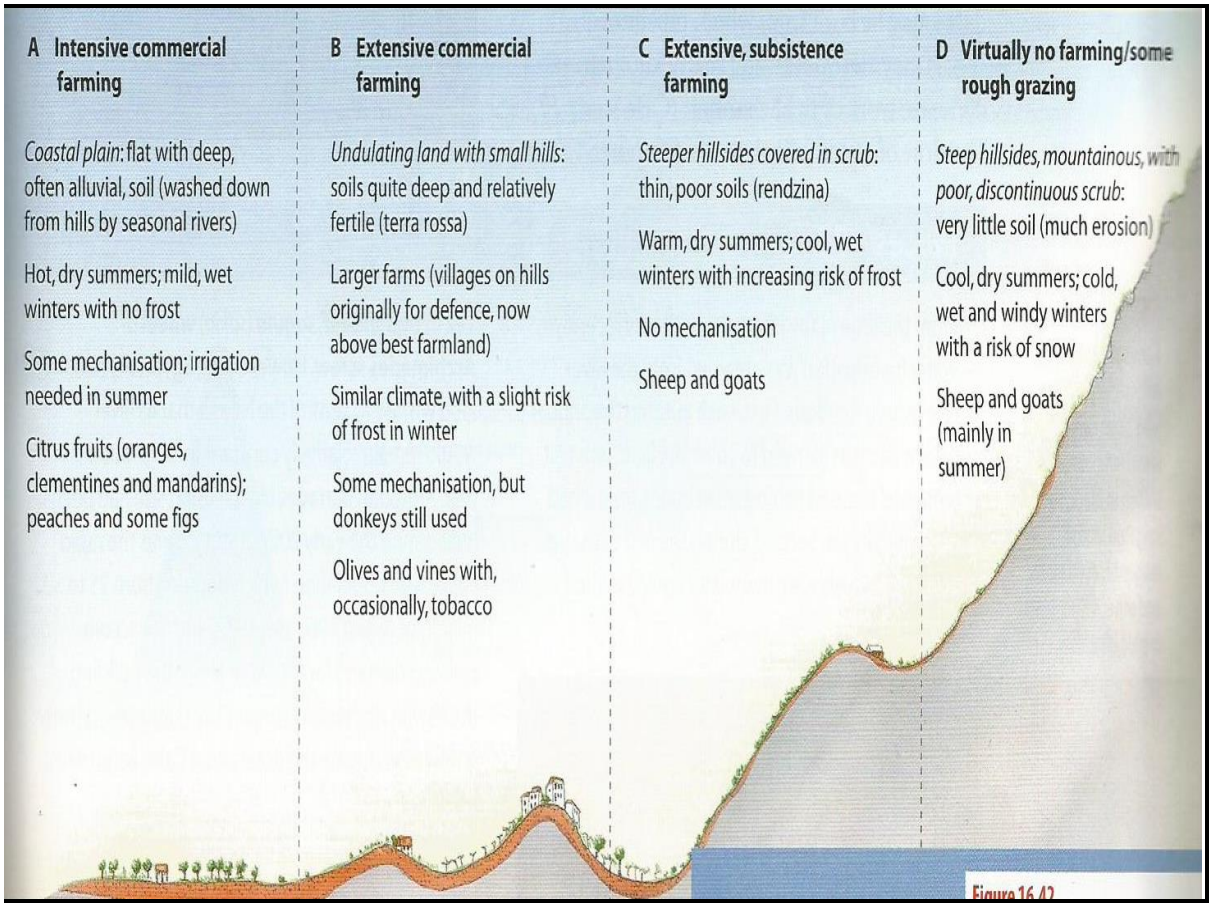


Figure 2.2 Types of Farming around the world

STUDENT LEARNING ACTIVITY 7

1. What is the difference between Total nomadism and semi nomad?

   i) _____

   _____

   ii) _____

   _____

2. _____ and _____ also called Truck Farming in the United States of America involves the intensive cultivation of vegetables and fruits.

3. What is the other term used to describe the type of farming that is used for plantation agriculture? _____

4. Extensive subsistence agriculture is a traditional type of agriculture that is practiced in most tropical countries or simply under developed regions of the world, Identify two factors that distinguishes this type of farming from the other types

   i) _____

   _____

   ii) _____

   _____

5. Identify at least two characteristics of nomadic herding.

   i)_____

   _____

   ii)_____

   _____

NOW CHECK YOUR ANSWERS AT THE END OF THE UNIT SUMMARY

12.1.2.3 : Dry Farming and Irrigation

Dry farming, also called Dryland Farming, is the cultivation of crops without irrigation in regions of limited moisture, typically less than 20 inches (50 centimetres) of precipitation annually. Dry farming depends upon efficient storage of the limited moisture in the soil and the selection of crops and growing methods that make the best use of this moisture.

Dry farming was an agricultural method that allowed crops to be cultivated on the prairie, which typically received low levels of rainfall and endured very hot summers and harsh winters. Growers who practiced dry farming cultivated some fields while allowing others to lie fallow, so that a field only supported crops every other year. In the off-year, the soil stored up enough moisture and nutrients for the following growing season. Another method of dry farming called for the soil to be tilled, rather than ploughed, to a depth of only three or four inches (eight to ten centimetres).

Dry farming locations: Dry farming may be practiced in areas that have significant annual rainfall during a wet season, often in the winter. Crops are cultivated during the subsequent dry season, using practices that make use of the stored moisture in the soil. California and Oregon, in the United States, are two states where dry farming is practiced for a variety of crops.

Dryland farming crops: Dry farmed crops may include grapes, tomatoes, pumpkins, beans, and other summer crops. These crops grow using the winter water stored in the soil, rather than depending on rainfall during the growing season.

Dry land farming process: Dry land farming has evolved as a set of techniques and management practices used by farmers to continually adapt to the presence or lack of moisture in a given crop cycle. In marginal regions, a farmer should be financially able to survive occasional crop failures, perhaps for several years in succession. Survival as a dry land farmer requires careful husbandry of the moisture available for the crop and aggressive management of expenses to minimize losses in poor years. Dry land farming involves the constant assessing of the amount of moisture present or lacking for any given crop cycle and planning accordingly. Dryland farmers know that to be financially successful they have to be aggressive during the good years in order to offset the dry years.

Figure 2.3: A dry land farm

Dry land farming is dependent on natural rainfall, which can leave the ground vulnerable to dust storms, particularly if poor farming techniques are used or if the storms strike at a particularly vulnerable time. The fact that a fallow period must be included in the crop rotation means that fields cannot always be protected by a cover crop, which might otherwise offer protection against erosion.

Dry farming process: Dry farming depends on making the best use of the "bank" of soil moisture that was created by winter rainfall. Some dry farming practices include:

- Wider than normal spacing, to provide a larger bank of moisture for each plant.
- Strict weed control, to ensure that weeds do not consume soil moisture needed by the cultivated plants.
- Cultivation of soil to produce a "dust mulch", thought to prevent the loss of water through capillary action. This practice is controversial, and is not universally advocated.

Figure 2.4: A Hopi Indian in his Dry Farm, Arizona, USA

Overcoming Water Shortage

Dry farming is a farming practise that involves special treatment of the land to overcome a shortage of water. One method is to crop the land only every two years, conserving at least part of the rainfall of one year to add to that received in the next by pulverizing the soil surface or by protecting it with mulch (a layer of straw or decaying plant leaves).

Mulching

Any dried grass or leaves which are placed on the soil around the plants are called mulch. Mulch prevents water loss and stops the weeds from growing. It also adds plant food to the soil when it rots. Mulching will help reduce soil erosion. If fruit, such as watermelons and cucumbers, rest on mulch, it will help prevent fruit rot.

Weeding and Earthing Up

For a farmer, a weed is any plant growing in the food garden that the farmer did not want. In our traditional agricultural system mixed cropping is very common and crops compete with weeds for food and sunlight.

Irrigation

Figure 2.5: An irrigation sprinkler watering a lawn

Figure 2.6: Irrigation canal in Osmaniye, Turkey

Irrigation is the method in which water is supplied to plants at regular intervals for agriculture. It is used to assist in the growing of agricultural crops, maintenance of landscapes, and re-vegetation of disturbed soils in dry areas and during periods of inadequate rainfall. Additionally, irrigation also has a few other uses in crop production, which include protecting plants against frost, suppressing weed growth in grain fields[1] and preventing soil consolidation. In contrast, agriculture that relies only on direct rainfall is referred to as rain-fed or dryland farming. It is needed when

- Rainfall is limited
- Drought
- Farming is intensive

Irrigation systems are also used for dust suppression, disposal of sewage, and in mining. Irrigation is often studied together with drainage, which is the natural or artificial removal of surface and sub-surface water from a given area. Irrigation has been a central feature of agriculture for over 5,000 years and is the product of many cultures. Historically, it was the basis for economies and societies across the globe, from Asia to the Southwestern United States. Archaeological investigation has identified as evidence of irrigation where the natural rainfall was insufficient to support crops for rainfed agriculture.

Figure 2.7: irrigation in Tamil Nadu (India)

Various types of irrigation techniques differ in how the water obtained from the source is distributed within the field. In general, the goal is to supply the entire field uniformly with water, so that each plant has the amount of water it needs, neither too much nor too little

Types of Irrigation

1. **Perennial Irrigation**

By this method water is supplied to cultivated areas throughout the year. It involves the construction of huge dams across rivers so that reservoirs are created to store water. **Perennial irrigation** was practiced in the Mesopotamian plain whereby crops were regularly watered throughout the growing season by coaxing water through a matrix of small channels formed in the field.

2. **Annual Irrigation**

Annual irrigation is sometimes known as **basin irrigation** as it depends entirely on the annual flooding of the river during heavy rainfall periods in the upper parts of its valley. The flood plain is carefully leveled and banked by mud walls into small fields and irrigation ditches are dug to help distribute the flood waters during the season.

> Ancient Egyptians practiced **Basin irrigation** using the flooding of the Nile to inundate land plots which had been surrounded by dykes. The flood water was held until the fertile sediment had settled before the surplus was returned to the watercourse.

Figure 2.8 Basin flood irrigation of wheat

3. **Tank Irrigation**

This method is practiced in many parts of India and Sri-Lanka. It involves the construction of tanks.

4. **Well Irrigation**

A well is a shaft sunk into the ground to below the water table so that the water seeps into it and collects in it. This type of irrigation can only take place in regions made of sedimentary rocks below whose surface there are considerable quantities of water

5. **Surface Irrigation**

In *surface* (*furrow*, *flood*, or *level basin*) irrigation systems, water moves across the surface of agricultural lands, in order to wet it and infiltrate into the soil. Surface irrigation can be subdivided into furrow, *borderstrip or basin irrigation*. It is often called *flood irrigation* when the irrigation results in flooding or near flooding of the cultivated land. Historically, this has been the most common method of irrigating agricultural land and still is in most parts of the world.

Figure 2.9: Surface irrigation

Where water levels from the irrigation source permit, they are controlled by dikes, usually plugged by soil. This is often seen in terraced rice fields (rice paddies), where the method is used to flood or control the level of water in each distinct field. In some cases, the water is pumped, or lifted by human or animal power to the level of the land. The field water efficiency of surface irrigation is typically lower than other

forms of irrigation but has the potential for efficiencies in the range of 70% - 90% under appropriate management.

Figure 2.10 Impact sprinkler head

6. **Localized Irrigation**

It is a system where water is distributed under low pressure through a piped network, in a pre-determined pattern, and applied as a small discharge to each plant or adjacent to it. Drip irrigation, spray or micro-sprinkler irrigation and bubbler irrigation belong to this category of irrigation methods.

7. **Subsurface Textile Irrigation (SSTI)**

This is a technology designed specifically for subsurface irrigation in all soil textures from desert sands to heavy clays. A typical subsurface textile irrigation system has an impermeable base layer (usually polyethylene or polypropylene), a drip line running along that base, a layer of geotextile on top of the drip line and, finally, a narrow impermeable layer on top of the geotextile (see diagram). Unlike standard drip irrigation, the spacing of emitters in the drip pipe is not critical as the geotextile moves the water along the fabric up to 2 m from the dripper.

8. **Drip Irrigation**

Drip (or micro) irrigation, also known as trickle irrigation, functions as its name suggests. In this system water falls drop by drop just at the position of roots. Water is delivered at or near the root zone of plants, drop by drop. This method can be the most water-efficient method of irrigation, if managed properly, since evaporation and runoff are minimized. The field water efficiency of drip irrigation is typically in the range of 80 to 90 percent when managed correctly.

In modern agriculture, drip irrigation is often combined with plastic mulch, further reducing evaporation, and is also the means of delivery of fertilizer. The process is known as fertigation.

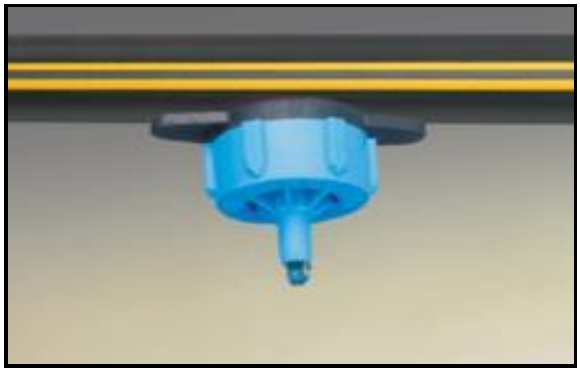


Figure 2.11 Drip irrigation – a dripper in action

Figure 2.12: Grapes in Petrolina, semi-arid area

9. Sprinkler Or Overhead Irrigation

In sprinkler or overhead irrigation, water is piped to one or more central locations within the field and distributed by overhead high-pressure sprinklers or guns. A system utilizing sprinklers, sprays, or guns mounted overhead on permanently installed risers is often referred to as a *solid-set* irrigation system. Higher pressure sprinklers that rotate are called *rotors* and are driven by a ball drive, gear drive, or impact mechanism. Sprinklers can also be mounted on moving platforms connected to the water source by a hose. Automatically moving wheeled systems known as *traveling sprinklers* may irrigate areas such as small farms, sports fields, parks, pastures, and cemeteries unattended.

Figure 2.13 Sprinkler irrigation of blueberries in Plainville, New York, United States

Other travelers use a flat rubber hose that is dragged along behind while the sprinkler platform is pulled by a cable. These cable-type travelers are definitely old technology and their use is limited in today's modern irrigation projects.

Irrigation using Center pivot

Figure 2.14: A small center pivot system from beginning to end

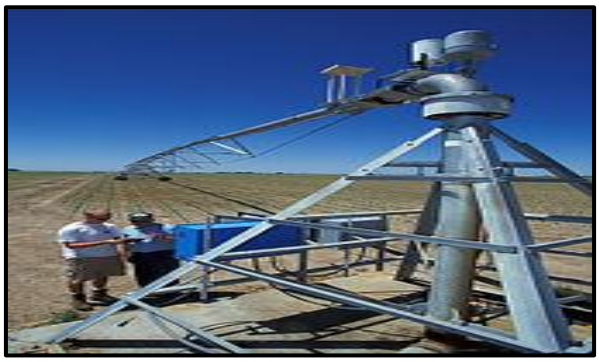


Figure 2.15: The hub of a center-pivot irrigation system

Figure 2.16: Center pivot with drop sprinkler

Figure 2.17: Wheel line irrigation system in Idaho, 2001

10. Center Pivot Irrigation

This is a form of sprinkler irrigation consisting of several segments of pipe (usually galvanized steel or aluminium) joined together and supported by trusses, mounted on wheeled towers with sprinklers positioned along its length. The system moves in a circular pattern and is fed with water from the pivot point at the center of the arc. Most center pivot systems now have drops hanging from a u-shaped pipe attached at the top of the pipe with sprinkler head that are positioned a few feet (at most) above the crop, thus limiting evaporative losses.

11. Sub-Irrigation

Sub-irrigation has been used for many years in field crops in areas with high water tables. It is a method of artificially raising the water table to allow the soil to be moistened from below the plants' root zone. Often those systems are located on permanent grasslands in lowlands or river valleys and combined with drainage infrastructure. A system of pumping stations, canals, weirs and gates allows it to increase or decrease the water level in a network of ditches and thereby control the water table.

Sub-irrigation is also used in commercial greenhouse production, usually for potted plants. Water is delivered from below, absorbed upwards, and the excess collected for recycling.

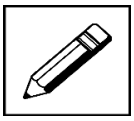
Typically, a solution of water and nutrients floods a container or flows through a trough for a short period of time, 10–20 minutes, and is then pumped back into a holding tank for reuse. Sub-irrigation in greenhouses requires fairly sophisticated, expensive equipment and management. Advantages are water and nutrient conservation, and labor-saving through lowered system maintenance and automation. It is similar in principle and action to subsurface basin irrigation.

12. In-Ground Irrigation

Most commercial and residential irrigation systems are "in ground" systems, which means that everything is buried in the ground. With the pipes, sprinklers, emitters (drippers), and irrigation valves being hidden, it makes for a cleaner, more presentable landscape without garden hoses or other items having to be moved around manually. This does, however, create some drawbacks in the maintenance of a completely buried system.

When the water is pressurized, the head will pop up out of the ground and water the desired area until the valve closes and shuts off that zone. Once there is no more water pressure in the lateral line, the sprinkler head will retract back into the ground. Emitters are generally laid on the soil surface or buried a few inches to reduce evaporation losses.

NOW TURN TO THE NEXT PAGE AND DO STUDENT ACTIVITY 8



STUDENT LEARNING ACTIVITY 8

1. What is Dry land farming?

   _____

   _____

2. Which irrigation system will encounter problems when it comes to maintenance of the system? _____

3. Which two irrigation systems uses the water table to source water from?

   _____

   _____

4. Dryland farming was initially a farming method used in which country?

   _____

5. There are different types of irrigation techniques and they differ in how the water obtained from the source is distributed within the field. What is the common goal of all irrigation systems?

   _____

   _____

   _____

NOW CHECK YOUR ANSWERS AT THE END OF THE UNIT

12.1.2.4 Factors Affecting Farming

Farming systems vary within and between countries because the inputs, whether physical or human or economic, will be different. The processes and the outputs will therefore be affected. For example; Rice farming in India is quite different from the system of mixed farming in the English Midlands.

Types of Farming

Each farming type is best suited to the area it occupies. **Arable farming** is the ploughing of the land and the growing of crops**. Pastoral farmers** leave the land under grass and rear animals, usually cattle or sheep or both. In **mixed farming**, crops are grown and animals are reared.

Farming can take place anywhere but one thing to remember is farming methods and practises will always different in certain areas. The factors that affect the types of farming in certain areas are;

a. Environmental factors b. Cultural factors

c. Economical factors d. Behavioural factors

1. Environmental Factors Affecting Farming:

There are four environmental factors that affect farming in any given area.

1. Climate 2. Landform 3. Edaphic (soil) 4. Global warming

1.1 Climate: Extreme climatic conditions affect farming of both crops and animals and the climatic conditions are;

a. Temperature: temperature is critical for plant and animal growth. Temperature must be conducive for plants and animals. Extreme hot, dry or cold temperatures can affect farming both arable and pastoral farming..

b. Precipitation: The average annual rainfall of an area can determine the type of farming. Both plants and animals need water to survive so the amount of moisture is determined by rainfall. Farming types will vary with relation to the amount of rainfall that area receives. Erosion removes the topsoil causing it to become infertile. Example: long steady rainfall provides sufficient moisture, while short heavy downpours lead to surface run offs causing erosion.

c. Wind: Local and strong winds do affect farming, especially where land is exposed to wind and there are no wind breakers and crops can be destroyed. Wind can also increase evapotranspiration rates, also reducing moisture and making soil vulnerable to erosion.

Several localised winds have harmful effects on farming;

- the mistral brings cold air to south of France
- Khamsin is a dry dust laden wind found in Egypt
- Santa Ana causes bush fires in California

1.2. Landform

a. Altitude: The decrease in temperature with height can affect farming. The growing season also decreases with height.

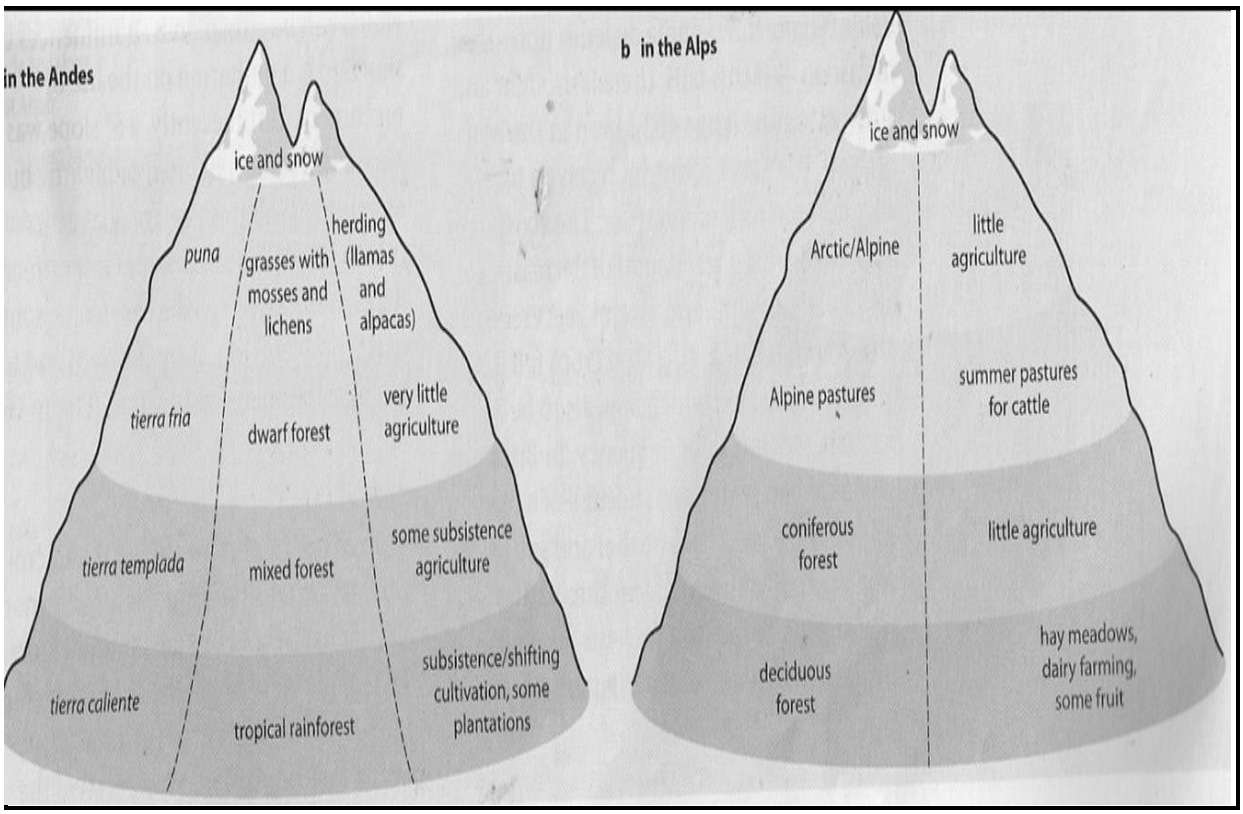


Figure 2.18 The angle of the slope

b. Angle of the slope (gradient): Slope affects the depth of the soil, its moisture content and its PH level. Slope influences erosion and discourages the use of machineries.

c. Aspect

i) Adret slopes are located in the northern hemisphere but they face the South.

- They have higher temperatures
- Receive maximum incoming solar radiation and sunshine
- Drier soil content
- Crops and trees grow to higher altitudes

ii) Ubac slopes are located in the Southern Hemisphere but face the North and maybe permanently covered in shade.

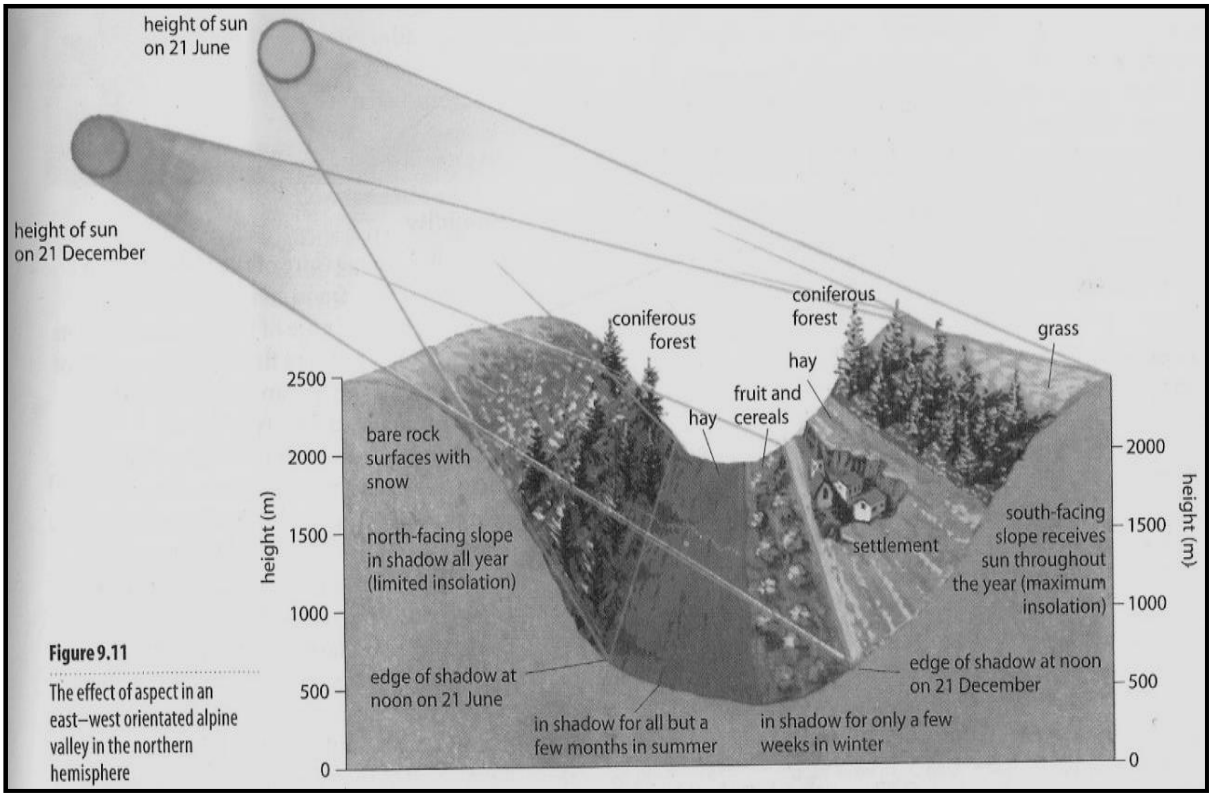


Fig 2.19 The angle of the slope

1.3. Edaphic (Soil) Factors: Farming depends on the;

- Dept
- Stoneliness
- PH level (acidic)
- Leaching and mineral content of soil

The type of soil determines the type of farming

a. Clay soil are heavy, acidic, poorly drained and cold and ideally should be left under permanent grass

b. Sandy soils are lighter, less acidic, well drained and warmer and more suited to vegetables and fruits

c. Lime soils /chalk are light in texture, alkaline and dry and high cereal yields

1.4. Global Warming

The Greenhouse effect does not only lead to temperature increase but changes in rainfall (precipitation) patterns.

2. Cultural (Human) Factors Affecting Farming

The society a farmer comes from can also affect the type of farming.

a. Land Tenure: Farmers may be owner-occupiers, tenants, landless labourers or state employees on the land which they farm. There are two types of this tenancy:

i) Cash tenancy-is when farmers have to give as much as 80% of their income on a fixed arrangement rent to the landowner.
ii) Share-Cropping- is when the farmer has to give part of this crop direct to the landowner. The farmer works hard with little incentive and remains poor.

3. Economic Factors Affecting Farming

3.1. Transport: This includes the type of transport available, the time taken and the cost of moving raw materials to the farm and produce to the market.

a. For perishable commodities, like milk and fresh fruits, the need for speedy transport to the market demands an efficient transport network.

b. While for Bulky goods, like potatoes, transports cost must be lower for output to be profitable.

3.2. Markets: Role of market is closely linked with transport (perishable and bulky goods). Market demand depends upon the size and affluence of the market population, its religious and cultural beliefs.

3.3. Capital

a. Capital Intensive farms: Most economically developed countries, with their supporting banking systems, private investment and government subsidies have large reserves of readily available finance which over time are used to build up capital intensive farms. For Example: Dairy farming, market gardening, mechanised cereal growing Capital is obtained at low interest rates.

b. Labour Intensive: Farmers in developing countries often lack the support from financial institutions and having limited capital resources of their own have to resort to Labour intensive methods of farming

3.4. Technology: Technological developments such as new strains of seeds, cross breeding of animals, improved machinery and irrigation also affects farming.

4. Behavioural Factors Affecting Farming: One age ambition perception and knowledge or experience can affect farming.

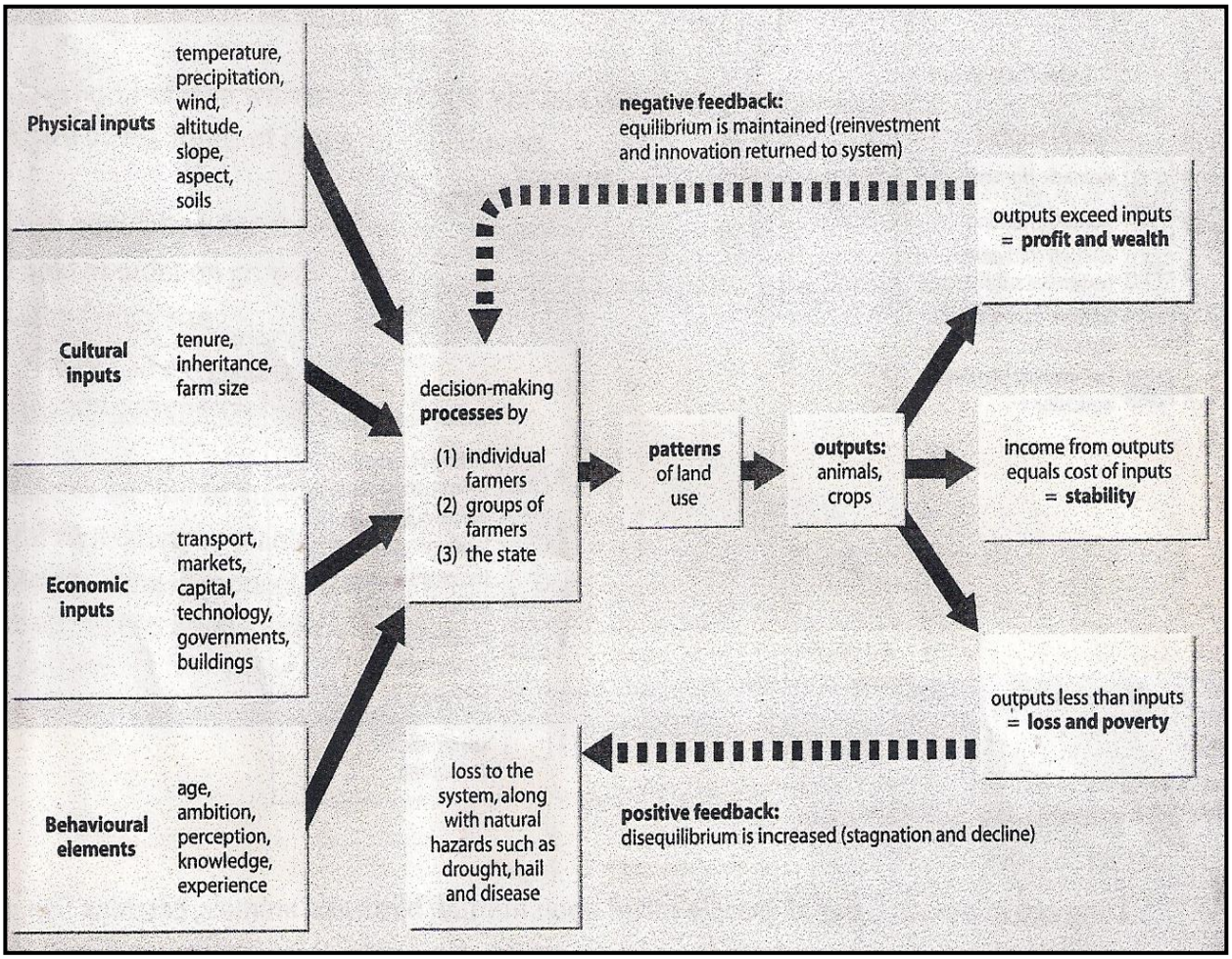


Figure 2.0 The farming system

The diagram shows how physical cultural economical and behavioural factors form the inputs. In areas where farming is less developed, physical factors are usually more important but as human inputs increase these physical controls become less significant.

STUDENT LEARNING ACTIVITY 9

1. Explain how wind affects farming?

_____

_____

_____

2. Use Figure 1.6 to answer this question.
Farming is an example of a system. As a system it has inputs processes and outputs of the system. Variations in which of this factors, is responsible for the different types and patterns of farming around the world?

_____

_____

_____

3. For produce like dairy products and fruit and vegetables, the need for speedy transport to the market demands an efficient transport network. Explain

_____

_____

_____

4. Winds affect types of farming in many ways. Below is a description of two localized winds that affect farming in those specific regions. State the names of those winds;

i) . _____ brings cold air to the south of France

ii) _____ is a dry dust laden wind found in Egypt

iii) ._____ is a dry wind that blows from the Sahara

NOW CHECK YOUR ANSWERS AT THE END OF THE UNIT SUMMARY

12.1.2.5 : Green Revolution and Genetic Modification of Crops

Rapid population increase in Economically Least Developed Countries has placed many traditional farming systems under considerable strain. The so call Green revolution refers to the many important agricultural developments which have allowed food production at a global pace to generally keep pace.

The Green Revolution refers to the application of modern, Western –type, farming techniques to developing countries or we can say it is the name given to a number of measures designed to increase agricultural yields in the third world. These include the development of high yielding varieties (HYV) of wheat and rice which demand in turn irrigation, fertilizers and pesticides.

The invention and rapid diffusion of more productive agricultural techniques during the 1970 and 1980 is called the Green Revolution. In general the green revolution has improved food supplies in many parts of the country, but it also created adverse social, environmental and political conditions.

History of Green Revolution

Its beginning were in Mexico when in the two decades after the Second world war, new varieties or hybrids of wheat and maize were developed in an attempt to solve the country's domestic food problem. The new strains of seeds produced dwarf plants capable of withstanding strong winds, heavy rain and diseases (especially the rust, which had attacked large areas). Yields of wheat and maize doubled respectively, and the new seeds were taken to the Indian subcontinent. Later new varieties of improved rice were developed in the Philippines. In 1964many farmers in India were short of food, lacked a balance diet and had an extremely low standard of living which then gave the government the choice of improving the country's farming technology. High yielding varieties of wheat and fertilizers were imported.

Practices Of Green Revolution

The green revolution involves two practices;

1. The introduction of new higher yields seeds
2. The expanded use of fertilizers

Because of the green revolution, agricultural productivity at a global scale has increased faster than population growth. The success of green revolution depends upon the support of infrastructures such as transport links and electricity to provide power for pumps. It also requires a high degree of education and willingness to change. Most HYVs are short stemmed plants which in the case of rice can be drowned by high water levels in paddy fields. Fertilizer application must be carefully controlled or plants become 'leggy' and yield diminishes. Yield increase can be spectacular, although fertilizers must be available and this

may add a further burden to the developing country. In parts of the world, fertilizer may be controlled by foreign multinational companies.

Genetic Modification of Crops

Genetically modified crops (GMCs, GM crops, or biotech crops) are plants used in agriculture, the DNA of which has been modified using genetic engineering techniques.

For centuries, farmers and scientist have used crossbreeding through artificial selection to develop genetically improved varieties of crop strain. This selective breeding has brought about amazing results. Take for example, the Ancient ears of corn were about the size of your finger and wild tomatoes were once the size of a grape. But traditional crossbreeding is a slow process; typically taking 15 years or more to produce a commercially valuable new crop variety and this method can only work when combining traits only from species that are genetically similar. Today scientists are creating a '**third green revolution'** actually a '**gene revolution'** by using genetic engineering to develop genetically improved strains of crops and livestock animals. It involves taking a gene from one species and transplanting it into the DNA of another species

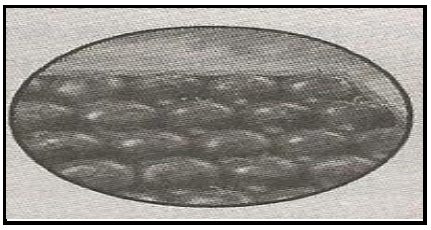
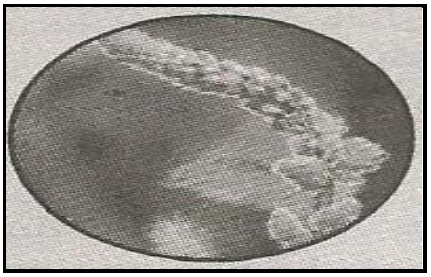
Figure 2.1 Some genetically modified food

Compared to traditional crossbreeding, gene taking about half as long to develop a new crop, usually cost less, allows the insertion of genes from almost any other organism into crops cells. For example, genetic engineers have developed potatoes that resist disease because they contain chicken genes and they have used genes from ordinary daffodils and soil bacterium to produce a golden rice. Ready or not, the world is entering the age of genetic engineering

Potential Draw Backs of Genetic Engineering

Despite its, considerable controversy has arisen over the use of genetically modified food (GMF) and other forms of genetic engineering. Its producers and investors see this kind of food as a potentially sustainable way to solve world hunger problems and improve human health. Some critics consider it, potentially dangerous. Critics recognize the potentially benefits of genetically modified crops. But they warn that we know too little about the long term potential harm to human health.

TABLE 9: ADVANTAGES AND DISADVANTAGES OF GENETICALLY MODIFIED CROPS

Projected Advantages		**Projected Disadvantages**
Need less fertilizer Need less water More resistant to insects, disease frost and drought Grow faster Can grow in slight salty soils Less spoilage Need less pesticide Tolerate higher level of herbicides Higher yields	  	Irreversible and unpredictable genetic and ecological effects. Harmful toxins in food from possible plant cell mutation New allergies in food. Lower nutrition Increased development of pesticides-resistant insects and plant disease. Can create herbicide-resistant weed Can harm beneficial insects Lower genetic diversity

NOW TURN TO THE NEXT PAGE AND DO STUDENT ACTIVITY 10

STUDENT LEARNING ACTIVITY 10

1. The success of green revolution depends upon the

   i) _____

   ii) _____

2. Green revolution calls for high usage of Fertilizer for best results. But Fertilizer application must be carefully controlled. Why should the amount of Fertilizer be controlled? _____

3. For centuries, farmers and scientist have used crossbreeding through artificial selection to develop genetically improved varieties of crop strain. This selective breeding has brought about amazing results. But there are disadvantages to this process. Identify two disadvantages of that process?

   i)_____

   _____

   ii)_____

   _____

4. What do these initials stand for?.

   i) GMF_____

   ii) HYV high yielding varieties: _____

_____

NOW CHECK YOUR ANSWERS AT THE END OF THE UNIT SUMMARY

12.1.2.6. Inequality in Food Production and Distribution of Food

Many of the world's poor do not have enough land or money to obtain food that give them the protein and essential vitamins and minerals they need to prevent malnutrition.

The number of people the earth can support depends mostly on their level of food consumption, how efficiently we can convert grain to meat and how many children individual couples decide to have. If everyone in the world today had the average U.S meat based diet, the world's current annual grain harvest could feed only 2.5 billion people.

Today we produce more than enough food to meet the basic nutritional needs of every person on the earth. Even with this surplus of food, one of every six people in developing countries is not getting enough to eat.

Most agricultural experts agree that the root cause of hunger and malnutrition is poverty, which prevents poor people from growing or buying enough food.
For example, India has been self-sufficient in food since 1990. But more than 200 million Indians- one fifth of the country's population are malnourished because they cannot afford to grow or buy the food they need. War and corruption can also deny poor people access to food.

Figure 2.2 Woman with goiter in Bangladesh.

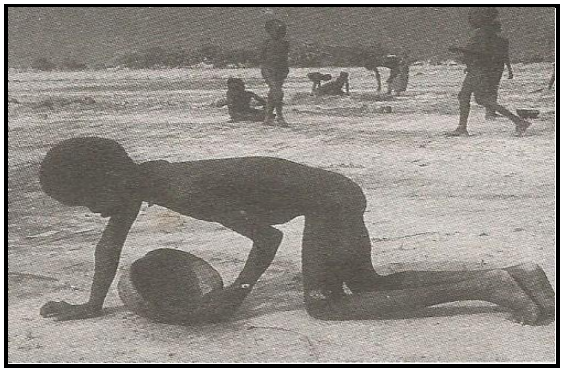


Figure 2.3 Starving children collecting ants to eat in Sudan

Food security means that every person in a given area has daily access to enough nutritious food to have an active and healthy life. At the national level food security can be provided by government programs that help the poor help themselves, family planning, education and jobs (especially for women) and small loans to help the poor start a business or buy enough land to grow their own food.

Many developing countries do not produce enough food to feed their people and are too poor to import enough food to provide national food security. This means that developed countries or nations and international lending institutions such as the World Bank must provide technical advice and funding to help such countries become more self-sufficient in meeting their food security needs. It also requires national governments to spend more of their funds on helping their rural poor.

Food security also depends on greatly reducing the harmful environmental effects of agriculture such as soil erosion and aquifer depletion.

STUDENT LEARNING ACTIVITY 11

1. Most agricultural experts agree that the root cause of hunger and malnutrition is

   _____

2. Even though with modern technology, food production has increased but distribution of food is still very much unevenly distributed with developed countries having surplus food whilst developing countries suffering from malnutrition. Explain the reasons why the uneven distribution.

   _____

   _____

   _____

3. What is food security?

   _____

   _____

   _____

4. If a developing country does not produce enough food to feed their population, they have the option of importing food

   _____

   _____

   _____

NOW CHECK YOUR ANSWERS AT THE END OF THE UNIT SUMMARY

12.1.3 MINERAL RESOURCES

Introduction

Welcome to heading 12.1.3 of Grade 12 Unit 1. This heading comprises of four sub-headings. They include:

12.1.3.1 What is Mineral?
12.1.3.2 Types of Minerals and their form
12.1.3.3 Methods of Mineral Extractions
12.1.3.4 Coal, Petroleum and Natural Gas

Objectives or aims

On successful completion of this heading, you will be able to:

- define mineral and differentiate between metallic and non-metallic minerals
- identify types of Mineral and their form
- discuss methods of mineral extractions.
- state the types of fossil fuels and their uses

Time Frame

This heading should be completed within 2 weeks.

If you set an average of 3 hours per day, you should be able to complete the heading comfortably by the end of the assigned week.

12.1.3.1 : What is a Mineral?

It is a common mistake to confuse minerals and rocks. To avoid making this mistake, you need to learn what each of these terms means to a geologist.

Geologists are scientists who study rock formation and structure.

So what are Minerals?

To the Geologist, minerals are inorganic substances which have a definite chemical composition. Sometimes the term is used to include all the minerals which occur in the earth's crust and of which are of economic value.

Definition of Terms:
Mineral is a chemical compound which occurs in the earth's crust and which forms the basis of rocks.
Metal is a chemical element which can be separated from a mineral by special treatment.
An **Ore** is a rock which has a metallic content sufficiently high to make it worth mining.

A mineral is generally defined as any natural accruing substance of definite chemical composition and consistent physical properties. An ore is a mineral or combination of minerals from which a useful substance, such gold, can be extracted and marketed at a price that will recover the costs of mining and processing, and yield a profit.

The earth's crust is composed of rocks each of which is made up of minerals. Most minerals are compounds of several elements, example silica. A compound is formed when two or more elements are combined by chemical bonding. A few minerals are themselves elements, eg.carbon (diamond), gold and sulphur. Silica often combines with other oxides to form silicates, the most common of which are feldspar. Mica is another common silicate.

In order for a substance to be considered a mineral, it must be:

- Crystalline
- Solid
- Naturally found in nature
- Be inorganic
- Have a specific chemical composition wherever found that varies only within certain limits
- Contains atoms arranged in a regular pattern to form solid crystals.

Minerals are the bricks of materials that make up the Earth and all the solid bodies in the universe. They are usually defined both by their chemical composition and by their orderly internal structure. Most are solid crystalline substances.

The table below shows the classes of minerals.

Table 11: CLASSES OF MINERALS

Metals	**Non-Metals**	**Fuels**
Copper	Sand	Oil
Nickel	Gravel	Gas
Gold	Clay	Coal
Silver	Limestone	
Iron	Salt	

There are several different minerals known from the earth but only about thirty occur commonly. Studying minerals help us to understand the origin of the earth. Minerals are classified according to their composition and internal structure as well as by the properties of hardness, weight, colour and transparency. Although more than 4000 minerals have been discovered, only about 30 are common on the earth's surface.

NOW TURN TO THE NEXT PAGE TO DO STUDENT ACTIVITY 12

STUDENT LEARNING ACTIVITY 12

1. Define Minerals?

_____

_____

_____

1. Identify some of the factors that are used to classifying Minerals?

_____

_____

_____

2. Which type of mining technique is used for extracting bauxite?

_____

_____

NOW CHECK YOUR ANSWERS AT THE END OF THE UNIT SUMMARY

12.1.3.2 : Types of Minerals and their Form

Types of Minerals

Minerals are of three types:

i.) **Fuels.** Those which can be used to provide power, example coal and petroleum

ii.) **Metallic minerals.** These can be put into two groups;

a) non-ferrous minerals, that is minerals containing metals such as tin, aluminium and copper.

b) ferrous minerals, that is, minerals containing iron

iii) **Non-Metallic minerals**, eg. Asbestos, sulphur and salt.

Metallic minerals:

The cooling of molten magma in the earth's crust, at the time when violet movements are taking place below, resulted in gas and liquids being forced into the joints of the crustal rocks. The magma, gases and liquids derived from it contained metallic minerals which on cooling solidified into large masses into the magma itself and into thin layers in the joints of the crust.

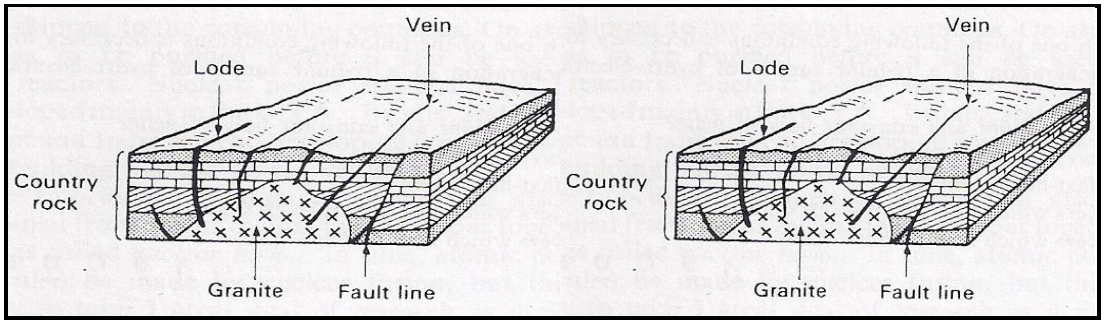


Figure 3.1 Earth's Crust showing Lode and Vein

The large masses are called **Lodes** and thin Layers are called **veins**. Sometimes lodes and veins are exposed at the surface and when that happens they are then called **reefs** and are usually found in ancient shield areas. Most metals occur as compounds, such as oxides or carbonates or sulphates but a few like gold occur in pure state.

Weathering and erosion by rivers of rocks containing lodes and veins have resulted in particles of the metallic minerals being transported to the base of slopes where they are deposited along the rock particles. These deposits of metallic minerals are called **alluvial or placer** deposits.

Example most of the extensive tin deposits of Malaysia are placer deposits.

Mining of Metallic Minerals

Metallic minerals are mined in different ways according to the nature of the deposits.
a). Placer deposits are usually mined by:

I. opencast methods ii. dredging

b). Vein and Lode deposits are mined by shaft (underground) methods.

Non-Ferrous Metals

a. Copper: was one of the first metals to be used by man.

- when smelted with tin it gave a harder metallic substance called bronze.
- (when 2 or more metals are smelted together, the resulting metallic substance is called an alloy)
- In man's history the period where bronze was commonly used was called Bronze Age.

Chief Uses for Copper

- manufacture of electrical equipment using copper (good conductor of electricity)
- Manufacture of phosphor-bronze, very hard and used for making engines

Occurrence, Mining and Processing Of Copper

- Copper occurs in pure state and also as compounds with sulphur and with oxygen
- Copper sulphide is most important source of copper (with copper content of 20%)
- Pure copper occurs in small particles contained in rocks.
- Most of worlds copper production comes from open cast working. After ore is mined it is concentrated, then smelted and finally refined.
- Concentrated ores have a copper content of not less then 70% and are called *matte copper.*
- Matte copper is smelted to reduce it to almost pure copper which is called *blister copper.*

Important copper producing regions

- The USA- Mining in Arizona and Utah
- the CIS-copper deposits are mined in the Ural mountains
- Zambia and Zaire
- Chile and Canada

b. Tin

Used in the Mediterranean civilisations almost 5000 years ago mainly for making bronze and pewter (an alloy of lead and tin) Its main use up to the mid-19 th century was in the manufacturing of these alloys and also used in the making of tin plate.

Occurrence, Mining and Processing of Tin

Tin occurs in two types of deposits, lodes and veins deposits and placer deposits and it usually occurs as tin oxides in a black ore called cassiterite. Nearly 75% of world's annual production of tin comes from placer deposits, the most important from Malaysia, S/China, Thailand and Indonesia. The rest comes from Lode deposits mainly from Bolivia. Tin ore is mined in placer deposits by tin dredging, by hydraulic mining and by gravel pump mining.

Tin Dredging: A dredge is a huge floating machine which digs out alluvium containing tin ore and which separates the cassiterite from the particles of rock. This is done by washing, and the rock particles are thrown out at the back of the dredge as tailings. A dredge is very expensive and therefore tin dredging is only operated by large companies. Dredges are powered by electricity.

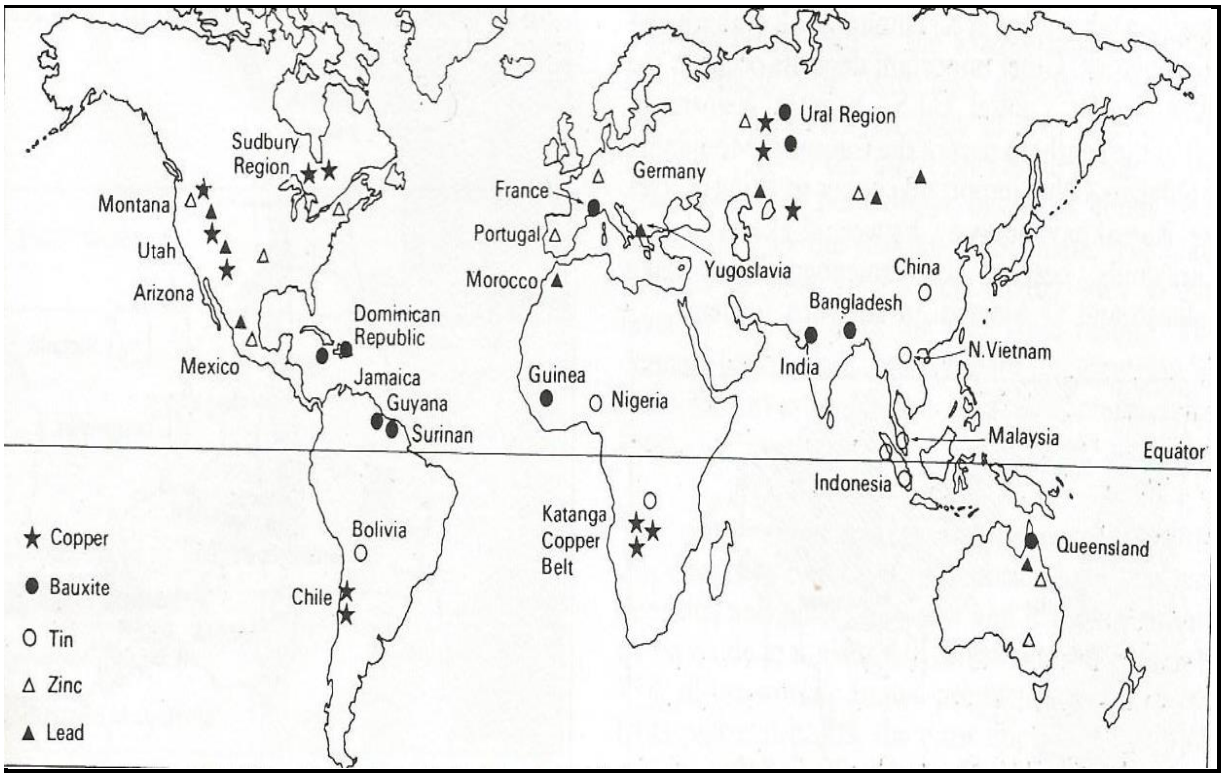


Figure 3.2: The main Bauxite, Copper, Tin, Lead and Zinc producing regions of the world.

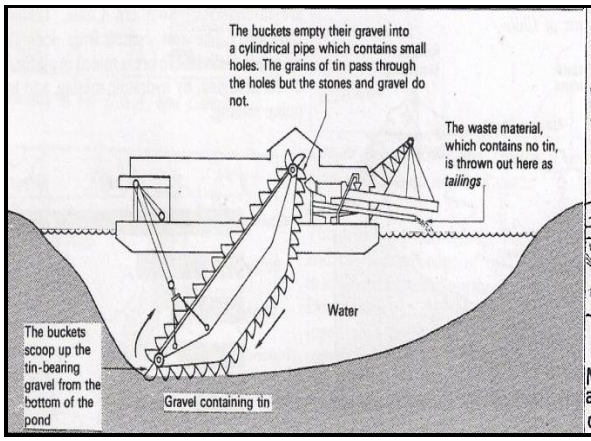


Figure 3.3: View of a Tin Dredge

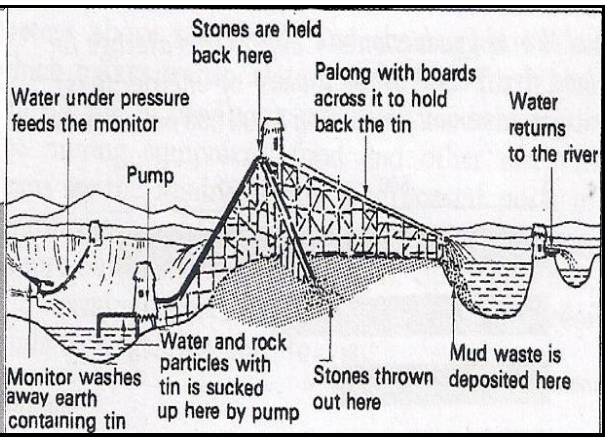


Figure 3.4 Diagram of a Palong

Gravel Pump Mining

Type of mining involves breaking up the tin bearing alluvium with powerful jets of water from a monitor.

Lode Deposits

Similar to coal mining where shafts are dug down to lode deposits and underground galleries and are excavated from the shaft into the lode. Eg Bolivia tin is mined in this way.

Main Tin Producing Regions*:* Malaysia, Bolivia,

c. Aluminium

Characteristics of Aluminium:

- Light weight metal combined with strength
- It is resistance to corrosion
- Good conductivity
- Can be easily rolled into sheets, that is it is *malleable*
- Can be easily drawn out into wire and moulded in to any shape, that is it is *ductile.*

The main uses of Aluminium

- Widely used in the manufacture of aircraft, railway carriages, buses and motor cars
- Manufacture of electrical goods and domestic utensils like cooking utensils, refrigirators, washing machines and cooking ovens.
- consumed in the manufacture of beer and soft drink cans, airplanes, electrical cable and many other products.

OCCURRENCE, MINING and PROCESSING OF BAUXITE

- Bauxite and Cryolite are the two main aluminium ores.
- Bauxite is a clay which is rich in aluminium hydroxide.

i. Most important bauxite deposits occurs in humid tropical regions or in regions which once had a tropical climate where the process of leaching has resulted in the formation of aluminium hydroxide concentrates in the subsoil.

ii. Cryolite is an aluminium ore containing aluminium oxide.

- Most common method of mining aluminium ores is by opencast mining because of the ores are near to the surface.
- Open pit mining is usual technique for extracting bauxite.
- After mining bauxite is crushed, washed and treated chemically to produce aluminium oxide called *alumina.*
- The alumina is then smelted to give about 99% pure metal by using electricity.
- Abundant supply of electricity is required so therefore most alumina smelters are located near to hydroelectric power plants.

Main Producing bauxite producing regions

Australia and Jamaica: both are mined by opencast methods.
Largest Aluminium mine is USA in Arkansas.

d. Lead. It is soft metal which is easy to work and used by man for a long time.

- The main ore is galena (lead sulphide),
- Smelting of lead ores:
- Galena is first roasted to drive off sulphur, after which is heated with coke. The liquid lead collects at the bottom of the furnace which later is led to solidify and later refined.
- The main uses of lead today are for making battery plates, sheaths to protect electric wiring and cables, tanks for storing acids

e. Zinc

- Zinc ores occur in many parts of the world but especially in parts of Europe and North America. The most common ore is Zinc Blende (zinc sulphide)
- Zinc is extracted from its ores either by distillation or by electrolysis.

i). Distillation: ore is first roasted to turn it into zinc oxide, here the sulphur is driven to off as sulphur dioxide and this is used for making sulphuric acid.

ii). Electrolysis: the zinc blende is first roasted to produce zinc oxide which then is dissolved in sulphuric acid. Process used only in regions where there is abundant supply of hydro-electricity.

The main uses of zinc

a. For making alloys- used in the making of brass an alloy of zinc and copper. Its used in the alloy increased with the expansion of electrical industry.

b. for galvanizing: resist corrosion by air and water and therefore a thin coating of zinc applied to iron and steel sheets protects these from rusting.

c. miscellaneous uses: used as roofing material, making toothpaste tubes, casing of dry batteries and making paints.

Major Zinc ore is sphalerite. Sphalerite is usually found closely associated with galena Most lead mines also extract zinc. Main producing regions: Canada is the largest producer of zinc ore.

f. Silver: coins, tableware, jewelry, photographic film and many other items are made of silver. Silver, found as a native metal and in sulfide ore is a common by-product of lead and copper mining. Largest silver producers in USA

g. Gold: Main used is as a basis for the monetary system of many countries.

Occurrence, Mining and Processing Of Gold

- Gold occurs in placer, vein and reef deposits
- Rare and valuable metal gold is used in coins, jewelry, decoration, dentistry, electronics and space program.
- Gold bars are stored to back national currency though this use is rapidly disappearing.

Non-Metallic Minerals

With the exception of gemstones such as diamonds and rubies, non-metallic resources do not have the glamour of many metals or energy resources. They are generally inexpensive and are needed in large quantities. Some non-metalic minerals include stone, salt phosphates,nitrates, potash graphite, sulphur, asbestos, mica

1. Stone: Has been used as an important building material for a long time in many parts of the world. The most extensively used building stones are limestone, granite and marble. Slate which splits into thin sheets is used for making roof tiles.

2. Phosphates: These occur in North Africa, the USA and the C.I.S and are used for making fertilizers.

3. Nitrates also used for making fertilizers and are used extensively for atmospheric nitrogen.most important deposits occurs in the Atacama Desert of Northern Chile.

4. Potash also used in the manufacture of fertilizers. Largest deposits occur in East Germany.

5. Graphite: This is a form of carbon. It is soft and is used mainly in the manufacture of lead for pencils and paints, dry batteries and certain lubricants. Chief deposits occur in Sri Lanka, Malagasy and Korea.

6. Rock Salt is crystallined

- occurs extensively in all oceans and seas but especially those of the tropics and in certain types of rocks.
- Used in eating and manufacturing of many important chemicals

Main producing regions are: USA, Germany (Stassfurt) , UK (Cheshire) and Poland

7. Mica

- Occurs in igneous rocks and can be split easily into thin sheets.
- Resist great heat and electricity and is semi-transparent.
- Used for making windows to furnances and as insulators in electrical equipment.

Producing regions: North Carolina-USA, Damodar of Northern India

8. Asbestos

- This is a fibrous mineral which occurs in certain types of igneous rocks.
- Fibres can be spun and woven into textiles.
- Principal property of asbestos is great resistance to electricity and heat.
- Used for making fireproof clothing and materials, insulating materials.
- Producing regions are: Eastern Canada and South Africa

9. Sulphur:

- occurs mainly in regions of volcanic activity and hot springs
- Widely used in the manufacturing of great variety of chemicals and the vulcanization (hardening) of rubber, manufacture of insecticides and medicines. Regions of Sulphur deposits are in Gulf coast of USA and Sicily.

TURN TO THE NEXT PAGE AND DO STUDENT ACTIVITY 13

STUDENT LEARNING ACTIVITY 13

1. The most common method of mining aluminium ores is by opencast mining. Explain the reason why it cannot use other methods of mining?

   _____

   _____

   _____

2. Which non-metallic mineral is used in the making of fertilizer?

   _____

3. Which type of mining technique is used for extracting bauxite?

   _____

   _____

4. What is the main distinguishing difference between a bronze and an alloy?

   _____

   _____

   _____.

5. Explain what type of mining is gravel pump mining.

   _____

   _____

   _____

NOW CHECK YOUR ANSWERS AT THE END OF THE UNIT SUMMARY

12.1.3.3 : Methods of Mineral Extraction

Mining is the name given to the extraction of mineral ores and oil from the earth's crust. When extracted, minerals cannot be replaced, and therefore mineral reserves in the earth's crust will eventually decreased. Minerals therefore are considered as non-renewable resources.

Mining can be carried out on the earth's surface or underground. The two forms of surface mines are **strip mines**, used for mining some beds of coal, and **open pit mines**, in which ore is exposed in a large excavation

Mining methods differ from region to region, depending on the location of the minerals, the depth at which they exist, and the level of technological skills available. **Shaft mining** is practised in places where minerals occur deep in the earth's crust, while **open pit (open cast) mining**, using either dredges or hydraulic pumps or some other method is practised where minerals occur at or near the earth's surface.

Mining and The Environment

Mining operations and their mining waste disposal methods are considered one of the main sources of environmental degradation. Social awareness of this problem is of a global nature and government actions to stem the damage to the natural environment have led to numerous international agreements and laws directed toward the prevention of activities and events that may adversely affect the environment

Whenever mining takes place, there are four main ways in which the environment may be affected.

1. The erosion of soil and loss of vegetation in the area which is cleared for mining.
2. The pollution that results from the sediment from the tailings and waste rock that ends up in rivers and the sea.
3. The chemical pollution which occurs due to chemicals that are used during the extraction process and released into the environment through the tailings.
4. The heavy metals that occur naturally in the rocks and which may be released into the environment through the tailings

Metals are found in naturally occurring substances called minerals. Examples of some minerals from which metals are extracted are listed in the table on the next page.

Some important minerals and the metals that can be extracted are shown below.

Table 12: **MINERALS AND METALS THAT CAN BE EXTRACTED**

Minerals	**Formular**	**Metal Obtained**	**Formular**
Bauxite	Al_2O_3	Aluminium	Al
Chalcopyrite	$CuFeS_2$	Copper	Cu
Haematite	$Fe2O_3$	Iron	Fe
Galena	PbS	Lead	Pb
Cinnabar	HgS	Mercury	Hg
Rock salt	NaCl	Sodium	Na
Calamine	$ZnCO_3$	Zinc	Zn

Metals in Papua New Guinea

Papua New Guinea has many valuable mineral deposits, particular of copper, silver and gold. However, there are other metals which are also being mined.

Table 13: **OTHER MINERALS AND THE METALS THAT CAN BE EXTRACTED**

Minerals	**Formular**	**Metal Obtained**	**Formular**
Niccolite	NiAS	Nickel	Ni
Linnaerite	Co_3S_4	Cobalt	Co
Pyrolusite	MnO_2	Manganese	Mn
Argentite	Ag_2S	Silver	Ag
Molybdenite	MoS_2	Molybdenite	Mo
Gibbsite	$Al(OH)_3$	Aluminium	Al
Silver	Ag	Silver	Ag
Gold	Au	Gold	Au
Chalcopyrite	$CuFeS_2$	Copper	Cu

Metal Ores

Rocks from which metals are obtained are called ores, and a large amount is known as an ore body. The metal or metal compound in the ore is known as a mineral. In the countries of the south Pacific on the 'rim of fire' or sometimes called the' Ring of Fire' the plates forming the Earth's crust grind together and complex geological processes bring increased concentration of many metal ores, including gold, near to the surface. Some rocks contain one metal compound or metals in large enough amounts to make it worth digging up and extracting the metal.

Searching for Metals

Even large ore bodies are very small when compared with the size of the earth, and so scientists have instruments and methods to help them find ore bodies.

Extracting Pure Metals

1. Alluvial gold

A few metals are found free in nature. Gold is one such metal. It is usually found in veins in gold bearing rock, such as quartz. When this rock is weathered and eroded, the sand and gravel formed are mixed with alluvial gold. Gold found in this way is known as a placer deposit, and is usually the first gold to be discovered. Prospectors can separate the gold from the surrounding sand and gravel by panning. The mixture is whirled round and round with water, repeatedly throwing away the lighter mud, sand and gravel, and leaving the heavy gold grains at the bottom of the pan with some black sand.

Figure 3.5 Alluvial Gold Recovered From Tupuku River

Extracting Metals from Compounds

Most metals occur as compounds mixed with other minerals in rocks. The main stages in extracting metals from their ores are usually mining, concentration, smelting and refining. During the mining stage, the ore is dug out of the ground. The ore may be on the surface or deep underground. In PNG most of the mines are surface mines and are called open cut

mines. After suitable mineral deposits are located, several different mining techniques are used to remove the deposits, depending on their location and type. Shallow deposits are removed by **surface mining** and deep deposits are removed by **subsurface mining**.

In surface mining, mechanized equipment strips away the overburden of the soil and rock and usually discards it as waste material called spoil. The type of surface mining used depends on the resource being sought and on local topography. Methods include the following:

- **Open-pit mining** or open cast mining in which machines dig holes and remove ores such as iron and copper and sand, and gravel, and stone (such as limestone and marble). In open cast mining, all the vegetation and topsoil are removed, thus destroying wildlife habitat and preventing other types of economic activities such as farming.
- **Dredging**, in which chain buckets and draglines scrape up underwater mineral deposits.

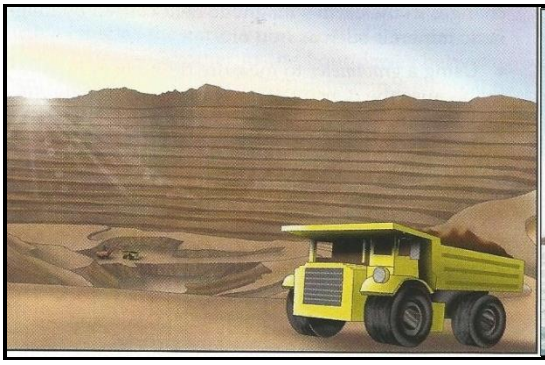


Figure 3.6 Open pit mine

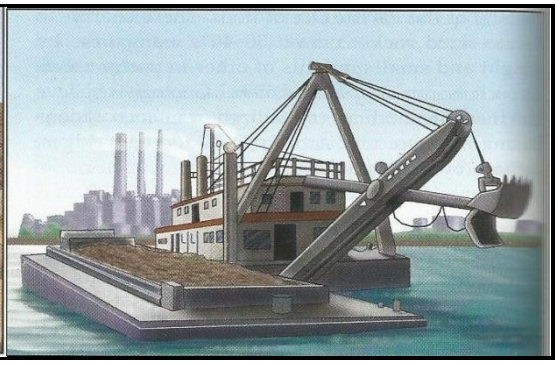


Figure 3.7 Dredging

- **Area strip mining**, used where the terrain is fairly flat. An earthmover strips away the overburden, and a power shovel digs a cut to remove the mineral deposit. After the mineral is removed, the trench is filled with overburden and a new cut made parallel to the previous one. The process is repeated over the entire site. If the land is not restored, area strip mining leaves a wavy series of highly erodible hills of rubble called spoil banks

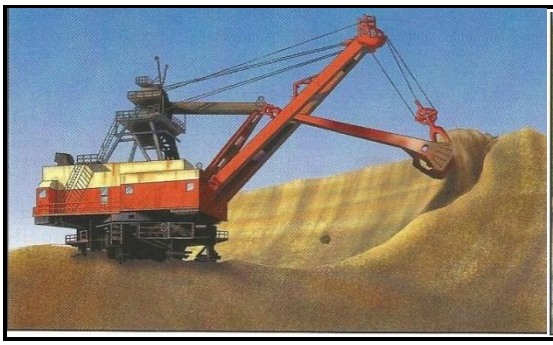


Figure 3.8: Area strip mining

Figure 3.9 Contour strip mining

- **Contour strip mining**, used on hilly or mountainous terrain. A power shovel cuts a series of terraces into the side of the hill. An earthmover removes the overburden, and a power shovel extracts the coal, with the overburden from each new terrace dumped onto the one below. Unless the land is restored, a wall of dirt is left in front of a highly erodible bank of soil and a rock called a highwall.

Surface mined lands can be restored (except in semi-arid and semiarid areas), but this is expensive and is not done in many countries.

Subsurface mining is used to remove coal and various metal ores that are too deep to be extracted by surface mining. Miners dig a deep vertical shaft, blast subsurface tunnels and chambers to get to the deposit and use machinery to remove the ore or coal and transport it to the surface.
Subsurface mining disturbs less than one –tenth as much land as surface mining and usually produces less waste material. However, it leaves much of the resource in the ground and is more dangerous and expensive than surface mining. Hazards include collapse of roof of walls of underground mines, explosions of dust and natural gas and lung diseases caused by prolonged inhalation of mining dust.

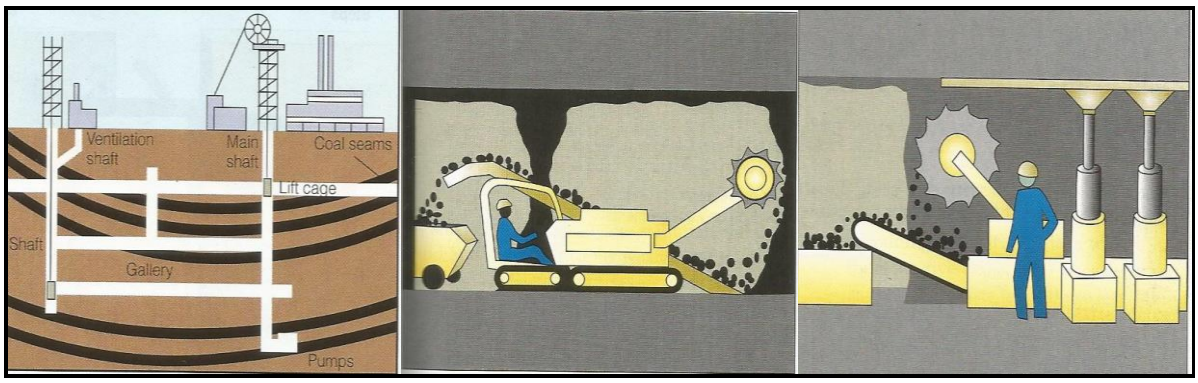


Figure 3.10 Surface and sub-surface Mining

After suitable mineral deposits are located, several different mining techniques are used to remove the deposits, depending on their location and type. Shallow deposits are removed by **surface mining** and deep deposits are removed by **subsurface mining**.

TURN TO THE NEXT PAGE AND DO ACTIVITY 14

STUDENT LEARNING ACTIVITY 14

1. What are the different extraction methods used in surface mining?

   _____

   _____

   _____

2. Which type of mining is more common in PNG? _____

3. Once the mineral deposits are located, different mining techniques are used to remove the deposits, depending on two factors; their

   i) _____ and ii) _____ .

4. Identify 3 main factors that play a vital role in determining which type of mining method is to be used in a particular area?

   i) _____

   ii) _____

   iii) _____

NOW CHECK YOUR ANSWERS AT THE END OF THE UNIT SUMMARY

12.1.3.4 : Coal Petroleum and Natural Gas

Energy is vital to life, from it we get light and heat and it is what allows economic growth. Most of the energy we use comes from fossil fuels such as petroleum, coal and natural gas

Non -renewable resources- this are sources of energy that are limited and can be forever be depleted through use. They represent up to 85 percent of the world's energy consumption and form the basis of today's insecure energy economy.

These nonrenewable sources of energy can be classified into two large groups:

1. Fossil Fuels –coal, petroleum and natural gas

2. Nuclear energy which is produced in nuclear power plants from uranium-a scarce, controlled radioactive material.

Types of Fossil Fuels

Fossil Fuels

- is a term that refers to coal oil and gas, or is
- Any fuel which is found underground buried within sedimentary rocks, coal, oil (crude oil), natural gas.
- fossil fuels contain high percentage of carbon.
- Formed from the fossilized remains of dead plants and animals by exposure to heat and pressure in the Earth's crust over millions of years.

Fossil fuels are non-renewable resources because they take millions of years to form and reserves are being depleted much faster than new ones are being made.

Fossil fuels are the result of the sedimentation of plants and animals that lived millions of years ago and whose remains were deposited at the bottom of estuaries and swamps. Their combustion releases into the atmosphere most of the gases that cause acid rain and the greenhouse effect.

Oil and Natural Gas

Crude oil is a thick liquid containing hydrocarbons that we extract from underground deposits and separate into products such as gasoline, heating oil and asphalt.

Within the petroleum industry, petroleum is a broad term that includes both crude oil and natural gas.

In common usage petroleum is synonymous with crude oil. Many geologists also use it this way.

Natural Gas

- Formed by the breakdown of organic matter, it can be found in isolation or deposited together with petroleum. One way of transporting it to places of consumption is through gas pipelines.
- is a gaseous mixture of naturally occurring hydrocarbons in the form of ethane and methane
- often found in the same geological structures as petroluem
- is also the cleanest of all fossil fuels (and probable the first to run out)

Natural gas requires the same conditions as oil for accumulation. Gas can exist at greater depth than oil however variations in source rock, depth of burial and thermal history of organic matter probable control whether gas or oil both accumulate in that region.

Petroleum

- Derived from organic matter and is associated with sedimentary rocks that have been folded.
- Petroleum is the main energy source in the developed world.
- It comes from ancient organic deposits that have been buried in the bowels of the earth for hundreds of millions of years.
- Its pure state is called crude oil hence the oil must first be distilled to separate its components.

This valuable resource which pollutes the atmosphere when burned is non-renewable and available only in limited reserves.

Uses of Petroleum

- Is the base for many industrial products such as heavy fuel oils, lubricating oils, diesel oils, paraffin and petrol.
- Also used in the manufacture of detergents, synthetic textiles, plastic, paints, insecticides, fertilizers, toiletries and synthetic rubber.

OIL POOLS: underground accumulation of oil.
OIL FIELDS: are regions underlain by one or more oil pools.
RESOURCES: total amount of a geologic material in all deposits, discovered and undiscovered.
RESERVES: a small part of resources. They are short term supply.

Environmental Effects:

- Pipelines carrying oil can be broken by faulting, landsliding, acts of war-causing an oil spill.
- Tanker spillage from collisions or groundings can create oil slicks at sea.
- Oil slicks can drift ashore, fouling the beaches.
- the refining and burning of petroleum can cause air pollution.

Controlling Environmental Effects

Advanced technology and strict laws are helping to control some of this environmental effects.

Origin of Oil and Gas

- Oil and natural gas originate from organic matter in marine sediment.
- Continued sedimentation buries the organic matter and subjects it to higher temperatures and pressures which converts the organic matter to oil and gas.

Both oil and gas are less dense than water so they generally tend to rise upward through water saturated rock and sediment.

Occurrence of Oil and Gas

Oil Pools are valuable underground accumulations of oil and they are found only where four specific conditions occur together:

1. SOURCE ROCK: (such as shale) contains organic matter that is converted to petroleum by burial and other depositional changes.

2. RESERVOIR ROCK: (usually sandstone and limestone) that is sufficiently porous and permeable to store and transmit the petroleum.

3. A TRAP: a set of conditions to hold petroleum in a reservoir rock and prevent its escape by migration.

4. DEEP ENOUGH BURIAL (thermal maturity) to cook the oil and gas out of the organic matter.

Coal

- Is the third major energy resource.
- Coal most widely used, releases sulphur and mercury. Sulphur causes atmospheric pollution.
- Is easy to obtain and use but is the dirtiest of all energy resources.

Use of coal is now increasing as petroleum becomes scarcer and more expensive.

Uses of Coal

- used for generating electricity.
- used to make coke which is also used in steel making.
- can be burned as liquid fuel. (powered and mixed with water).
- used to produce a variety of products such as ammonia, dyes, perfumes.
- disinfectants, plastics and artificial fibres.

Origin of Coal

Coal is a sedimentary rock that forms from the compaction of plant growth that has not completely decayed. The plant fossils in coal beds include; leaves, stems tree trunks and stumps with roots.

Common Varieties (Rank) Of Coal

a) Peat

- not coal but represents the initial stage of coal development.
- When dry can be burned as fuel.
- Burns with a lot of smoke but gives rather poor flame.

b) **Lignite** (Brown Coal)

- Represents the next stage where more carbon is added
- Is dark brown in colour and burn better than peat.
- has only less than 70% carbon and burns with a smoky flame
- leaves abundant waste hence has limited uses.

c) Bituminous Coal

- it is fairly hard, has a shiny black colour but burns well
- has 70% to 90% carbon, burns freely but leaves ash behind
- used for producing coke, coal gas or steam

d**) Anthracite Coal**

- best coal of all, has high carbon content.
- burns with a hot bright flame.
- contains about 90% carbon and is the best quality.
- burns very slowly but without waste.

Environmental Effects

- presence of mine usually lowers the local water table as ground water is pumped out of the mine.
- the drainage out of the mines tends to be highly acid, polluting surface streams and water supplies.
- When coal is burned ash and sulfur gases pollute the air.

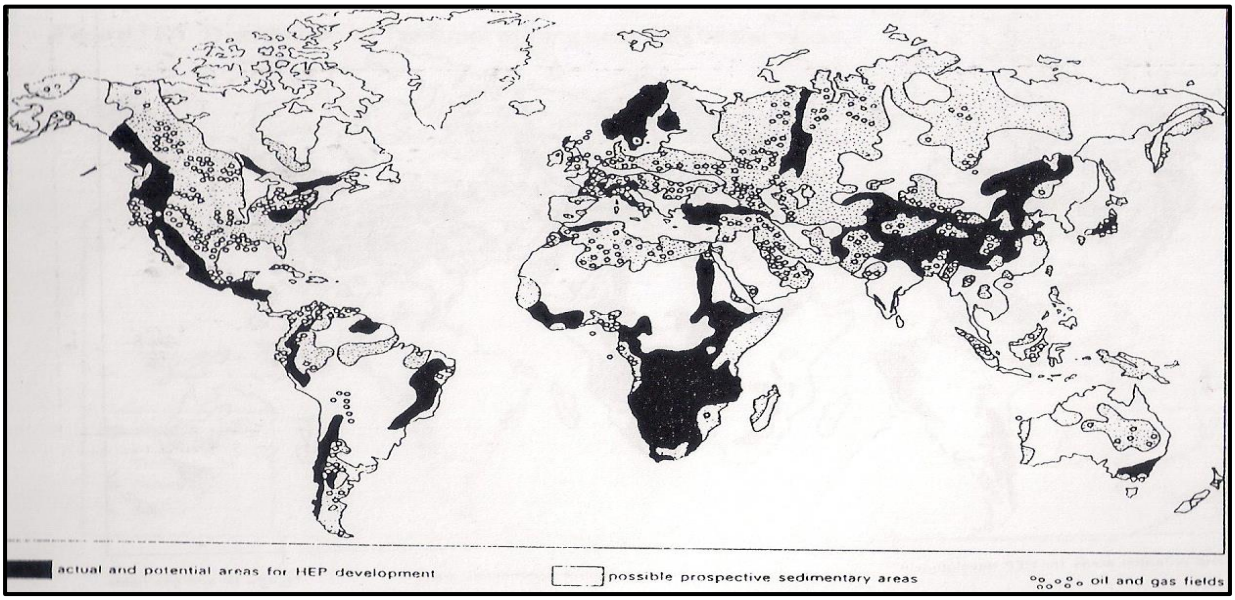


Figure 3.11: World Map showing different mineral location

Cause and Effect

The burning of fossil fuels and the cutting of deciduous forest and rainforest cause an increase in the concentration of carbon dioxide, methane and other greenhouse gases. They trap heat and increase the greenhouse effect.

NOW TURN TO THE NEXT PAGE AND DO STUDENT ACTIVITY 15

STUDENT LEARNING ACTIVITY 15

1. Which coal ranking is regarded as the best coal?

_____

2. Of the three fossil fuels, which type is the dirtiest?

_____

3. What is the difference between Oil Pools and Oil Fields?

_____

_____

_____

_____

4. Explain the Dieback process used by Ok Tedi mining?

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

NOW CHECK YOUR ANSWERS AT THE END OF THE UNIT SUMMARY

12.1.4: COSTS AND BENEFIT OF MINING

Introduction

Welcome to heading 12.1.4 of Grade 12 Unit 1. This heading comprises of four sub-headings. They include:

12.1.4.1 Major Mineral Deposit in Papua New Guinea
12.1.4.2 Mine Waste Management; Experiences in Papua New Guinea
12.1.4.3 Land Degradation and Rehabilitation
12.1.4.4 Socio-Economic Benefits and Costs of Mining

Objectives or aims

On successful completion of this heading, you will be able to:

- Define and discuss logging benefits in Papua New Guinea and its effect on the economy of Papua New Guinea
- identify and discuss illegal and corrupt logging practices in Papua New Guinea
- Define land degradation and explain it effects on the environment and state measures taken to minimise its effect
- Identify and discuss the social and economic benefits for local people and the government of Papua New Guinea from the operating mines and petroleum in Papua New Guinea

Time Frame

This heading should be completed within 2 weeks.

If you set an average of 3 hours per day, you should be able to complete the heading comfortably by the end of the assigned week.

12.1.4.1 : Major Mineral Deposits in Papua New Guinea

Mining methods differ from region to region, depending on the location of the minerals, the depth at which they exist, and the level of technological skills available. **Shaft mining** is practised in places where minerals occur deep in the earth's crust, while **open pit (open cast)** mining, using either **dredges or hydraulic pumps** or some other method is practised where mineral occur at or near the earth's surface.

Mineralisation and Mines

Papua New Guinea's rugged mountains, complex geology and substantial mineral resource all results from its position on the Pacific 'Rim of Fire', the interactive tectonic boundary or collision zone between the continental crust of the Australian Plate to the south and the oceanic Pacific Plate to the north.

Exploration in the country is running at a very high level, with increased projects record, the number of exploration has risen dramatically and there has been a diversification in mineral elements. In 2013 PNG commenced exporting nickel and cobalt, and in exploration, in addition to the historic gold, silver and copper. Papua New Guinea is seen as a highly prospective country with its existing large scale operations at Lihir, Ok Tedi, Pogera, Ramu and Hidden Valley. Listed in the table below is the 2011 Mine production summary from the large mines in the country.

2011 Mine Production

MINE	GOLD (oz)	SILVER (oz)	COPPER (t)	MINE LIFE
Lihir	653,037			15 years
Porgera	538,957	106,538		12 years
Ok Tedi	417,236	1,048,546	130,456	10 years
Hidden Valley	231,383	1,826,370		14 years
Simberi	57,282	10,037		10 years
Tolukuma	33,119	54,409		5 years
Sinivit	6,400	2221		2 years

All of Papua New Guinea's major mining developments have taken place in the modern era, operated with large –scale mining methods and using up to date methods of metallurgical extraction.

The Ok Tedi mine has been exporting gold/copper-gold concentrate continuously since 1984, making a leading contribution to PNG's export earnings over that period. The mine is expected to implement a mine life extention program that will continue operations well beyond the current closure date of 2015, possibly beyond 2022.

Figure 4.1: Ok Tedi Mine

1. The Pogera mine produced its first gold in 1990 and for the first several years of mining was a million ounce per annum projects.
2. The Lihir Island mine commenced gold shipments in 1997, and is approaching the completion of its significant million ounce plant upgrade**.** Lihir remains PNG's largest gold producer. Lihir is an open cut gold mine wholly owned by Newcrest mining.
3. The most recent mine to come online is at Hidden Valley and is operated by Morobe Mining Joint Ventures. It currently has a fourteen year mine life. Hidden Valley is an open pit, gold-silver mine and processing plant in Morobe Province. The mine is operated by Morobe Mining Joint Ventures, a 50:50 joint venture between Harmony, a company that operates primarily in South Africa, a Newcrest Mining, an Australian gold and copper mining company

New mines opened in the ensuing period included

- the Simberi mines, now undergoing expansion, Simberi Oxide Gold Project is an open pit gold and silver mine operated by Allied Gold, an Australian based company
- the small Sinivit heap leach mine, which has since closed;
- the gold-silver Hidden Valley mine

- and the US 21 billion Ramu Nickel mine, the first mine in PNG to be owned and operated by a Chinese company, China Metallugical Group Corp. Exports of Nickel and cobalt- both first for PNG began in March 2012
- Apart from this large scale mines, PNG is expected to become the first deep sea mining nation in the world when Nautilus Mineral commences production in the 2014 from the solwara 1 seafloor massive sulphide deposits. This is a totally new type of mining and is a prime example of technology transfer in this case from the oil and gas industry.

Development and planning progresses on advanced projects; Foremost among the new project is the deep sea mining venture of Toronto-listed Nautilus Minerals. Nautilus is already building what will be the world's first sea floor production system and production support vessel that will mine copper and gold from massive sea floor sulphide deposits some 1600 metres below the surface of the Bismark sea. The Solwara 1 project site is in deep waters between New Ireland and East New Britain Provinces. Mining is tipped to start in 2017. Further to this, very significant mineral deposits at the feasibility stage of exploration occur at Frieda River in West Sepik Province, Wafi Golpu north of the Hidden Valley mine in Morobe Province, and Yandera in Madang Province, as well a number of smaller gold deposits in advanced exploration feasibility stage at Woodlark Island in the Solomon Sea, Mt Kare near Pogera in Enga Province, and Inwauna on Normanby Island.

Mineral and Mining Projects in Papua New Guinea

Mineral and Petroleum resources in PNG are owned by the state., allowing for equitable national distribution of the resulting benefits which is vital to the development of PNG and allows resources to be developed for the benefit of all citizens as required by the constitution. PNG's mining and petroleum industry is the backbone of the economy and contributes over one third of government tax revenue. Papua New Guinea has one of the most equitable benefit sharing systems in the wold for mining and petroleum developments. PNG may have extensive natural resources but extracting them comes at a cost. Papua New Guinea's positive economic growth has now been sustained for a decade, commencing in the early 2000's and strengthening progressively.

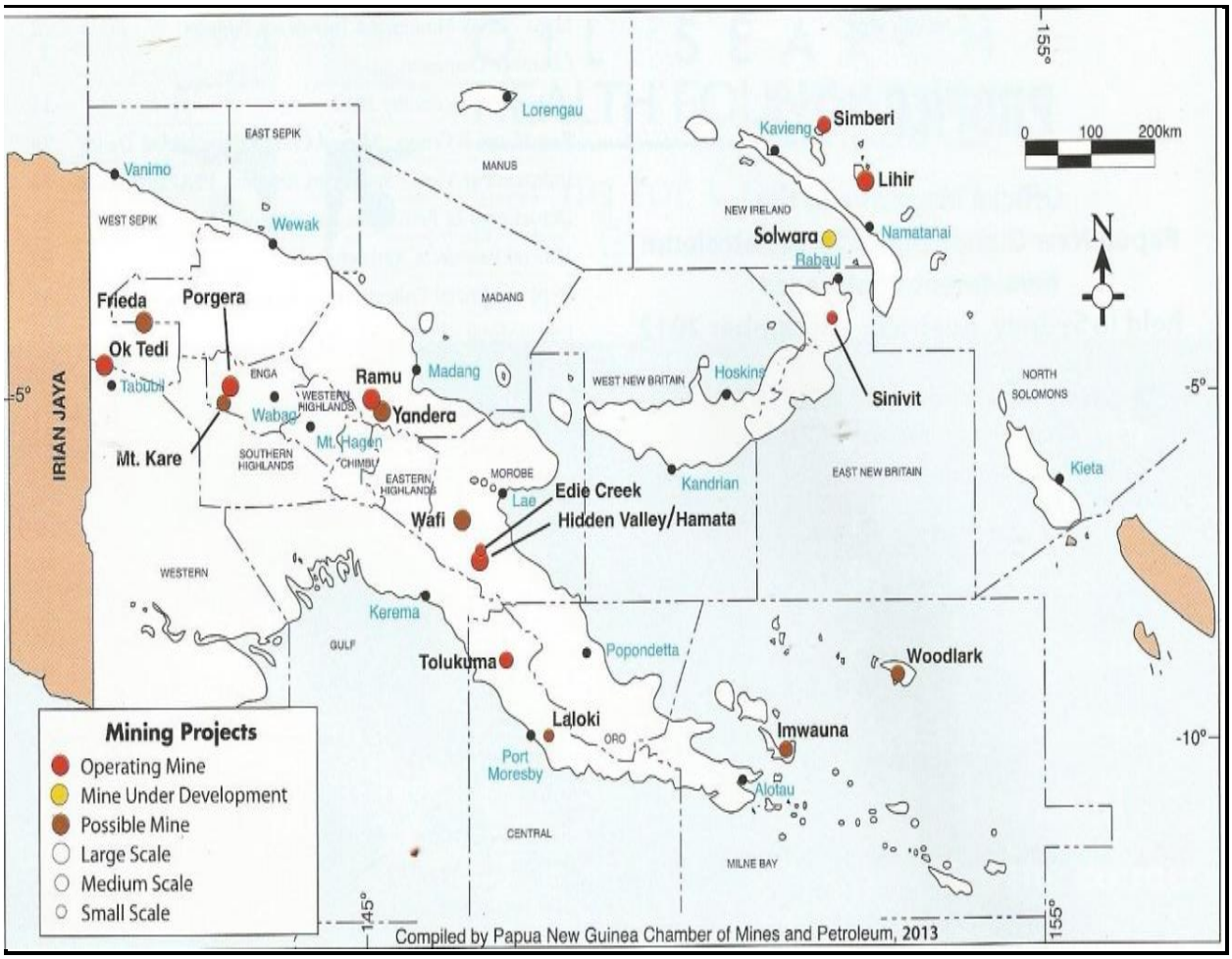


Figure 4.2 Mining projects in PNG

Papua New Guinea Petroleum Projects

One of the most important aspects of petroleum exploration development and production in PNG is the fact that access to the potential resource has to be made through the customary owned lands, and appropriate compensation paid .

The key resources issue in PNG today is thus the challenge facing government at all levels and landowners in converting the benefits generated by the mining industry into real and tangible improvements in the lives of everyday citizens. This fundamental issue can only be addressed through good governance, accountability and revenue transparency. The mining and petroleum sectors have delivered improvements in infrastructure to parts to PNG and made a very significant contribution to education and training at all levels in the country.

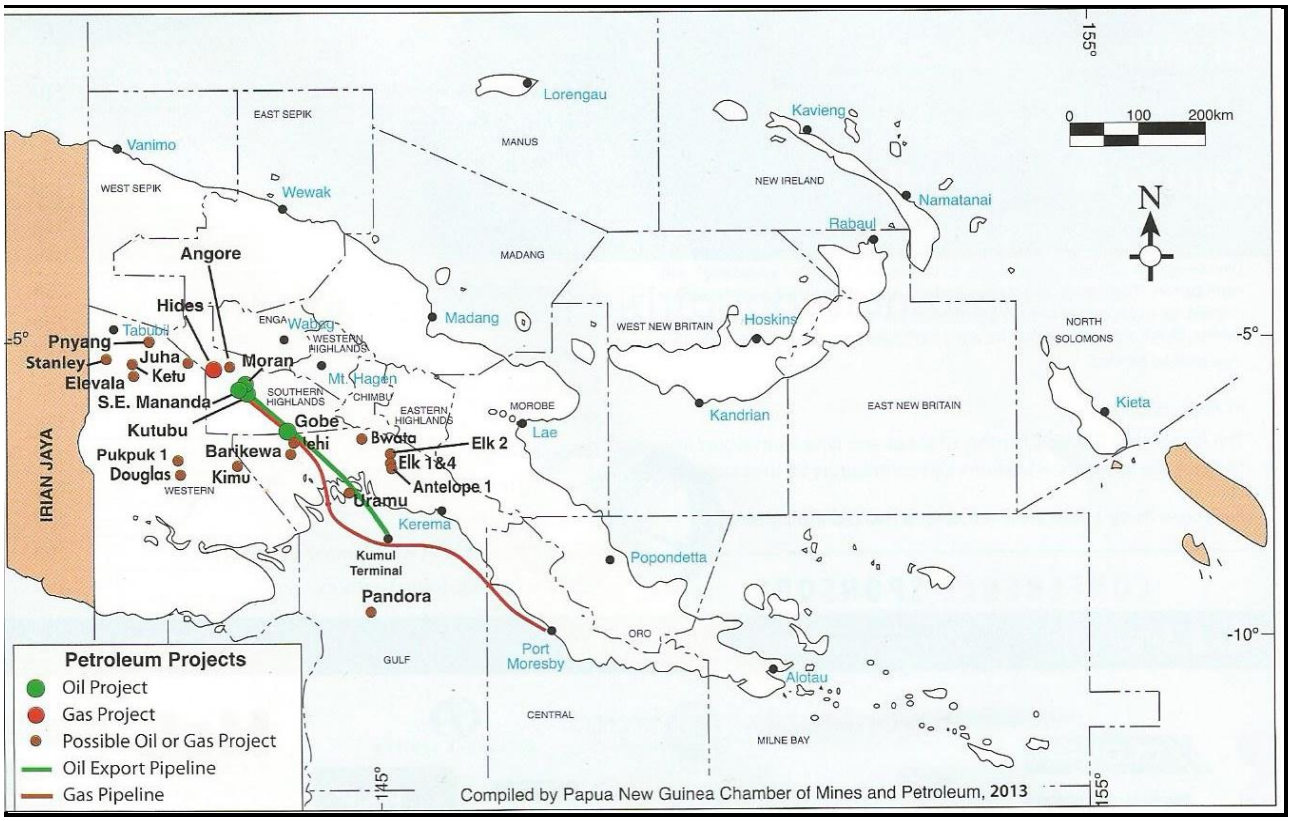


Figure 4.3 Petroleum projects in PNG

Table PNG future Mines

Project	Owner/Status	Resource Estimation	Proposed Annual Production	Predicted Start-up/ Mine Life
Solwara 1	Nautilus Minerals (In development)	2Mt at 6.8% Cu, 23g/t Ag, 5g/t Au and 0.4% Zn	Au 300,000oz Ag 50,000oz Cu 150,000t	2014 +3years
Woodlark Island	Kula Gold (DFS completed, ML application by end 2012)	19.7Mt at 2.45g/t Au	Au 90,000oz	2015 9years
Yandera	Marengo Mining (Feasibility study near completion)	486Mt at 0.37% Cu and 347Mt at 0.31% Cu	Cu 124,000t Mo 6,700t	+20 years
Frieda River	Xstrata (DFS completed)	2,090Mt at 0.45% Cu, 0.22g/t Au and 0.7g/t Ag	Cu 190,000t Au 280,000oz	+20 years
Golpu	Morobe Mining Joint Ventures (Feasibility study to commence 2013)	1 billion tonnes at 0.90% Cu and 0.63g/t Au	Au 490,000oz Cu 290,000t	+24 years

STUDENT LEARNING ACTIVITY 16

1. Which type of mining method is appropriate in extracting minerals that occur deep in the earth's crust?

   _____

2. What machines are needed in extracting minerals that occur deep in the earth's crust?

   _____

3. Make a list of major minerals mined in Papua New Guinea?

   _____

4. Which two mining sites in Papua New Guinea have the longest mine life?

   _____

5. Mining is booming in Papua New Guinea. What could have been the prime reason for having a lot of mineral deposits in Papua New Guinea?

   _____

   _____

   _____

   _____

   _____

NOW CHECK YOUR ANSWERS AT THE END OF THE UNIT SUMMARY

12.1.4.2 : Mine Waste Management Experiences in PNG

This subtopic looks at the impacts and effects of mine waste management in Papua New Guinea which specifically looks at a case study of two mines in Papua New Guinea, which is the Ok Tedi Mine and Lihir Gold Mine. First of all, we need to really understand the term **mining waste**.

Mining waste is also called tailing or mine dumps. Mining waste is actually the leftovers after the process of separating the valuable fraction from the uneconomical fractions of the minerals. The mine wastes constitute a potential source of contamination to the environment, as heavy metals and acids are released in large amounts. A great variety of microorganisms are found in mine waste and microbiological processes are usually responsible for the environment hazard created by mine waste. Better management of mining waste will not only protect our environment from harmful chemicals but instil confidence in the people of mining operations in PNG.

Mining in its broadest sense is the process of obtaining useful minerals from the earth's crust.

PNG's experience of mining and economics

Papua New Guinea is endowed with a rich natural resource base, including major gold and copper deposits, large oil and natural gas reserves, vast expanses of agricultural land, and extensive forests and maritime fisheries. During the 1980's PNG experienced a proliferation of mining projects. With the third largest gold reserves in the world, the country has become a magnet for giant multinationals. The development of these mineral resources has been a mixed blessing. Toxic waste from the mines has polluted many areas of the country. In a typical metal mining operation, tailings consist of crushed rock and ore, after most of the target metals have been removed. Mine tailings are often toxic, and if not contained, are harmful to the environment. The global economic and environmental climate has progressively changed in recent years. There is growing pressure on mining companies to clean up their toxic tailings. The Lihir Gold Mine and the Ok Tedi Gold mine are examples of two multinational mining operations that presents their own social, economic and physical environmental impacts. This paper discusses the problem of mine waste disposal at these two mines.

PNG's experience of mining and the environment

The rural communities of PNG depend heavily on nature to sustain their livelihood. Introduction of mining activities in remote areas of PNG has affected a lot of people. Waste disposal from process plants and sediment runoffs from open cut mines are dumped into rivers and oceans. Smothering of riverbeds and ocean floors, heavy metal contamination and acid mine drainage are consequences of mine waste disposal into the environment. Toxicity of heavy metals is generally chronic rather than acute, so diseases associated with them are evident only over a long period of time. People's main concerns come from observable

changes in say a river – discolouration, odour, taste or feel – rather than chemical quantification of some scientific phenomenon unknown to villagers.
At the end of the 1980's several mine projects triggered major conflicts In 1990, concerned local communities, adversely affected by the Ok Tedi mine, raised environmental issues. Mining disasters and spills in PNG, and their subsequent environmental impacts have been heavily reported. In August 1999, an environmental row that was erupting in PNG around plans for a US$38 million nickel mine whose tailings would be dumped into the sea along the country's northern coast. The furore followed the release of scientific reports confirming serious damage to river systems and livelihoods by the 15 year dumping of tailings from the Ok Tedi copper mine. On 22nd August 1999, the call from World Wildlife Fund to close the giant copper mine of Ok Tedi which announced that waste management procedures at the mine were not working The Ok Tedi mine experience highlights this. The PNG government has a 30% stake in the Ok Tedi Mine however it has destroyed over 1000 square kilometers of wetland and virgin forest. Toxic material dumped directly in the Fly River has made it rise 4-5 m in places, causing dieback along the banks. It is killing all life in the river, and all the arable land close to the river which resulted in about 100,000 people have been affected.

Figure 4.4: Location of Lihir Gold Mine

Lihir Island is located in Papua New Guinea's (PNG) New Ireland Province, about 700 km northeast of Port Moresby. Lihir Island is situated off Papua New Guinea's New Ireland Province, about 700 km northeast of Port Moresby. It covers an area of 200 km2. The Lihir Mine Company operates a gold mine on the north end of the island. The mine's processing plant and the corresponding infrastructure occupies 7.3 square kilometers of land on the island.

There are 7,100 people living in the Lihir group of islands, 5000 of those on Lihir Island itself Prior to the mine, they survived through subsistence agriculture, supplemented by a few cash crops and fish.

Lihir management strategies to manage mining waste

There are 3 categories of waste to be disposed of at the mine site.

1. Dumping of waste rock at sea.
2. Submarine tailing deposition (STD) after processing. STD as an entity will be discussed below followed by a specific discussion on cyanide, the solvent used in processing.
3. Stockpiling of low-grade ore for later processing. Whilst not truly an immediate waste, the stockpile of rock will sit for up to 25 years and will have an effect on water concentrates of heavy metals as it is under the influence of water and weather during this time.

Figure 4.5: Waste Rock disposals at Lihir

Dumping of waste rock at sea

The processing of 104 million tons of proved and probable ore reserves from the Lihir mine will create 341 million tons of waste rock. While some rock will be used to extend the land area near Luise Caldera, most material will be disposed of in the ocean about 1 km from the shoreline. Four barges operate 24 hours a day and dump between 1,400 and 4,600 tons of rock per hour (Shearman 2001). Barges operate 24 hours a day to dump waste rock outside the harbor.

The Kennecott environmental report for the mine operators states that it is expected that concentrations of metals [from the waste rock] in the water column are unlikely to exceed the standards outside the immediate dumping area, and that they are likely to be attenuated by the processes of precipitation and adsorption. The prospectus in turn predicts that the main impacts of dumping the rock will be damage to the coral reefs due to increased turbidity of the water, and the smothering of sea floor benthos. In November

1990, the government in Port Moresby asked that the waste rock from Lihir be backfilled into the mine pit, or be dumped farther ashore. These requests were turned down by the mine consortium as being too costly.
It is undisputed that the waste rock submarine mountains cover a large area of the seafloor. What is disputed is whether these bottom deposits affect the fish that are harvested. Many of the fish that local people catch from the PNG waters are caught in the 100-200 m depth range, and they commonly hunt for food down to depths of 800 m or more. Microorganisms also migrate up and down the water column on a daily basis feeding at a depth of 12-50 m on single celled plants. Even if the deposits cannot be seen in the surface water, further down, these sediments can make fish leave the area, change their habits or can affect their breeding behavior. Alternatively, fish may be attracted by the protection from predators that sediment-filled water provides and in turn can be harmed by toxic components in the deposited material blocking their gill filaments .

Submarine tailings deposition of waste products after processing

The aim of Submarine Tailings Discharge (STD) is to deposit mine wastes in deep stratified waters where it is likely that tailings will be trapped below the mixed surface layer and flow as a dense slurry to a deposition site on the deep ocean floor. The process has increasingly come into favor throughout the Asia-Pacific region where on-land disposal options are problematic. In comparison to on-land tailings retention, the mining industry has regularly argued that STD is safer both to local people and the environment.

Figure 4.6: DSTP Lihir

At Lihir, all post processing waste from the mine is channelled by pipeline directly into the sea. Over the life of the mine this will amount to 341,432 tons. The Lihir mining operation discharges this waste directly into the sea to a depth of 125 m, 1.5 km from the island, via a STD pipe. It is hoped that the waste will slide down an ocean trench, the logic being that at such depths, it will fail to affect the surface layer of the ocean. The mine's Environmental Plan admits that benthic macro invertebrates will be exposed to high concentrations of cyanide and metals in the area of the tailings sediments. The toxics can be accumulated in the food chain.

The ideal aim of an STD operation is to have the tailings travel from the mouth of the underwater pipe in a continuous current to the sea floor. It is inevitable, however, that substantial quantities of mine waste will separate from the main tailings flow and form plumes of waste that will spread out across the ocean. Different currents can carry these plumes into surface waters. The mine waste that reaches the sea floor does not necessarily stay there. Almost certainly, deep-water currents will move tailings away from the disposal area. The most serious potential problem is related to upwelling. This term is used to describe the movement of deep ocean water to the surface of the sea. This usually occurs along the coastline, and under normal circumstances is one of the most productive marine processes because it provides food, for fish and other animals. Upwellings are often the site of the best fishing. Unfortunately upwelling can also bring mine waste back to the surface of the ocean, where it is most dangerous to marine life.

Waste rock from the mine is used for construction of a platform across the harbour for use in a later cofferdam wall or deposited offshore. Submarine disposal of waste rock is carefully planned and controlled to achieve a continuous rill slope along the steeply dipping sea floor and to prevent uncontrolled slumping.

DSTP (Deep Sea Tailing Placement) is a specialised form of marine tailing placement that is only viable where there are suitable geographic and physical conditions. DSTP is increasingly being seen as a viable alternative to on land storage of tailing, particularly at island and coastal mine sites where deep water is close to shore, and where geotechnical conditions and social considerations do not favour on land storage. It is currently being used by several mining operations around the world. Mines in PNG which have implemented this mine waste management system include:

1. Misima Mines Limited-now ceased operations
2. Lihir Gold Limited-currently operational
3. Simberi Oxide Gold Project-currently operational
4. Ramu NiCo Limted-under construction

Figure 4.7: Mining activities at Ok Tedi

Mine Waste Management in Ok Tedi Gold Mine

The Mine located in the star mountains of the Western Province, Ok Tedi Mining Limited (OTML) operates the Mt Fubilan open pit copper, silver mine and process plant. From the late 1980s, tailings and waste rock have been discharged by the mine into the Ok Tedi River

and Fly River. The particle size distribution of tailings includes a significant sand fraction which then gets to be deposited on the river bed due to the river lacking the energy to transporting downstream. Over time, the river bed filled with sand overflowed on to its floodplain. The then rainforest habitat floodplain turns to an aquatic habitat- a process referred to as **Dieback**.

In 1998, OTML has operated a dredge at Bige in the Lower Ok Tedi to capture the bulk of the sand-sized fraction passing down the river. Since dredging commenced, there has been an improvement in the river system downstream of Bige, Dieback has been minimised and secondary growth has commenced along the river banks around Bige. Following the implementation of dredging, the bed level gradually declined in the Ok Tedi downstream of the dredge and stabilised in the upper Middle Fly.

Figure 4.8 Current view of Ok Tedi mine

In addition to the physical effect of sand deposition in the river channels, gradually rising pyrite grades in the ore and hence mill tailings resulted in an increased risk of Acid rock Drainage developing in the Ok Tedi and Fly Rivers (ARD). ARD occurs when pyrite (a common mineral in sulphidic ores) reacts with air and water to produce sulphuric acid To control this risk, in 2008 the company implemented the Mine Waste Tailings Project which consist of a floatation plant at a mill (the tailing processing plant)l to remove pyrite from the mill tailings.

Figure 4.9 Dredges in Operation at Bige

Waste Management Techniques

Before the mining activities are done, land to be used is withdrawn from traditional uses and land selected is usually not from an area where many people would live so that it is free for the mining activities to be done.

Copper and Gold at Ok Tedi mining reduces the original ecosystem diversity with habitats supporting a variety of plants and animals. After mining the land has to be reclaimed. However, this process takes time and cannot necessarily re-establish the original biodiversity. The impact of sub-surface mining on the surroundings will be less than for open pit mines.

Disposal of mining wastes needs additional land use. It has been found that after processing, the waste material occupies a greater volume than the material extracted, and therefore cannot be wholly disposed underground. To avoid contamination of the groundwater, the solid waste from the thermal treatment process is disposed in an open dump (landfill or "heaps"), not underground. The waste material may consist of several pollutants including sulfates, heavy metals, and hydrocarbons some of which are toxic. To avoid contamination of the groundwater, the solid waste from the thermal treatment process is disposed in an open dump (landfill or "heaps"), not underground.

Waste Management

By nature, mining involves the production of large quantities of waste, in some cases contributing significantly to a nation's total waste output. The amount of waste produced depends on the type of mineral extracted, as well as the size of the mine. Gold and silver are among the most wasteful metals, with more than 99 percent of ore extracted ending up as waste.

Disposing of such large quantities of waste poses tremendous challenges for the mining industry and may significantly impact the environment. The impacts are often more pronounced for open-pit mines than for underground mines, which tend to produce less waste. Degradation of aquatic ecosystems and receiving water bodies, often involving substantial reductions in water quality, can be among the most severe potential impacts of metals extraction. Pollution of water bodies results from three primary factors: **sedimentation, acid drainage, and metals deposition**.

Effects of Mining on Environment

a) Positive Effects

The economic effects of copper-gold mining in Ok Tedi is increasing in employment and providing local revenue and royalties whereby few if mitigation measures may be necessary. However, with large mining projects there are situation in which existing infrastructure and social services are inadequate to meet the needs of large workforces that are not local to the

area. This is especially true on tribal land where there can be both cultural differences and discrepancies in the income paid to the landowners.

Mining in Ok Tedi provides Education and gives access to basic needs such as running water and electricity. The following mitigation measures may be applicable to avoid or reduce these impacts depending upon site and project.

b) Negative Effects

Figure 4.11: Air Pollution from Ok Tedi Mine

Some of the negative effects of Ok Tedi mining around the local area is that it destroys the natural habitat of the plants and the animals. Some of the animals and plants due to deforestation have become extinct. Most of the tribal hunting grounds of the locals would have been destroyed and the surrounding areas polluted.

NOW TURN TO THE NEXT PAGE TO DO STUDENT ACTIVITY 17

STUDENT LEARNING ACTIVITY 17

1. What is mining waste?

_____

_____

2. Lihir Gold Mine management strategies to managing mining waste include waste being categorized into three (3) categories. What are they?

a. _____

b. _____

c. _____

3. What is the the most serious potential problem relating to Submarine tailing deposition (STD)?

_____

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4. Explain the Dieback process used by Ok tedi mining?

_____

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NOW CHECK YOUR ANSWERS AT THE END OF THE UNIT SUMMARY

12.1.4.3 : Land Degradation and Rehabilitation

Land degradation is a process in which the value of the physical environment is affected by one or more combination of human activities on the land.

This is considered to be an important topic of the 21st century due to the implications land degradation has upon agronomic productivity, the environment, and its effects on food security. It is estimated that up to 40% of the world's agricultural land is seriously degraded.

Land degradation is a broad term that can be applied differently across a wide range of scenarios. There are four main ways of looking at land degradation and its impact on the environment around it:

- A temporary or permanent decline in the productive capacity of the land. This can be seen through a loss of biomass, a loss of actual productivity or in potential productivity, or a loss or change in vegetative cover and soil nutrients.
- A decline in the lands “usefulness”: A loss or reduction in the lands capacity to provide resources for human livelihoods. This can be measured from a baseline of past land use.
- Loss of biodiversity: A loss of range of species or ecosystem complexity as a decline in the environmental quality.
- Shifting ecological risk: increased vulnerability of the environment or people to destruction or crisis. This is measured through a baseline in the form of pre-existing

Causes of land degradation

Land degradation is a global problem, largely related to agricultural use. The major causes include:

- Land clearance, such as clear cutting and deforestation
- Agricultural depletion of soil nutrients through poor farming practices
- Livestock including overgrazing and over drafting
- Inappropriate Irrigation and over drafting
- Urban sprawl and commercial development
- Land pollution including industrial waste
- Vehicle off-roading
- Quarrying of stone, sand, ore and minerals.

Effects of land degradation

The main outcome of land degradation is a substantial reduction in the productivity of the land. The major stresses on vulnerable land include:

- Accelerated soil erosion by wind and water
- Soil acidification and the formation of acid sulfate soil resulting in barren soil

- Soil alkalinisation owing to irrigation with water containing sodium bicarbonate leading to poor soil structure and reduced crop yields
- Soil salination in irrigated land requiring soil salinity control to reclaim the land
- Soil water logging in irrigated land which calls for some form of subsurface land drainage to remediate the negative effects
- Destruction of soil structure including loss of organic matter

Overcutting of vegetation occurs when people cut forests, woodlands and shrub lands—to obtain timber, fuel wood and other products—at a pace exceeding the rate of natural regrowth. This is frequent in semi-arid environments, where fuel wood shortages are often severe.

Overgrazing is the grazing of natural pastures at stocking intensities above the livestock carrying capacity; the resulting decrease in the vegetation cover is a leading cause of wind and water erosion. It is a significant factor in Afghanistan.

Agricultural activities that can cause land degradation include shifting cultivation without adequate fallow periods, absence of soil conservation measures, fertilizer use, and a host of possible problems arising from faulty planning or management of irrigation. They are a major factor in Sri Lanka and the dominant one in Bangladesh.

The role of population factors in land degradation processes obviously occurs in the context of the underlying causes. In the region, in fact, it is indeed one of the two along with land shortage, and land shortage itself ultimately is a consequence of continued population growth in the face of the finiteness of land resources. In the context of land shortage the growing population pressure, during 1980-1990, has led to decreases in the already small areas of agricultural land per person in six out of eight countries (14% for India and 22% for Pakistan).

Population pressure also operates through other mechanisms. Improper agricultural practices, for instance, occur only under constraints such as the saturation of good lands under population pressure which leads settlers to cultivate too shallow or too steep soils, plough fallow land before it has recovered its fertility, or attempt to obtain multiple crops by irrigating unsuitable soils. High population density is not always related to land degradation. Rather, it is the practices of the human population that can cause a landscape to become degraded. Populations can be a benefit to the land and make it more productive than it is in its natural state.

Severe land degradation affects a significant portion of the Earth's arable lands, decreasing the wealth and economic development of nations. As the land resource base becomes less productive, food security is compromised and competition for dwindling resources increases, the seeds of famine and potential conflict are sewn.

Mine rehabilitation

Mine closure is a process undertaken when the operational stage of a mine is ending or has ended, and the final decommissioning and mine rehabilitation is being underway.
Mine rehabilitation is the restoration of the post-mined landscape to the intended post-mining land use.
Mine completion is the goal of mine closure. A completed mine has reached a state where mining lease ownership can be relinquished and responsibility accepted by the next land user.

In broad terms, rehabilitation refers to the measures undertaken to return land on which mining has taken place to the agreed post-closure uses. In some jurisdictions, the legal requirement is for restoration of the pre-mining land use, whereas in others the end uses of the land are open to a process of negotiation, either with the regulatory authorities or with a broader set of stakeholders. Since mining represents a transient land use,

Ok Tedi mine **rehabilitation** aims to minimize and mitigate the environmental effects of modern mining, which may in the case of open pit mining involve movement of significant volumes of rock. Rehabilitation management is an ongoing process, often resulting in open pit mines being backfilled.

After mining finishes, the mine area must undergo rehabilitation.

- Waste dumps are contoured to flatten them out, to further stabilize them against erosion
- If the ore contains sulfides it is usually covered with a layer of clay to prevent access of rain and oxygen from the air, which can oxidize the sulfides to produce sulfuric acid
- Landfills are covered with topsoil, and vegetation is planted to help consolidate the material
- Dumps are usually fenced off to prevent livestock denuding them of vegetation
- The open pit is then surrounded with a fence, to prevent access, and it generally eventually fills up with groundwater
- Tailings dams are left to evaporate, then covered with waste rock, clay if need be, and soil, which is planted to stabilize it.

For open pit mines, rehabilitation is not always a significant problem or cost. This is because of the higher grade of the ore and lower volumes of waste rock and tailings. In some situations, stoppes are backfilled with concrete slurry so that minimal waste is left at surface.

Often in gold mines, rehabilitation is performed by scavenger operations which treat the soil within the plant area for spilled gold using modified placer mining gravity collection plants.

STUDENT LEARNING ACTIVITY 18

1. What is land degradation?

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2. What causes land degradation?

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3. What is mine rehabilitation?

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4. What is the main outcome of land degradation?

_____

_____

_____

NOW CHECK YOUR ANSWERS AT THE END OF THE UNIT SUMMARY

12.1.4.4 : Socio Economic Benefits and Cost of Mining

Socio-Economic Benefits

Royalties economically brings wealth and helps develop the rural villages. It also helps reduces poverty and crime rates.

The mines have really helped bringing about Infrastructure development to the area where they are situated. Especially for the rural areas in the Western Province, livelihood of people living there is very much affected due to the mining activities taking place infrastructural development has taken place and has brought about many developments.

Cost of Mining on Environment

Positive Effects

The economic effects of copper-gold mining in Ok Tedi is increasing in employment and providing local revenue and royalties whereby few if mitigation measures may be necessary. However with large mining projects there are situation in which existing infrastructure and social services are inadequate to meet the needs of large workforces that are not local to the area. This is especially true on tribal land where there can be both cultural differences and discrepancies in the income paid to the landowners.

Mining in Ok Tedi provides Education and gives access to basic needs such as running water and electricity. The following mitigation measures may be applicable to avoid or reduce these impacts depending upon site and project

Ok Tedi mines' recent push for improvement in rehabilitation practices has aimed to increase species richness in rehabilitated areas to the same level as the adjacent forest. In 1992 the species richness in rehabilitated areas was just over 60 percent of the forest average. At the last measurement in areas rehabilitated in 1999, average species richness was 96.8 percent of the forest average. Improvements have come from improved topsoil handling methods, seed collection, treatment and application methods and the planting of nursery-grown recalcitrant species. By and large all monitoring indicates that the rehabilitated areas are developing towards the stated objective. However, given the level of disturbance from the mining activities and the age that the forest will need to reach to fulfil all of its functions, it will take some time to confirm this.

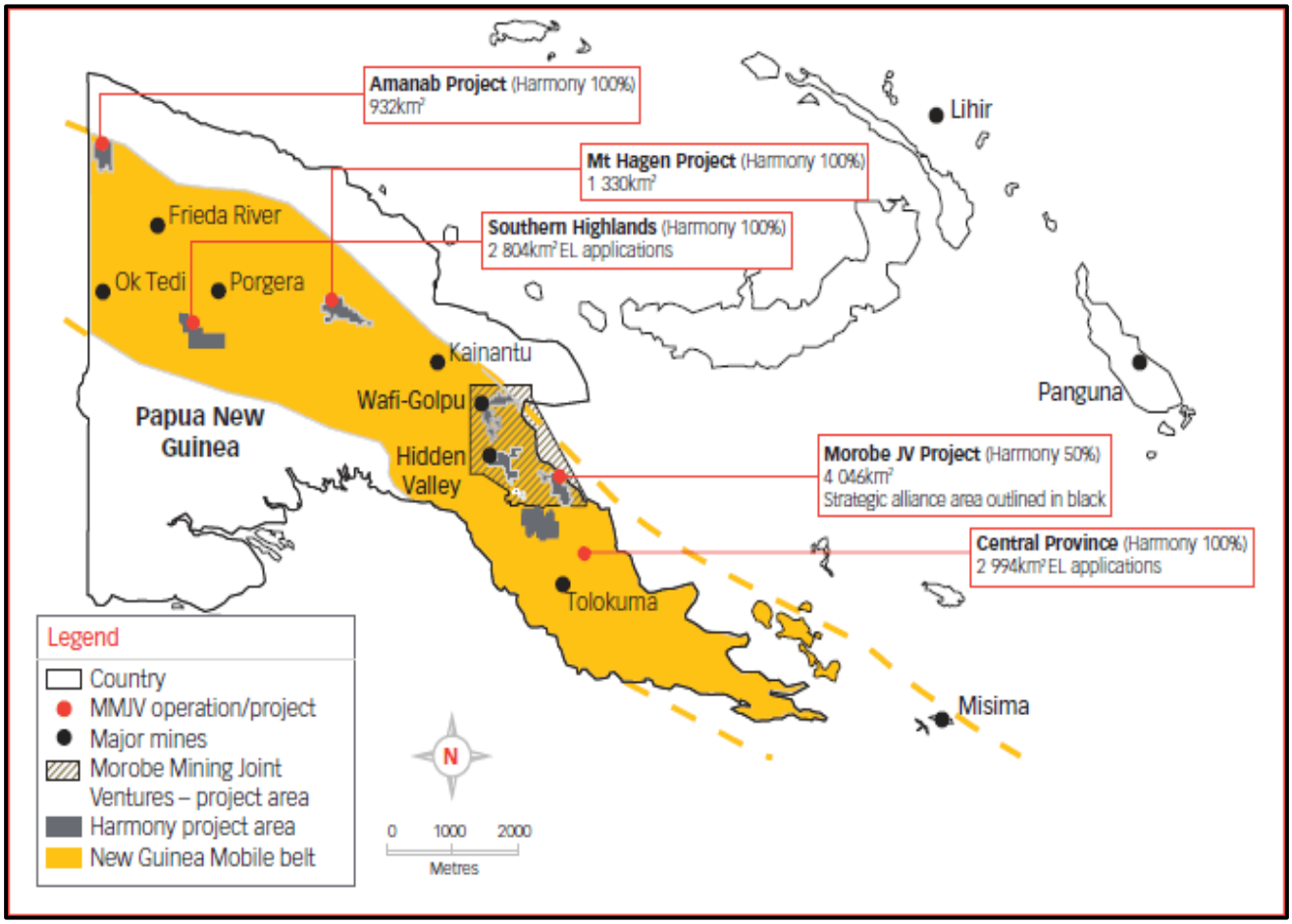
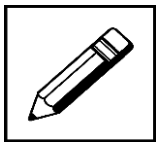


Figure 4.12: Mining Projects in the New Guinea mainland

NOW TURN TO THE NEXT PAGE AND DO STUDENT ACITIVITY 19



STUDENT LEARNING ACTIVITY 19

1. Identify two main ways Ok Tedi has brought about economic developments in the province?

   i) _____ ii) _____

2. Ok Tedi mines' recent push for improvement in rehabilitation practices has aimed at;

   _____

3. Identify two main ways Ok Tedi has brought about Socio benefits in the province?

   i) _____ ii) _____

_____

NOW CHECK YOUR ANSWERS AT THE END OF THE UNIT SUMMARY

12.1.5: LOGGING ISSUES IN PAPUA NEW GUINEA

Introduction

Welcome to heading 12.1.5 of Grade 12 Unit 1. This heading comprises of three sub-headings. They include:

12.1.5.1 The Logging Industry in Papua New Guinea
12.1.5.2 Illegal and Corrupt logging Practices
12.1.5.3 Rain Forest and Carbon Trading

Objectives or aims

On successful completion of this heading, you will be able to:

- define and discuss logging benefits in Papua New Guinea and its effect on the economy of Papua New Guinea
- identify and discuss illegal and corrupt logging practices in Papua New Guinea
- explain the importance of Rainforest preservation and carbon trading.
- state the roles of the office of the Climate Change.

Time Frame

This heading should be completed within 2 weeks.

If you set an average of 3 hours per day, you should be able to complete the unit comfortably by the end of the assigned week.

12.1.5.1 : Logging Industry in Papua New Guinea

Papua New Guinea's Forests and Timber

Papua New Guinea is one of the world's 10 largest tropical rainforest nations. In 2002 PNG had 33 million hectares of forests, more than any other country in Southeast Asia/Pacific except Indonesia. More than 70% of PNG remains forested. The tropical forests of the island of New Guinea (of which PNG represents the eastern half) have been ranked among the world's 10 most ecologically distinctive forest regions. New Guinea's forests are home to 191 species of mammals and 750 species of birds, with the majority of these found nowhere else. PNG's forests provide subsistence food and building materials for a large proportion of the population, which remains predominantly rural. There are more than 800 local languages spoken, and most people retain a close spiritual and cultural association with the forest. Unlike most other tropical forest nations, almost all of PNG's forests are under the customary ownership of local people.

Some 15% of PNG's primary rainforests were lost in the 30 years to 2002, while a further 9% were degraded. Rates of deforestation and degradation in the early 2000s were higher than those seen in the Brazilian Amazon and in most Congo Basin countries, but lower than in Indonesia or Malaysia. The rate of deforestation and degradation is increasing. Commercial logging is the most important driver of forest degradation in PNG. Subsistence agriculture has traditionally been the main driver of deforestation, but this is likely to have changed in recent years as very large areas have been licensed for conversion to commercial agricultural plantations

PNG is a mountainous country, and the majority of the country's forests are judged to be commercially inaccessible. Most of PNG's commercially accessible rainforests have been allocated for logging, but many concessions are inactive. As of 2006 there were 33 active logging concessions, covering a total of 5.25 million hectares; more recent information from the Papua Illegal logging in Papua New Guinea.

Papua New Guinea Forestry Authority (PNGFA) for 2011 shows 'current' logging concessions covering 5.8 million hectares. A handful of Malaysian multinational logging firms dominate the timber industry, with just one – Rimbunan Hijau – responsible for about a third of all log exports. Around a third of PNG's commercially accessible forests have already been logged.

PNG is the second largest exporter of tropical timber in the world, after Malaysia. More than 90% of timber exports are raw logs. Annual export volumes increased gradually during the 1970s and 1980s, expanded rapidly in the 1990s to a peak of 3 million cubic metres, dropped back to an average of 2 million cubic metres a year during the late 1990s and early 2000s, before rapidly increasing again in the last 10 years (2002 to 2012). Log exports in 2011, at 3.5 million cubic metres, were the highest ever recorded. Most of the recent increase has been driven by forest conversion (see pp. 25-26). Before 2000 Japan was the largest buyer of PNG logs, but 80% of PNG's logs are now destined for China. A very wide range of timber species are harvested in PNG, with no single species representing more than 5% of

production in 2009. Some of the more important species are kwila (*Intsia bijuga* – also known as merbau – representing 11% of natural forest log exports in 2012), taun (*Pometia spp*.; 16%), terminalia (*Terminalia spp.*) and bintangor (*Calophyllum spp.*). An uncertain, but most likely significant, proportion of PNG's timber exports to China are re-exported as processed products, especially in the form of plywood.

In 1989 the government-commissioned Barnett Inquiry concluded that the logging industry in PNG was 'out of control', documenting pervasive corruption, bribery, non-compliance with regulations, extensive violations of landholders' rights and extreme environmental devastation. A major effort at reform followed: a moratorium was placed on new logging licences; a new forest policy and forestry law was promulgated; and a number of politicians and civil servants were removed from office. A decade later, however, a series of independent reviews found that illegality and poor forest governance remained the norm (see p. 22-23). Some 75% of log exports from selective harvesting still come from concessions issued before stricter rules on concession allocation were implemented in 1991.

In the international English-language media, illegal logging in Papua New Guinea receives slightly more attention than illegal logging in Ghana, Cameroon or the Republic of Congo, but far less than illegal logging in Brazil or Indonesia. The level of attention has been closely linked to the activities of international NGOs. The level of attention was maintained into the following year, in large part as a result of the island of New Guinea, the second largest in the world has one of the last great expanses of tropical rainforest. Although much of this area is still untouched, the rainforest is rapidly being developed in more accessible regions.

Logging is one of the most prominent and best known forms of rainforest degradation and destruction. Despite improved logging techniques and greater international awareness and concern for the rainforest, unsustainable logging of the tropical rainforest continues- much of it practised illegally by criminal syndicates. In the late 1900s after depleting much of The forest sector contributes significantly to the economic and social wellbeing of the people of Papua New Guinea. It ranks as the third largest foreign exchange earner.

A major thrust of the Government's Medium Term Development Strategy is to improve the economy through increased export income. The Forest Authority is responsible for the sustainable management and utilisation of Papua New Guinea's forest resource.

Figure 5.1: Transporting of round logs for export overseas

The PNG Forest Authority

The Forest Authority (PNGFA) is the Government custodian and manager of the country's forest resource. PNGFA is the custodian of Government owned plantations and is responsible for negotiations of all timber industry activity in the country.

The Prime Role of the PNG Forest Authority is to secure forest resources, natural or plantation, and facilitate their utilisation for the social and economic benefits of the people of Papua New Guinea, on a sustainable basis.

PNG Forest Authority Core Objectives and Core Functions

The Authority pursues the following objectives, as mandated by the Forestry Act 1991

- The management, development and protection of the Nation's forest resource and environment in such a way as to conserve and renew them as an asset for succeeding generations.
- The maximization of Papua New Guinea participation in the wise use and development of the forest resource as a renewable asset:
- The utilization of the nation's forest resources to achieve economic growth, employment creation and industrial and increased downstream processing of the forest resources:
- The encouragement of scientific study and research into the forest resources as to contribute towards a sound ecological balance, consistent with the National development objectives.

Core Functions

The Authority undertakes the following functions, as mandated by the Forestry Act 1991 (as amended)

- To provide advice to the Minister on Forest policies and legislations pertaining to forest matters.
- To prepare and review the National Forest Plan and recommend it to the National Executive Council for approval
- Through the managing director , to direct and supervise the National Forest Service
- To negotiate Forest Management Agreements
- To act as agent of the state, as required, in relation to any international agreement relating to forestry matters
- To carry out such other functions as are necessary to achieve its objectives or as are given under this Act or any other Law.

Papua New Guinea has a total of over 46 million hectares of which 73% is covered by tropical rainforest, mangroves and dry deciduous forest. These forests have a high tree species mix and support a rich variety of flora and fauna. PNG's largest renewable resource is its forest, both natural and plantation. Fifteen million hectares are classified as productive forest, including high quality tropical hardwoods, and forest products are a major export revenue source for the country.

The tropical rainforest of PNG has more than 480 commercial or potential commercial species. As with most tropical hardwood forest around the world, only a minor percentage is harvested. Currently wood export from PNG is in the form of logs. Processed wood products consist mainly of Veneer, Woodchips and sawn timber.

TURN TO THE NEXT PAGE TO DO STUDENT ACTIVITY 21

STUDENT LEARNING ACTIVITY 20

1. Which organization is given the responsibility to monitor and manage the country's forest?

   _____

   _____

   _____

2. What is the legislature that enacts the monitoring and managing of the country's forest?

   _____

3. Name three core functions of the organization that manages the country's forest as stipulated by the legislature?

   i) _____

   ii) _____

   iii) _____

4. What percentage of the PNGs 46 million hectares landmass is covered by forest?

   _____

NOW CHECK YOUR ANSWERS AT THE END OF THE UNIT SUMMARY

12.1.5.2 : Illegal and Corrupt Logging Practices

In recent years, several Papua New Guinea (PNG) and international environmental non-governmental organizations (ENGOs) have spearheaded an aggressive campaign to stop commercial harvesting of timber in Papua New Guinea. The ENGOs have argued consistently that all commercial harvesting of timber in PNG is both illegal and unsustainable.

The legal framework under which the forest sector operates is enshrined in the PNG constitution, the Forest Act 1991 (as amended in 1996/2000/2005) and a number of relevant acts of parliament as they relate to the development, management and utilization of PNG forest resources. All harvesting operations must operate under procedures as laid down under the PNG logging Code of Practice 1996 and the Environment Act 2000.
Illegal logging and illegal trades of the forest products are major concerns of both the International Tropical Timber Organisation (ITTO) Trade Advisory group (TAG) and civil society adviser group.

According to a study carried out by Chatham House, an assessment of levels of illegal logging and related trade in Papua New Guinea (PNG), the state of forest governance, and the response from the government and private sector to the issue of illegal logging. Using both primary research and secondary sources, the study assesses the situation using a set of standardized indicators previously developed by Chatham House, including: an assessment of the country's policy framework and enforcement; an experts' perception survey; wood balance analysis; trade data analysis; assessment of media coverage; and an assessment of levels of certification and legality verification.
Most of PNG's commercially accessible forests have been designated for logging. Industrial logging has been shown to be the main driver of forest degradation, while forest loss due to conversion for agriculture has become a significant issue in recent years. Log production reached a record high in 2011 as a result of large volumes being sourced from the clear-felling of forests under 'Special Agricultural and Business Leases' (SABL).

Levels of illegal logging

Illegal practices are widespread, and the weight of available information (including independent reviews commissioned by the government, and the views of private sector experts surveyed by Chatham House) suggests that the majority of timber production in PNG is illegal in some way.

The types of illegality recorded include: licences being issued or extended in breach of regulations (especially those relating to consultation with indigenous landowners); extensive breaches of harvesting regulations by concessionaires; and, most recently, the abuse of licences for clear-felling forest for commercial agricultural plantations. However, there is relatively little completely unlicensed logging in PNG, and little or no smuggling of timber abroad. Logging-related tax payment is better than in many other countries. Illegal small-scale sawmilling to supply urban markets in PNG is thought to be a significant problem: wood balance analysis suggests that this may account for 10% of all harvesting in PNG. However, further research is needed on the nature and extent of this. Most of PNG's timber

is exported as logs to China and only a very small percentage of PNG's exports are for Europe or the US, and this share is declining in response to increased concerns about illegal logging and import controls. This reduces the likelihood that legislation in these latter markets will provide an incentive for producers to improve practices.

Response to the issue

The legal framework for forestry is quite strong in many respects. It includes strong checks and balances, including limits to discretionary powers and the involvement of non-government stakeholders in decision-making. Customary rights are uniquely strong. However, this strong framework has been fundamentally undermined by major failures in implementation and enforcement.

There is almost non-existent enforcement of the law: penalties are low and never fully applied; resources for monitoring are woefully insufficient; and no best-practice methods are used to detect illegality remotely. There is also an extreme lack of transparency in the sector. The PNG government has been less engaged in international efforts to tackle illegal logging and associated trade than have the authorities in most other major tropical forest nations. Deep-rooted problems with corruption and poor forest governance in PNG have been documented in detail on multiple occasions over the past 25 years, yet successive administrations have failed to address Illegal logging in Papua New Guinea

Once loggers can reach a forest, they use a various methods to harvest the trees. **Selective cutting** reduces crowding, removes diseased trees, encourages growth of younger trees, maintains a stand of trees of different species and ages, and allows a forest to be used for multiple purposes. However, a form of selective cutting in which most or all of the largest trees are removed (a process called **creaming**) leads to environmental degradation and loss of biodiversity.

Clear cutting is the removal of all trees from an area in a single cutting, leaving a few uniformly distributed. Clear cutting leaves ugly unnatural forest openings and eliminates any potential recreational value for several decades. It also destroys some wildlife habitats and thus reduces biodiversity and reduces

STUDENT LEARNING ACTIVITY 21

1. Illegal practices are widespread and some of the types of illegality recorded include:

2. What is the main goal of the Kyoto Protocol?

_____

_____

3. What does the Abreviations stand for?

a) ENGO_____

b)ITTO_____

c)TAG_____

d) SABL_____

4. Papua New guinea export most of its timber to which country?

_____

5. What has been identifies as the main driver of forest degradation in the country?

_____

NOW CHECK YOUR ANSWERS AT THE END OF THE UNIT SUMMARY

12.1.5.3 : Rainforest Preservation and Carbon Trading

Rainforest are recognized as the riches and the most complicated environment on earth. They contain more life than all other environments combined. Even though rainforest cover only about 6% of the earth's surface, they are estimated to contain 75% of all varieties of life on Earth. For example, the remaining rainforest in Panama have as many different species as the whole European continent.

Rainforest are not only the riches environment on our planet but also are the most valuable. They are vital to the essential life support systems of the earth, and they provide a rich and vast array of resources for humans to use. Apart from timber, the huge variety of life in the rainforest has given us an abundance of resources.

Rainforest Preservation

As people begin to realize the importance of rainforest, many of them have started to work towards preserving these 'green dinosaurs.' Some of these methods of conservation are relevant to government and large companies, but some of them are relevant to you and the choices that you make.

1. **Protect the remaining forest**

While only six percent of the world's rainforest are in a national park or reserve, there are many large areas of rainforest under protection. The number and size of these national parks are slowly increasing.

2. **Using the forest without destroying it**

This is called sustainable development. It means that resources are taken from the rainforest but the forest remains largely intact. Timber users can now purchase timber from forest that are properly managed.

3. **Using alternative timber**

One further step in using timber is not to use rainforest timber at all. Many rainforest trees are now grown in plantations; and using alternative materials such as steel beams in houses and recycled papers in cardboard helps take the strain off the rainforest.

One alternative that has been developed is the processing of old coconut palms to create hardwood. The company that is developing this resource, Tangaloa, claims that there are enough non-productive coconut palms to produce timber equivalent to one million rainforest trees. If this concept proves popular, plantations of coconut palms could be grown specifically for this purpose.

4. **You and Me**

While most of us do not have rainforest growing in our backyards, the choices we make each day can and do make a difference to the way resources are used around the world. There

are many organisation that aim to conserve the world's remaining rainforest, and some of their suggestions are:

- Use less wood and paper
- Write to businesses that destroy the rainforest
- Educate yourself about the importance of rainforest
- Look for alternatives to rainforest products

What is carbon trading?

The carbon trade came about in response to the Kyoto Protocol. Signed in Kyoto, Japan, by some 180 countries in December 1997, the Kyoto Protocol calls for 38 industrialized countries to reduce their greenhouse gas emissions between the years 2008 to 2012 to levels that are 5.2% lower than those of 1990.

Carbon is an element stored in fossil fuels such as coal and oil. When these fuels are burned, carbon dioxide is released and acts as what we term a "greenhouse gas".

The idea behind carbon trading is quite similar to the trading of securities or commodities in a marketplace. Carbon would be given an economic value, allowing people, companies or nations to trade it. If a nation bought carbon, it would be buying the rights to burn it, and a nation selling carbon would be giving up its rights to burn it. The value of the carbon would be based on the ability of the country owning the carbon to store it or to prevent it from being released into the atmosphere. (The better you are at storing it, the more you can charge for it.)

A market would be created to facilitate the buying and selling of the rights to emit greenhouse gases. The industrialized nations for which reducing emissions is a daunting task could buy the emission rights from another nation whose industries do not produce as much of these gases. The market for carbon is possible because the goal of the Kyoto Protocol is to reduce emissions as a collective.

On the one hand, carbon trading seems like a win-win situation: greenhouse gas emissions may be reduced while some countries reap economic benefit. On the other hand, critics of the idea suspect that some countries will exploit the trading system and the consequences will be negative. While carbon trading may have its merits, debate over this type of market is inevitable, since it involves finding a compromise between profit, equality and ecological concerns.

An exchange of credits between nations designed to reduce emissions of carbon dioxide. The carbon trade allows countries that have higher carbon emissions to purchase the right

to release more carbon dioxide into the atmosphere from countries that have lower carbon emissions. The carbon trade originated with the 1997 Kyoto Protocol and is intended to reduce overall carbon dioxide emissions to 5% below 1990 levels between 2008 and 2012.

The carbon trade also refers to the ability of individual companies to trade polluting rights through a regulatory system known as cap and trade. Companies that pollute less can sell their unused pollution rights to companies that pollute more. The goal is to ensure that companies in the aggregate do not exceed a baseline level of pollution and to provide a financial incentive for companies to pollute less.

Under the carbon trading , a country having more emissions of carbon is able to purchase the right to emit more and the country have less emissions trades the right to emit carbon to other countries.

TURN TO THE NEXT PAGE AND DO ACTIVITY 22

STUDENT LEARNING ACTIVITY 22

1. Why is the loss of primary forest so disastrous?

_____

_____

_____

2. What is Carbon Trading?

_____

_____

3. What is the main goal of the Kyoto Protocol?

_____

4. Some of these methods of conservation in preserving the rainforest is using alternative timber. What is this alternative timber?

_____

NOW CHECK YOUR ANSWERS AT THE END OF THE UNIT SUMMARY

UNIT SUMMARY

12.1.1 SUMMARY

- Climate change is a change in global or regional climate patterns, in particular a change from the mid to late 20th century onwards as a result of increased levels of atmospheric carbon dioxide produced by the use of fossil fuels.
- Global warming is a gradual increase in the overall temperature of the earth's atmosphere generally attributed to the greenhouse effect caused by increased levels of greenhouse gases.
- Greenhouse effect is simply the way the gases in the atmosphere keep warmth escaping from the earth's surface.
- Greenhouse gases include carbon dioxide, methane, nitrous oxide tropospheric ozone and Chlorofluorocarbon (CFCs).
- Burning fossil fuels such as oil, gas, coal produces greenhouse gases mainly carbon dioxide, methane and nitrous oxide.
- Burning of fossil fuels provide energy to power vehicles, machines in industries, heat and cool homes and run many other appliances.
- Burning of fossil fuels is the main cause of increased greenhouse gases in the atmosphere resulting in global warming.
- The effects of global warming include
    - melting ice and snow
    - rising sea levels
    - changing ocean currents
    - impact on agriculture
    - impact on people
    - impact on biodiversity
- Alternative sources of energy such as geothermal, tidal, hydro, wind and solar energy are more economical and safe to use as they are sustainable and cause no or less damage to the environment.
- REDD stands for Reduction in Emission in Degradation and Deforestation. It is a mechanism put in place to reward developing countries for reducing emissions from deforestation and forest degradation.

12.1.2 SUMMARY

- Agriculture is the science or practice of farming, including cultivation of the soil for the growing of crops and the rearing of animals to provide food, wool, and other products.
- Agricultural practices can be grouped into three main groups which includes;
    1. ARABLE: Is the growing of crops usually on flatter land where soils are of a higher quality.
    2. PASTORAL: is the raising of animal usually on land which is less favourable to arable farming (i.e. colder, wetter, steeper and higher land).
    3. MIXED: is the growing of crops and the rearing of animals together. It is practiced on a commercial scale in developed countries.
- The different types of farming in the world today include
    1. hunting and gathering
    2. shifting cultivation
    3. nomadic herding
    4. intensive subsistence
    5. tropical agriculture and
    6. intensive commercial farming
    7. extensive commercial farming
    8. extensive commercial pastoralism
    9. Mediterranean agriculture
- Dry farming, also called Dryland Farming, is the cultivation of crops without irrigation in regions of limited moisture, typically less than 20 inches (50 centimetres) of precipitation annually.
- Dry farming depends upon efficient storage of the limited moisture in the soil and the selection of crops and growing methods that make the best use of this moisture.
- Dry farming may be practiced in areas that have significant annual rainfall during a wet season, often in the winter. Crops are cultivated during the subsequent dry season, using practices that make use of the stored moisture in the soil.
- Dry farmed crops may include grapes, tomatoes, pumpkins, beans, and other summer crops. These crops grow using the winter water stored in the soil, rather than depending on rainfall during the growing season.
- Irrigation is the method in which water is supplied to plants at regular intervals for agriculture.
- Types of irrigation include
    1. Perennial irrigation
    2. Annual irrigation
    3. Tank irrigation
    4. Well irrigation
    5. Surface irrigation

6. Localized irrigation
7. Subsistence textile irrigation
8. Drip irrigation
9. In sprinkler or overhead irrigation
10. Centre pivot irrigation
11. Sub-irrigation
12. In-ground irrigation

- Four major factors that affect farming are:
    1. Environment
    2. Culture
    3. Economic and
    4. Behaviour
- The Green Revolution refers to the application of modern, Western-type, farming techniques or measures that is designed to increase agricultural yields.
- The green revolution involves two practices;
    1. The introduction of new higher yields seeds
    2. The expanded use of fertilizers
- Genetically modified crops (GMCs, GM crops, or biotech crops) are plants used in agriculture, the DNA of which has been modified using genetic engineering techniques.
- Today scientists are creating a 'third green revolution' actually a 'gene revolution' by using genetic engineering to develop genetically improved strains of crops and livestock animals.
- Despite the benefits of genetically modified crops, critics warn that we know too little about the long term potential harm to human health.
- There is unequal distribution of food resources globally resulting in some countries having surplus (mainly developed countries) while others having shortage (mainly developing or under developed countries).
- War and corruption can also deny poor people access to food.
- Food security means that every person in a given area has daily access to enough nutritious food to have an active and healthy life.

12.1.3 SUMMARY

- Minerals are inorganic substances which have a definite chemical composition. Sometimes the term is used to include all the minerals which occur in the earth's crust and of which are of economic value. They occur in the earth's crust and which forms the basis of rocks.
- In order for a substance to be considered a mineral, it must be:

- Crystalline
- Solid
- Naturally found in nature
- Be inorganic
- Have a specific chemical composition wherever found that varies only within certain limits
- Contains atoms arranged in a regular pattern to form solid crystals.

- There three type of minerals. They are metallic minerals, non-metallic minerals and those that can be used to provide power like coal and petroleum.
- Mining is the name given to the extraction of mineral ores and oil from the earth's crust.
- Mining can be carried out on the earth's surface or underground. The two forms of surface mines are strip mines, used for mining some beds of coal, and open pit mines, in which ore is exposed in a large excavation.
- The four main ways in which the environment can be affected by mining are:
    1. The erosion of soil and loss of vegetation in the area which is cleared for mining.
    2. The pollution that results from the sediment from the tailings and waste rock that ends up in rivers and the sea.
    3. The chemical pollution which occurs due to chemicals that are used during the extraction process and released into the environment through the tailings.
    4. The heavy metals that occur naturally in the rocks and which may be released into the environment through the tailings.
- Minerals that produce energy are fossil fuels. They are petroleum (crude oil and natural gas) and coal.

12.1.4 SUMMARY

- The main methods of mining in Papua New Guinea include shaft mining, open pit and dredges or hydraulic pumps.
- Mineral and Petroleum resources in PNG are owned by the state., allowing for equitable national distribution of the resulting benefits which is vital to the development of PNG and allows resources to be developed for the benefit of all citizens as required by the constitution.
- The key resources issue in PNG today is the challenges facing government at all levels and landowners in converting the benefits generated by the mining industry into real and tangible improvements in the lives of everyday citizens.
- Mining waste is also called tailing or mine dumps. Mining waste is actually the leftovers after the process of separating the valuable fraction from the uneconomical fractions of the minerals.

- The mine wastes constitute a potential source of contamination to the environment, as heavy metals and acids are released in large amounts.
- The mine wastes constitute a potential source of contamination to the environment, as heavy metals and acids are released in large amounts.
- **Land degradation** is a process in which the value of the physical environment is affected by one or more combination of human activities on the land.
- Royalties economically brings wealth and helps develop the rural villages. It also helps reduces poverty and crime rates.

12.1.5 SUMMARY

- Papua New Guinea is one of the world's 10 largest tropical rainforest nations.
- Almost all of PNG's forests are under the customary ownership of local people.
- PNG is the second largest exporter of tropical timber in the world, after Malaysia.
- More than 90% of timber exports are raw logs.
- Logging is one of the most prominent and best known forms of rainforest degradation and destruction.
- Despite improved logging techniques and greater international awareness and concern for the rainforest, unsustainable logging of the tropical rainforest continues-much of it practiced illegally by criminal syndicates.
- The Forest Authority is responsible for the sustainable management and utilisation of Papua New Guinea's forest resource.
- The tropical rainforest of PNG has more than 480 commercial or potential commercial species.
- The legal framework under which the forest sector operates is enshrined in the PNG constitution, the Forest Act 1991 (as amended in 1996/2000/2005) and a number of relevant acts of parliament as they relate to the development, management and utilization of PNG forest resources.
- All harvesting operations must operate under procedures as laid down under the PNG logging Code of Practice 1996 and the Environment Act 2000.
- Many people are beginning to realize the importance of rainforest and have started work towards preserving them.
- Carbon trade is a measure taken by the United Nation to encourage developing countries to reduce the emission of greenhouse gases by preserving their forests as carbon sinks.

ANSWERS TO LEARNING ACTIVITIES

Student Learning Activity 1

1. Green house refers to the way gases in the atmosphere keep the earth warm by preventing the heat given off from the surface of the earth to escape into the space.

2. Greenhouse gases include carbon dioxide, methane, nitrous oxide tropospheric ozone and Chlorofluorocarbon (CFCs).

3. Complete the table below by identifying how the factors listed under solution will help solve or minimize the problem or the things we can do to help minimize the problems caused by greenhouse effect. The first one has been done as an example.

Table 1 Controlling greenhouse gases.

SOLUTION	HOW IT HELPS	THINGS WE CAN DO
1. Control population growth	With fewer people there is less burning and industrial activity so less greenhouse gases are released.	Birth control
2. Reforest	**Regenerates the forests and maintains sufficient carbon dioxide in the atmosphere because it is a major carbon sink. Restores the home to animal species**	**Replace every tree cut. Encourage sustainable farming and logging. Educate people on the importance of forest.**
3. Energy conservation	**Reduces the burning of fossil fuels which then results in the emission of less carbon dioxide from factories, cars and homes into the atmosphere**	**Reduce the use of vehicles by walking, especially to places that are not too far from us. Control the use of electrical appliances and switch of appliances not in use. Use clean and renewable energy sources from fossil fuels.**

Student Learning Activity 2

1. a) gas b) oil
2. Gas
3. They are all non-renewable resources
4. When fossil fuels are burned, they release carbon dioxide and other greenhouse gases into the atmosphere. The excess greenhouse gases trap the heat given of from the surface of the earth and so over time, increase the average earth's temperature.
5. Photosynthesis
6. Coal

Student Learning Activity 3

1.

EFFECTS OF GLOBAL WARMING	LOCALLY FELT AND SEEN	GLOBALLY FELT AND SEEN
1.Beach Erosion	✓	✓
2.Melting Ice	×	✓
3. Heat waves	✓	×
4. Sea level rising	✓	✓
5.. Coral bleaching	✓	✓
6..Variability in rainfall l patterns	✓	✓

2. Sample answers

i) Lower population growth rate by imposing strict birth control measures to lower the population growth. This will reduce the use of world's resources and the burning of fossil fuels for production of goods to feed and make life comfortable for the population.

ii) Use clean renewable energy such as solar, hydro, wind and wave energy

iii) Replant trees to replace every tree cut to maintain forest as a major carbon sink.

iv) Reforestation

v) Recycle used manufactured materials

Student Learning Activity 4

1. Wind Energy
2. Hydro
3. Bio Fuel

Student Learning Activity 5

1. REDD – Reduction in Emission in Degradation and Deforestation
2. The main aim of the United Nation's REDD initiative is to encourage developing countries to reduce the emission of greenhouse gases by protecting their forests from deforestation and degradation. In this way the forest can be protected and managed in a sustainable way which then results in the conservation of biodiversity and assist in the fight against climate change.
3. Carbon trade is an exchange of credits between nations designed to reduce emission of carbon dioxide.
4. Anything that absorbs or stores carbon dioxide. In nature, forests and oceans are major carbon sinks.
5. United States of America (USA) and Australia

Student Learning Activity 6

1. Shifting cultivation involves farming at a site for a few years and then moving onto a new site to allow the previous site to fallow or regain its fertility. A sedentary farming is practiced in one place.
2. i) Arable ii) Pastoral iii) Mixed
3. A mixed farm involves growing of crops and rearing of animals together.

4. An intensive farming is done on a small scale while extensive is usually on a large scale.

Student Learning Activities 7

1. i) Total nomadism-is where the nomad has no permanent home
   ii) Semi-nomads- may live seasonally in a village

2. Market Gardening and fruit farming which is also called Truck Farming in the United States of America involves the intensive cultivation of vegetables and fruits.

3. Mono-cropping / monoculture

4. a) Farmers clear the land for planting by slash and burn agriculture.

   b) Farmers grow crops on a cleared field for only a few years until soil nutrients are depleted and leave it fallow (nothing planted) for many years so the soil can recover.

5. i) animals are source of life
   ii) there is no ownership of land
   iii) is adapted to dry climates where planting crops is impossible

---

Student Learning Activity 8

1. It is a farming practise that involves special treatment of the land to overcome a shortage of water. One method is to crop the land only every two years, conserving at least

2. In ground irrigation systems

3. Sub-irrigation and well irrigation

4. USA

5. The goal is to supply the entire field uniformly with water, so that each plant has the amount of water it needs, neither too much nor too little.

Student Learning Activity 9

1. Winds affect farming, especially where land is exposed to wind and there are no wind breakers and crops can be destroyed. Wind can also increase evapotranspiration rates, also reducing moisture and making soil vulnerable to erosion.

2. Input

3. They are perishable commodities which means, they get bad or stale very quickly after a day once picked, used or open, so they need to be closer to the market and also transport has to be efficient.

4. i) . Mistral

ii) Khamsin

iii) Santa Ana

Student Learning Activity 10

1. The success of green revolution depends upon the:

i) support of infrastructures such as transport links and electricity to provide power for pumps.
ii) It also requires a high degree of education and willingness to change.

2. To avoid plants from becoming leggy (having weak stems) and result in less yields.

3. i) traditional crossbreeding is a slow process, typically taking 15 years or more to produce a commercially valuable new crop variety and

ii) this method can only work when combining traits only from species that are genetically similar.

4. i) GMF- Genetically Modified Food

ii) HYV - High Yielding Varieties

Student Learning Activity 11

1. Poverty

2. The developed countries are too poor to afford nutritious food and also import enough food to provide national food security

3. When smelted with tin it gives a harder metallic substance called bronze.
When 2 or more metals are smelted together, the resulting metallic substance is called an alloy.

Type of mining involves breaking up the tin bearing alluvium with powerful jets of water from a monitor

Student Learning Activity 12

1. Minerals are the bricks of materials that make up the Earth and all the solid bodies in the universe. They are usually defined both by their chemical composition and by their orderly internal structure.

2. Minerals are classified according to their composition and internal structure as well as by the properties of hardness, weight, colour and transparency.

3. Open pit mining is the usual technique for extracting bauxite.

Student Learning Activity 13

1. Because the ores are near to the surface?

2. Nitrate

3. When smelted with tin it gives a harder metallic substance called bronze.
   When 2 or more metals are smelted together, the resulting metallic substance is called an alloy.

4. Type of mining involves breaking up the tin bearing alluvium with powerful jets of water from a monitor.

Student Learning Activity 14

1. The different extraction methods used in surface mining are strip mining and open pit mining.

2. surface mine

3. i) location and ii) type.

4. i) location of the minerals
   ii) the depth at which they exist and
   iii) the level of technological skills available.

StudentLearning Activity 15

1. Anthracite

2. Coal

3. Oil Pools – underground accumulation of oil
   Oil Fields – are regions underlain by one or more oil pools.

4. The tailings and waste rock have been discharged by the mine into the Ok Tedi River and Fly River. The particle size distribution of tailings includes a significant sand fraction which then gets to be deposited on the river bed due to the river lacking the energy to transporting downstream. Over time, the river bed filled with sand overflowed on to its floodplain. The then rainforest habitat floodplain turns to an aquatic habitat- a process referred to as Dieback

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Student Learning Activity 16

1. Shaft Mining

2. Dredges or hydraulic pumps

3. Gold, silver, copper, nickel and cobalt

4. Lihir and Hidden Valley

5. Papua New Guinea's rugged mountains, complex geology and substantial mineral resource all results from its location in the Pacific Region, especially on the Pacific 'Rim of Fire'. This is an interactive tectonic boundary or collision zone between the continental crust of the Australian Plate to the south and the oceanic Pacific Plate to the north

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Student Learning Activity 17

1. Mining waste is actually the leftovers after the process of separating the valuable fraction from the uneconomical fractions of the minerals. The most serious potential problem is related to upwelling.

2. a. Dumping of waste rock at sea.

   b. Submarine tailing deposition (STD) after processing. STD as an entity will be discussed

   c. Stockpiling of low-grade ore for later processing. Whilst not truly an immediate waste.

3. Upwelling. This term is used to describe the movement of deep ocean water to the surface of the sea. This usually occurs along the coastline, and under normal circumstances is one of the most productive marine processes because it provides food, for fish and other animals. Upwelling is often the site of the best fishing. Unfortunately upwelling can also bring mine waste back to the surface of the ocean, where it is most dangerous to marine life.

4. The tailings and waste rock have been discharged by the mine into the Ok Tedi River and Fly River. The particle size distribution of tailings includes a significant sand fraction which then gets to be deposited on the river bed due to the river lacking the energy to transporting downstream. Over time, the river bed filled with sand overflowed on to its floodplain. The then rainforest habitat floodplain turns to an aquatic habitat- a process referred to as Dieback.

Student Learning Activity 18

1. Land degradation is a process in which the value of the physical environment is affected by one or more combination of human activities on the land.

2. The following are the causes of land degradation.

   - Land clearance, such as clear cutting and deforestation
   - Agricultural depletion of soil nutrients through poor farming practices
   - Livestock including overgrazing and over drafting
   - Inappropriate Irrigation and over drafting
   - Urban sprawl and commercial development
   - Land pollution including industrial waste
   - Vehicle off-roading
   - Quarrying of stone, sand, ore and minerals.

5. Mine rehabilitation is the restoration of the post-mined landscape to the intended post-mining land use.

6. The main outcome/effect of land degradation is a large reduction in the productivity of the land. Degraded land not only affects land productivity, but also promotes reduction in the different types of vegetation which eventually results in the alteration of important natural cycles that sustain life on earth. Furthermore it leads to increased carbon dioxide in the atmosphere and contributes to climate change and global warming.

Student Learning Activity 19

1. i) increasing in employment and

ii) providing local revenue and royalties

2. Increasing species richness in rehabilitated areas to the same level as the adjacent forest.

3. i) provides Education and
ii) gives access to basic services such as health, running water and electricity.

Student Learning Activity 20

1. PNGFA – Papua New Guinea Forestry Authority

2. The Forestry Act 1991

3. Any three of the following can be correct.

- To provide advice to the Minister on Forest policies and legislations pertaining to forest matters.
- To prepare and review the National Forest Plan and recommend it to the National Executive Council for approval
- Through the managing director , to direct and supervise the National Forest Service
- To negotiate Forest Management Agreements
- To act as agent of the state, as required, in relation to any international agreement relating to forestry matters
- To carry out such other functions as are necessary to achieve its objectives or as are given under this Act or any other Law.

Student Learning Activity 21

1. Some illegal practices recorded include licences being issued or extended in breach of regulations (especially those relating to consultation with indigenous landowners); extensive breaches of harvesting regulations by concessionaires; and, most recently, the abuse of licences for clear-felling forest for commercial agricultural plantations

3 a) ENGO – Environmental Non-Governmental Organisations
b) ITTO – International Tropical Timber Organisation
c) TAG – Trade Advisory Group
d) SABL - Special Agricultural and Business Leases

4. China

5. Industrial logging has been shown to be the main driver of forest degradation in the country.

Student Learning Activity 22

1. Forests are valuable as they are the life support systems on earth. They provide a rich and various resources for humans to use. The loss of primary forests will obviously threaten the livelihood of human beings and other animal species on earth.

2, Carbon Trading is a scheme where firms (or countries) buy and sell carbon permits as part of a programme to reduce carbon emissions. Usually firms are given a certain quote to pollute a certain amount. If they wish to pollute more than their allowance then, they have to buy more permits.

3. The goals of Kyoto protocol were to see countries collectively reduce emissions of greenhouse gases by 5.2% below the emission levels of 1990 by 2012.

4. Processing of old coconut palms to create hardwood.

NOW YOU MUST COMPLETE ALL THE ASSESSMENT TASKS IN ASSESSMENT BOOK 1 OF THIS UNIT. WHEN YOU FINISH, CROSS CHECK YOUR ANSWERS AND THEN SEND IT TO THE PROVINCIAL COORDINATOR FOR MARKING.

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