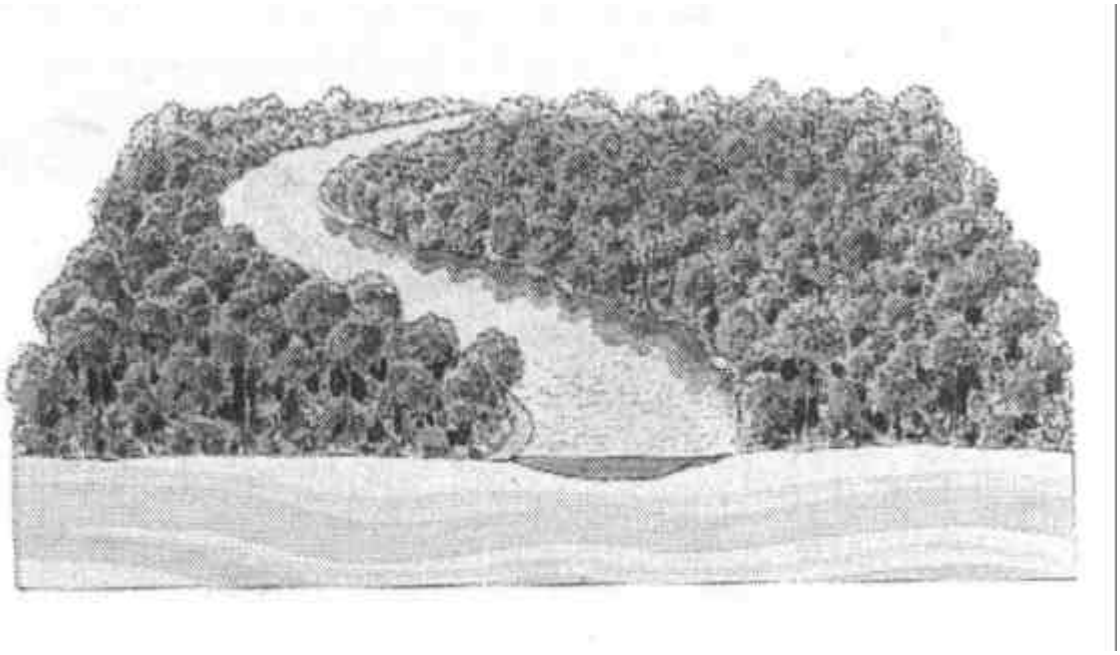
Social and Spiritual Development Strand
Social Science

Unit 1: Natural and Cultural Environments

Module 1.5: Resource Management



Student Support Material

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Unit outline

(Based on the National Curriculum Guidelines)

Unit 1 **Natural and Cultural Environments**	**1.1**	**Geography Skills (Core)**
	1.2	**Landuse and Settlement (Core)**
	1.3	**Environmental Issues (Core)**
	1.4	**Culture (Core)**
	1.5	**Resource Management (Optional)**

Icons

 Read or research

 Write or summarise

 Activity or discussion

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Module 1.5: Resource management

This module is content-based and fairly descriptive. It provides a brief outline of natural resources designed for students who did not study Geography in Grades 11 and 12. There may be some overlap with Science and Community Development modules. The most important part of the module is Sections 2 & 3 which examines the concept of sustainable development and the need for careful management of resources. Students will become increasingly aware that the use of natural resources depends on the way people perceive their needs, the economic and social structure of their society and the level of available technology.

Objectives

By the end of this module students will be able to:

- Identify the variety of natural resources and their influence on human development
- Develop concern for the protection and use of natural resources
- Describe the interrelationships between people and environments
- Understand the concept of renewable and non-renewable resources
- Consider the social and economic impact of resource development on individuals, communities and the nation
- Consider the environmental impact of resource development
- Recognise that resources are varied and determined by cultural values
- Identify the economic impact of resource development nationally and internationally
- Analyse the impact of different perspectives on resource development issues at local, national and global levels
- Form and express opinions about important issues relating to the use and development of resources
- Apply a range of skills such as observing, measuring and recording data, using data to explain, draw conclusions, and make predictions
- Recognise and discuss cause, effect and consequences

Topic 1: Natural Resources

Natural resources are those products and features of the earth that permit it to support life and satisfy people's needs. Land and water are natural resources. So are biological resources on the land and in the water, such as flowers, trees, birds, wild animals, and fish. Mineral resources include oil, coal, metals, stone, and sand. Other natural resources are air, sunshine, and climate. Natural resources are used to make:

- Food
- Fuel
- Raw materials for the production of finished goods

The wealth of a nation depends to an important degree on its natural resources. Most wealthy, or developed, countries--including Canada, Australia, and the United States--are rich in natural resources. However, some well-to-do nations, such as Denmark and Japan, have few resources. Developing countries generally have fewer resources, although some--like China, Indonesia, Papua New Guinea and Congo (Kinshasa)--have many natural resources.

Inexhaustible resources

Inexhaustible resources, such as sunlight and air, cannot be used up. Water is considered inexhaustible because the earth will always have the same amount of water. However, water supplies vary from one area to another, and some areas have shortages of clean, fresh water. The supplies of salt and some other minerals are so abundant that they are not likely to be used up.

Renewable resources

Renewable resources can be used and replaced. They include plants and animals, which reproduce and so replace themselves. In addition, because most renewable resources are living things, they interact with one another. Thus, the use of one renewable resource affects others. For example, the cutting down of trees affects other plants and many animals, as well as soil and water resources. Soil may be considered a renewable resource because crops can be grown on the same land for many years if the soil is cared for properly. However, if the soil is allowed to be washed or blown away, it can only be replaced over hundreds of years.

Nonrenewable resources

Nonrenewable resources are those that cannot be replaced or that can be replaced only over extremely long periods of time. Such resources include the fossil fuels (coal, petroleum, and natural gas) and the metallic and other ores. These resources take thousands or millions of years to form. Their supplies are being depleted faster than new supplies can form. Most nonrenewable resources can be stored for future use. Minerals are sometimes left in the ground to save them for the years ahead. Little interaction occurs among most nonrenewable resources, and so the use of one nonrenewable resource has little effect on another. For example, the mining of coal does not affect the supplies of silver or copper.

Recyclable resources

Recyclable resources, such as aluminium and copper, can be used more than once. For example, aluminium can be used to make containers and then be reprocessed and reused.

Mineral resources

Minerals are the most common solid material found on the earth. The earth's land and oceans all rest on a layer of rock made of minerals. All rocks found on the earth's surface also contain minerals. Even soil contains tiny pieces of minerals broken from rocks. Minerals include such common substances as rock salt and pencil "lead," and such rare ones as gold, silver, and gems. There are about 3,000 kinds of minerals, but only about 100 of them are common.

Mining is the process of taking mineral and other substances from the earth. These substances include metal compounds, non-minerals such as coal, sand, oil, and natural gas, and many other useful things. Some minerals can be mined more cheaply than others can because they are found at the earth's surface. Some minerals lie far beneath the surface, and can be removed only by digging deep underground. Other elements are found in oceans, lakes, and rivers.

There are many methods of mining. Each is based on where and how a mineral deposit is found in the earth. Minerals also vary in hardness and in the ease with which the mineral-bearing material called ore can be separated from the surrounding rocks. Some minerals occur in large bodies of water such as oceans and seas and are obtained by pumping. Today, most mines are highly mechanized. Hydraulically powered drills bore holes in the ore. Large machines dig and load the ore, and trains, trucks, and conveyors transport it. In underground mines, high-speed lifts called skips carry ore to the surface.

Surface mining methods are used when deposits occur at or near the surface of the earth. These methods include:

- Placer mining - a way of obtaining gold, platinum, tin, and other so-called heavy minerals from gravel and sand deposits - called placers - where nearby water supplies are plentiful. On a small scale, panning may be used to recover gold and other minerals from streams. On a larger scale, miners use sluicing.
- Dredging - used especially where mineral-bearing sand and gravel layers are exceptionally thick. In dredging, a pond or lake must be formed so that a large, barge-like machine called a dredge can be floated. An endless chain of buckets is attached to a boom (long beam) at the front end of the dredge. The buckets dip into the water when one end of the boom is lowered.
- Open-cast mining - used to recover valuable minerals from large, thick ore bodies (beds or veins of ore) lying close to the surface. First, the miners must remove the overburden - that is, the layer of rock and other material that covers the deposit. Then they use explosives to break up great masses of ore-bearing hard rock. The miners mine the deposit in a series of horizontal layers called benches. Miners build a road connecting the benches up the sides of the pit. Trucks or trains carry the ore up the road and out of the pit.
- Strip mining - a method of obtaining coal, phosphate, and other minerals that lie flat near the earth's surface. The ore is broken up with machines or explosives and then shovels or machines are used to load it into trucks or railway wagons.

- Quarrying - a way of mining a deposit that lies at the surface of the earth with little or no overburden. Such minerals as limestone, gypsum, and mica are produced from quarries. Sand and gravel used for making concrete, and large stones used for building are also mined in quarries. Miners have several methods of quarrying. Hard minerals are drilled or are blasted with explosives. Sand and gravel are simply shovelled onto trucks or trains and shipped. Building stones such as marble and granite are sold in natural blocks or pieces.

☞ 1.5 Activity 1

Strip mining has a bad reputation for causing great destruction in the mined areas. This is especially true in mountainous areas, where strip mining destroys vegetation on mountainsides and leads to mud slides and severe erosion of the land. Is this true in PNG? Discuss the problems caused by large-scale mines such as Ok Tedi and Panguna.

Underground mining methods are used when the mineral deposit lies deep beneath the earth's surface. First, the miners drive (dig) an opening into the mine. A vertical opening is called a shaft. A passage that is nearly horizontal, dug into the side of a hill or mountain, is called an adit. In coal mining, it is called a slope. From these main passages, miners dig systems of horizontal passages called levels. A wide variety of mining methods are available for removing the ore.

Pumping methods are used to recover minerals that occur in large bodies of water or that can be changed into liquid form. The waters of the ocean and of some lakes contain huge amounts of mineral elements. Miners often obtain them by pumping the water into plants where it is treated.

Mining in PNG

Papua New Guinea has a wide range of minerals, including gold, copper, and natural gas. Many of them are in rugged, mountainous areas that are difficult to mine but mining remains one of PNG's major industries. The first gold was found on Sudest Island in 1880. Prospecting and exploring continued from then on. The first large modern mine started producing income at Panguna in 1972. In 1992, well over a billion kinas worth of gold, copper/gold concentrate and silver was exported from PNG mines, two-fifths of all exports. Although the government insists on partial equity in most mines, ownership and control rests mainly with overseas interests such as BHP, CRA, Rio Tinto, Placer, Renison and Kennecott.

Excavating for mine infrastructure

Gold production

The receipts from mining, together with those from petroleum, constitute the bulk of PNG's export earnings (over 70%) and make up over 20% of GNP. Over the past twenty years, the government's income from this sector has derived from direct profits from its share holdings, together with licence fees charged and taxes payable by companies, employees and landowners who have received compensation payments.

Apart from the obvious financial benefits to PNG in generating foreign income, PNG's mining and petroleum projects play a major role in promoting education, training, services, employment and business opportunities to communities who live in remote locations that previously had little or no government services or economic activity.

The mining laws of PNG differentiate between the owners of the land and the owners of the mineral resources under the surface. The law says the State owns the minerals but must pay 'access fees' or compensation to the surface owners when it issues a mining license. In doing so the state must exercise control over the mining process, that is, regulate it, and it must at the same time extract revenue from it and distribute this to the people. However, according to customary law, the land and the minerals beneath it cannot be easily bought and sold, by the state or by anyone else. This conflict is the source of major difficulties for developers and investors.

☞ 1.5 Activity 2

Choose one of the following mine sites and provide details about – location, owners, what is mined, how it is mined, current status of the mine, landowner and/or other issues

Ok Tedi, Panguna, Lihir, Misima, Porgera

The ocean

The fishing industry is an important economic activity that provides food and jobs for millions of people. The fishing industry includes all the activities involved in the commercial and

recreational production of fish and shellfish. Catching, processing, marketing, and conservation of fish and shellfish are all parts of the industry. The industry also provides various other products from the sea, such as seaweed. Most of the world's fishing catch comes from sea fisheries. Species of cod, flatfish, herring, sardines, and tuna make up the world's most important fishery resources. Many governments practise fishery management to conserve fish. Rules limit the size and amount of fish that may be caught, and the fishing season.

Fish are an excellent source of protein, one of the chief nutrients (nourishing substances) that people need for a good diet. As the world's population has grown, so has the demand for food--especially food rich in protein. The fishing industry has increased its annual catch to help meet this demand.

During the early 1990's, the worldwide fish catch totalled about 98 million metric tons annually. In the early 1950's, the developing countries of the world accounted for little more than one-third of the total international fish catch. Since 1985, these countries have harvested more sea and inland fish than the industrial countries. After World War II ended in 1945, many countries expanded their fishing fleets. These fleets increased their fish catch along their home coasts as well as in distant waters. As a result, the fish harvest generally increased each year. At the same time, however, overfishing severely reduced the stocks of some kinds of fish. Disputes also arose among countries over the ownership of fish resources. Traditionally, fish have been considered common property--that is, no one owned them until they were caught. The fish then became the property of whoever caught them.

Who owns the ocean? This question became increasingly important as countries learned that fish and other ocean resources can be used up and that valuable minerals lie on and under the sea floor. Various United Nations committees worked to develop an agreement on ownership of the sea. Their efforts resulted in the Law of the Sea Treaty, drafted by a conference in 1982. The treaty went into effect in 1994, after more than 60 nations ratified it. The treaty calls for a system to protect the economic and environmental interests of coastal nations, while allowing the free passage of other countries' ships.

Under the treaty, the laws of a coastal nation apply throughout its territorial sea, which extends 12 nautical miles (22 kilometres) from the nation's shoreline. An exclusive economic zone (EEZ) extends, in most cases, 200 nautical miles (370 kilometres) beyond the nation's territorial sea. This means that each coastal nation, even if it is an island, has total control over resources and research within its EEZ. The remaining ocean area is defined as the high seas, where no nation may make a territorial claim. However, even on the high seas, various international agreements govern fishing methods and fishing catches.

Traditional and contemporary fishing and boating

The Law of the Sea also makes provisions concerning the resources of the sea floor. In particular, the treaty refers to the minerals, such as manganese, cobalt, copper, and nickel, that lie on or under the seabed. It states that mining operations should be supervised by an international seabed authority.

Fishing in PNG

PNG has 17000 kilometres of coastline and PNG waters are home to over 1500 species of fish. Coastal villagers still fish in traditional ways, catching fish for consumption, barter or a little cash income. As well, local fishermen power boats with outboard motors, fish at night, use small generators to run freezers and sell fish at markets and restaurants.

Industrial fishing is conducted off the coast of PNG by other nations under licence. This has meant that some Asian countries have become involved in fishing projects with PNG, especially the setting up of canning plants. However, tinned fish remains a major import- even on islands surrounded by fish. The other foreign groups interested in PNG's fish are tourists, divers, snorkellers and game fishermen. Diving and snorkelling is tremendously attractive, the water is clear and there is an abundance of reef, soft and hard corals as well as the hundreds of fish species.

Manus in fishing move (PC 22-11-99) Fisheries minister has thrown his support behind a K200 million long-line tuna-fishing project for Manus province. The project to be funded by the Sanko Busan Company of Japan in partnership with the provincial government, is estimated to create hundreds of job opportunities. The government's licensing agency – the National fisheries Authority – has yet to grant a license.	Madang company to begin barramundi sales (Nat 17-3-00) A company based in Madang, PNG Aquaculture, expects to commence supply of plate-sized Barramundi to hotels, resorts and restaurants beginning in May this year…PNG Aquaculture's success story began last October with the spawning of 1.5 million eggs and an initial production run of 100000 fish.
Fish pacts to earn K45 million (PC 2-3-00) Papua New Guinea expects to earn K45 million by the end of this year from vessels of South Korea and Taiwan that catch skipjack tuna and yellow fin in PNG waters.	Beche-de-mer ban remains (Nat 4-2-00) The national Fisheries Board has not lifted the ban on beche-de-mer harvesting in the waters of Western Province and PNG Torres Strait protected zone. The ban was imposed in view of 'critically low and unsustainable stock for further fishing'.
Tuna industry growth phenomenal: Authority (Nat 30-8-01) The number of PNG tuna operators has grown from 1 to 14 since Parliament passed its Domestication Policy in the fisheries in 1995. …The number of licensed boats has grown from 20 to 47, with two or three new licensees coming on board every year. The domestication policy forbids foreign operators from longline fishing, while Papua new Guinean are allowed to use both longline fishing and purse –seining fishing. Of the four types of fish caught PNG makes the most money from tuna.	Fisheries deals important for foreign relations (Nat 30-8-01) Fisheries access agreements are important for PNG's foreign relations with other countries, besides being a source of income for the country…Tuna fishing has become one of the fastest growing sectors of PNG's economy in the past five years. Although catches in recent years have not exceeded the recommended limits, there is evidence of decline in the yellowfin tuna population and concern over the status of Bigeye tuna stock in PNG waters.

☞ 1.5 Activity 3

Study the articles summarised in the table above and write a brief summary of current trends in PNG's fishing industry.

Forest resources

Forest is a large area of land covered with trees. But a forest is much more than just trees. It also includes smaller plants, such as mosses, shrubs, and wild flowers. In addition, many kinds of birds, insects, and other animals make their home in the forest. Millions upon millions of living things that can only be seen under a microscope also live in the forest. The living things and their environment together make up the forest ecosystem. The forest ecosystem is highly complicated. The trees and other green plants use sunlight to make their own food from the air and from water and minerals in the soil. The plants serve as food for certain animals. These animals, in turn, are eaten by other animals. After plants and animals die, their remains are broken down by bacteria and other organisms, such as protozoans and fungi. This process returns minerals to the soil, where they can again be used by green plants.

If the forest is wisely managed, it provides us with a continuous source of wood and other products. Before people began to clear the forests for farms and cities, great stretches of forestland covered about 60 per cent of the earth's land area. Today, forests occupy only about 25 per cent of the land.

A typical forest landscape – but what is it being used for?

The largest rainforests are in South and Central America, central Africa, and Southeast Asia. In many countries in these regions, the rainforest is being systematically destroyed in order to satisfy worldwide demand for timber or to clear land for farms and cities. In the late 1980's, tropical rainforests covered about 10 million square kilometres. About 100,000 square kilometres of rainforests are destroyed each year.

Commercial logging (cutting down trees for timber) causes tremendous environmental damage. Cutting down the larger trees often also brings down the smaller trees and the heavy machinery used tears up vegetation.

Fossil fuels (oil, gas, petroleum)

Gas (fuel) is one of our most important resources. We burn it to provide heat and to produce energy to run machinery. The chemical industry uses the chemicals in gas to make detergents, drugs, plastics, and many other products. There are two kinds of gas--natural gas and manufactured gas. A large proportion of gas used in the world is natural gas. Most scientists believe that natural gas has been forming beneath the earth's surface for hundreds of millions of years. The natural forces that created gas also created petroleum. As a result, natural gas is often found with or near oil deposits. The same methods are used to explore and drill into the earth for both fuels. Manufactured gas is produced chiefly from coal or petroleum, using heat and chemical processes.

Before its break-up, the Soviet Union was the leading producer of natural gas. The United States was the second largest producer. Until the 1960's, large quantities of natural gas were not available in most European countries, and manufactured gas was used widely. During the 1960's, the development of newly discovered gas fields led to the rapid expansion of Europe's natural gas industry. Expansion was especially rapid in the Soviet Union and the Netherlands. The world's largest known gas field was discovered in the Soviet Union in 1966. The United Kingdom also began to produce much natural gas from deposits that were found under the North Sea in the mid-1960's.

The gas industry consists of three main activities: (1) producing gas, either by drilling natural gas wells or by manufacturing gas; (2) transmitting gas, usually by pipeline, to large market areas; and (3) distributing gas to the user. Each part of the gas industry requires its own special skills and equipment. Some gas companies conduct all three activities, but most companies handle only one.

Petroleum industry in PNG

Oil exploration equipment

Gobe pipeline

Unlike gold, the presence of oil had been known to some traditional societies prior to its discovery by twentieth century oil explorers. In 1987, Chevron Niugini discovered oil near Lake Kutubu in Southern Highlands Province. The first production of oil was in 1992. By 1993, oil accounted for one-third of total exports and one-eighth of total government revenue. Further discoveries in the area included natural gas deposits at Hides and oil at Gobe.

Hides gas field

Concern over the mining industry's future in PNG

The sustainability of the mining industry beyond Year 2012 is in jeopardy. The mining operations we see today are the result of many years of exploration in a much more favourable investment climate that existed then, compared to the one that exists now.

If the government wants to continue to develop other sectors of the economy such as agriculture and fisheries to become viable sources of revenue for the future, it needs the mining sector to continue to provide the main revenue to do this.

If no new mines come into operation in the next ten (10) years, then Papua New Guinea will be left with only Lihir Mine operating. All other existing mines, OK Tedi, Porgera, Misima and Tolukuma would have been wound up and closed by the year 2012. Therefore, the creation an attractive investment climate is urgently needed to bring in more companies to do grassroots and advanced exploration in the country. Exploration for metals in PNG has been on a downward trend since the late 1980's and is getting worse, with expenditures falling from US$26.78 million in 1999 to US$14.98 million in the year 2000-1.

Papua New Guinea's foreign exchange earnings in the year 2000 from mining was K2.55 billion out of the total K5.6 billion of merchandise exports. This represents 46% of the total value of exports in the year 2000. This is a significant contribution to country's foreign exchange earnings. Therefore, it is essential that this significant industry must be sustained if Papua New Guinea is to maintain and increase the level of income generated from this sector in the years to come.

(*Post Courier* 31 May 2001)

Project to score several firsts

THE proposed world class Ramu Nickel/cobalt project is based on the extraction of low cost nickel and cobalt from a large area of 'wet tropical" laterite located in the Madang province. The deposit is located in the foothills of the Bismarck Ranges, with relatively easy access to the coast. Mine ore will be slurried from the mine site, a distance of 140 kilometres, to a refinery site located at Basamuk Bay on the Rai Coast. Finished product will be exported through a new deep-water wharf facility, which will be constructed as part of the project's development.

The project is operated and managed by Highlands Pacific (65 per cent) in joint venture with Nord Pacific (35 per cent). The Ramu project will be Papua New Guinea's first nickel and cobalt mine and the first time that full downstream processing of ore will take place within the country. End product will be pure metal products that are saleable direct to international markets.

When compared to other base metal projects in PNG, this value-added component will make a significant additional contribution to the nation's export earnings. It is estimated that the project will increase the value of PNG exports by 15 per cent. The project will benefit the national, provincial and local economies of the country through royalties, direct and indirect taxation, improvements in the nation's balance of trade, infrastructure development, commerce, employment and educational opportunities.

The project will produce 32,800 tonnes per annum of high-grade nickel and 3,200 tonnes per annum of cobalt. A production life of 20 years has been adopted in the feasibility study, but it is expected that the known mineral resource will support a mine life of 40 years. In addition, there is significant potential to substantially extend the overall life of the project, by further exploring in areas of known mineralisation in the vicinity of Kurumbukari.

The project is engineered to minimise environmental and social impact during its construction and operation, and incorporates progressive rehabilitation of the mine site throughout its operation. Ramu ore will be mined and beneficiated at Kurumbukari before being transported by pipeline to the refinery at Basamuk Bay. Infrastructure developed to support the refinery will include a power plant, an acid plant and a dedicated wharf to be used to import consumable and export product to world markets.

(*The National* 27 Oct 1999)

☞ 1.5 Activity 4

Trace the development of one resource company, for example, Chevron Niugini.

How and why have attitudes towards the mining industry changed in PNG in the last five years?

Brainstorm the various groups/organisations affected by mining developments and production. Select four groups from your list and identify the advantages and disadvantages of mining for each group.

Topic 2: Sustainable Development

Sustainable development is "economic and social development that meets the needs of the current generation without undermining the ability of future generations to meet their own needs". This definition was produced in 1987 by the World Commission on Environment and Development (WCED), otherwise known as the Brundtland Commission.

The first global meeting on this issue, the U.N. Conference on the Human Environment in 1972, focused mainly on the environmental issues, such as pollution and waste, that were most obvious in the wealthy nations, and associated with industrial development and a rapid growth in consumption. Although the need to combine development and environment goals was becoming evident, more emphasis was placed on the "limits to growth" arising from shortages in resources such as metals and fossil fuels.

But it was the World Conservation Strategy of 1980 that launched sustainable development as international policy, stressing the importance of integrating environmental protection and conservation values into the development process. This was followed by the UN Conference on Environment and Development (UNCED), otherwise known as the Earth Summit, in Rio de Janeiro in 1992. This conference approved a set of five agreements:

- *Agenda 21*—a global plan of action for sustainable development, containing over 100 program areas, ranging from trade and environment, through agriculture and desertification, to capacity building and technology transfer.
- *The Rio Declaration on Environment and Development*—a statement of 27 key principles to guide the integration of environment and development policies (including the polluter pays, prevention, and precautionary and participation principles).
- *The Statement of Principles on Forests*—the first global consensus on the management, conservation, and sustainable development of the world's forests.
- *The Framework Convention on Climate Change*—a legally binding agreement to stabilize greenhouse gases in the atmosphere at levels that will not upset the global climate.
- *The Convention on Biological Diversity*—a legally binding agreement to conserve the world's genetic, species, and ecosystem diversity and share the benefits of its use in a fair and equitable way.

Sustainable development is an interdisciplinary concept, drawing on the social and physical sciences as well as law, management, and politics. Meeting human needs forms the basis of sustainable development. A commitment to meet the needs of present and future generations has various implications. "Meeting the needs of the present" means satisfying:

- *Economic needs*—including access to an adequate livelihood or productive assets; also economic security when unemployed, ill, disabled or otherwise unable to secure a livelihood.
- *Social, cultural, and health needs*—including a shelter which is healthy, safe, affordable, and secure, within a community with provision for piped water, drainage, transport, health care, education, child development, and protection from environmental hazards. Services must meet the specific needs of children and of adults

responsible for children (mostly women). Achieving this implies a more equitable distribution of income between nations and, in most cases, within nations.

- *Political needs*—including freedom to participate in national and local politics and in decisions regarding the management and development of one's home and community, within a broader framework that ensures respect for civil and political rights and the implementation of environmental legislation.

Meeting such needs "without undermining the ability of future generations to meet their own needs" means:

- *Minimizing use or waste of non-renewable resources*—including minimizing the consumption of fossil fuels and substituting with renewable sources where feasible. Also, minimizing the waste of scarce mineral resources (by reducing use, reusing, recycling, and reclaiming).
- *Sustainable use of renewable resources*—including using freshwater, soils, and forests in ways that ensure a natural rate of recharge.
- *Keeping within the absorptive capacity of local and global sinks for wastes*—including the capacity of rivers to break down biodegradable wastes as well as the capacity of global environmental systems, such as climate, to absorb greenhouse gases.

At present, this rarely happens. There are a number of downward trends, which are moving away from, rather than towards, sustainability. Market failures, where economic transactions fail to take account of social or environmental costs; and policy failures, where governments inadvertently encourage environmental degradation, for example by subsidizing energy and water use, have contributed to the 'failure' of sustainable development. The issue is therefore not one of whether governments should intervene to steer development towards sustainability, but how.

There is a growing consensus that sustainable development means achieving a quality of life that can be maintained for many generations because it is:

- *Socially desirable*—fulfilling people's cultural, material, and spiritual needs in equitable ways.
- *Economically viable*—paying for itself, with costs not exceeding income.
- *Ecologically sustainable*—maintaining the long-term viability of supporting ecosystems.

Governments will have to negotiate trade-offs between objectives where integration is not possible. These negotiations will be greatly influenced by factors such as peace and security, prevailing economic interests, political systems, institutional arrangements, and cultural norms. There is no blueprint for sustainable development. It needs to be defined to meet and respect the particular needs and circumstances of individual countries, societies, and cultures. Decision-makers are now becoming aware that environmental goals can only be achieved by integrating them into mainstream social and economic policy-making. Critical to this process is the recognition that different perspectives on environment and development are both inevitable and legitimate. There could be, for example, very different environmental priorities between aid donors, recipient governments, and the poor of developing countries. National governments are responsible for providing the conditions which both permit and facilitate the necessary dialogue and negotiation between all sectors and interest groups in society.

Topic 3: Resource Management

Resource damage

Although the conservation of natural resources has been recognized as desirable by many peoples since ancient times, frequently the basic principles of sound land use have been ignored, with disastrous results. Major losses—for example, the silting of rivers and the flooding of lowlands—resulted from the destruction of the forests and grasslands that protected watersheds in northern China and the Tigris-Euphrates area. Large areas in North Africa and the Middle East were rendered barren by centuries of uncontrolled livestock grazing, unwise cultivation, and excessive cutting of woody plants for fuel. Similar damage has also occurred in most of the more recently developed regions of the world, sometimes through the unwise introduction of species into new environments. The increasing industrialization of nations around the world continues to present severe conservation problems although international cooperation efforts have also evolved in certain areas, such as the protection of some endangered species.

Conservation and development

Conservation is the management, protection, and wise use of natural resources. The earth has limited supplies of many natural resources. However, our use of these resources keeps increasing as the population grows and our standard of living rises. Without conservation, most of the earth's resources would be wasted, degraded, or destroyed

One of the most difficult challenges of conservation is to reconcile two, sometimes conflicting, goals —

1. To protect the environment and
2. To maintain or increase agricultural and industrial production.

For example, the agricultural use of some chemical fertilizers and pesticides pollutes the environment but also greatly increases crop yields. Thus, most farmers do not want to stop using these chemicals. To solve such problems, new management approaches are required. The difficult goals of conservation can be achieved only through the combined efforts of many people. Business leaders, government officials, scientists, and individual citizens must all work together to conserve natural resources.

Preserving the delicate balance of nature in biological resources appears to be the most difficult and important part of saving our natural resources. People have often upset this balance.

- Poor farming methods have ruined much farmland and left it barren
- Millions of metric tons of fertile topsoil that could produce good crops are washed away by rains each year
- Chemicals sprayed on crops and washed off by rain end up in rivers and streams, killing the fish in the streams

- Entire species of birds and animals have been killed off by hunters
- The world's great forests are diminishing as a result of logging and clearing
- The loss of the rainforest threatens the world's atmosphere and climate
- Fumes from cars and trucks and smoke from factories poison the air
- Air pollution in many cities kills trees and endangers human health

Resource management

From 1650 to 1850, the world population doubled. Since 1850, it has more than quadrupled. Today, the world has about 6 billion people. Although the rate of growth is slowing, by 2050 the world is expected to have almost 10 billion people. Such a large increase in the population will result in even greater demands for natural resources. More land will be needed for living space and for growing food. More fuel and fresh water will be required.

The rise in the standard of living in industrialized nations has created further demands for natural resources. In addition, many developing nations are working to raise their living standards and are increasing their demands for resources. The high living standards in many nations are supported largely by the growth of industry. Industry uses huge amounts of fuel and other resources, and it depends on continuous supplies of these resources.

In many cases, meeting demands for one resource makes it difficult to conserve another. The same land that is needed to produce food, wood, or fuel is often valued for its wildlife, recreational opportunities, or beautiful scenery. For example, the construction of a dam may provide water to irrigate farmland or to produce electric power, but it may also destroy scenic lands and wildlife habitats. Prairies, wetlands, forests, and other natural environments provide homes for many kinds of wildlife, contributing to the ecological diversity of the earth. If such environments are not preserved, large areas will consist of monocultures, environments that support only a few species of plants and animals.

Each kind of conservation has different problems and solutions. In many cases, however, the management of one resource affects several other resources. For example, the conservation of forests helps conserve water, soil, and wildlife resources. Forests absorb rain water and so keep it from running off the land too rapidly. They thus help prevent rain water from washing away the soil. Forests also provide homes for wildlife.

Managing water

The demand for water is constantly increasing as a result of population growth and the expansion of agriculture and industry. The earth has an abundant supply of water, but the water is unevenly distributed. Some areas do not receive enough rainfall, while others receive more than they need. Many dry regions face serious water shortages. In some areas, people have drilled so many wells to provide water for irrigation that the level of the ground water has been greatly lowered.

Some rural areas and cities obtain water by damming rivers to create reservoirs. Dams are also built to control flooding. However, in many cases, the construction of new dams to meet ever-increasing demands for water or to reduce flooding threatens wildlife. A dam may harm certain fish because it changes the flow of a river and causes less water to travel downstream. As the land behind a dam becomes flooded, some wildlife habitats are destroyed.

Water supplies for cities and farms can be increased partly through watershed management (the management of vegetation to prevent rapid runoff of rain water). Trees and other plants play an important part in the natural cycle of water. They keep water from running off the land and so allow it to filter into the ground. Underground supplies are thus refilled, and the water flows through underground channels into lakes and streams. When the plant cover is destroyed, this natural cycle is disturbed. Rain water runs off the land rapidly instead of filtering into the ground. Watershed management not only conserves water but also helps reduce flooding and soil erosion.

On a global scale, 25,000 people die each day as a result of poor water quality. Some 1.7 billion people, more than one third of the world's population, are without a safe water supply. An estimated quarter of the world suffers from chronic water shortages. The problem of water is more a case of distribution and quality than one of quantity.

Testing water quality

Enjoying water scenery

The development and efficient management of water resources is a priority concern in the Middle East, Africa, Asia, and the Pacific. Water supply in the rapidly urbanizing regions of Latin America, Asia, and Africa is also an issue, particularly with regard to serving the growing squatter settlements and other low-income urban communities.

The Water Resources Act 1982 (PNG)

The Water Resources Management (WRM) Branch located within the Environment Division of the Office of Environment and Conservation administers the Water Resources Act (Ch.205) of 1982.

The roles and functions of the WRM are stipulated in the Act. Under the Act the right to use, flow and control of water is vested in the state.

The WRM branch has been given the mandate by the National Executive Council to protect all water in the country, including underground water, surface streams, lakes, swamps and coastal waters.

Every person and organization using water is bound by the Act including government departments. Only customary users are exempted from the ACT.

Annual charges are made for all types of water use except recreation uses such as swimming and boating. The fee depends primarily on the volume of water used, or waste discharged to natural watercourses.
Water use permits serve as management tools. Permits must be obtained for the licensing of water uses such as

- Taking of water for consumption and domestic use
- Damming of natural water courses
- Diversion or otherwise interfering with natural water flow
- Waste disposal into water bodies.

☞ 1.5 Activity 5

Identify the main sources of water in your region. What problems are there in terms of town and village water supplies?

Take samples from three water sources and test the quality – colour, taste, and smell.

Write a report describing what you discovered.

Forest management

The conservation of forests that are used to produce timber depends on replacing trees that are cut down so that the forest has a sustained yield. Sustained yield is an approximate balance between the annual harvest and the annual growth of wood. In some places, such as North America, forest destruction has been slowed. However, in many other regions, especially those in tropical areas, forest destruction continues at a rapid pace.

Where tracts of virgin forest are given over to timber production, principles of management have evolved in order to minimize the destructiveness of the process and to make it as sustainable as possible. The management of forest trees for timber production involves three fundamental principles.

- The first is protection of the growing trees from fire, insects, and disease. However, fire, once regarded as a destroyer of forests, is now recognized as a management tool when carefully employed. Some important timber trees actually require fire for successful regeneration. Insects, such as the gypsy moth, spruce budworm, and pine sawfly, and disease, still take a heavy toll. However, biological control measures and some aerial spraying, proper cutting cycles, and slash disposal are increasingly effective.
- The second principle concerns proper harvesting methods, ranging from removal of all trees (clear-cutting) to removal of selected mature trees (selection cutting), and provision for reproduction, either naturally from seed trees or artificially by planting. The rate and frequency of any cutting should aim for sustained production over an indefinite period.
- The third principle of timber management is complete use of all trees harvested. Technological advances, such as particleboard and gluing, have created uses for branches, defective logs, trees too small to be milled into boards, and so-called

inferior trees. As demand for wilderness areas and recreational use of forests increases, management of commercial forests will become more intense.

Forest management encompasses various activities of planning, operations, and monitoring:

- Site quality assessment
- Forest stock and growth measurement
- Forest plan preparation
- Road and infrastructure provision
- Soil and water management to prepare and improve the site
- Silviculture (the tending of woodland) to alter the forest stock characteristics (tending, thinning out, felling, regenerating, or planting trees, and fertilization, to result in stands of desired species, age, and size composition)
- Harvesting operations
- Yield control measures to keep outputs at sustained levels
- Protection from pests, diseases, fire, and extreme climatic events

Logs collected from forest

Logs processed into timber

In Europe and North America, most forests are managed. However, in developing countries, relatively few forests are formally managed. Much tropical timber production still derives from natural forest. Selective logging has been attempted but in most places this has been sporadic.

Many timber production forests are now also in demand for other goods and services. The emphasis is not only on timber yield but also on broader sustainable forest management. This may include several of:

- Harvests of timber, fruits, fungi, medicinal plants, and animals
- Soil and water conservation
- Biodiversity conservation
- Recreation
- Landscape amenity

In addition, sustainable forest management entails balancing today's needs with those of future generations.

In many countries, the roles of different forest users are under reassessment. Government forestry departments are looking for ways of sharing the rights and responsibilities for forest management. Where government resources are limited, and where local people have a particular dependence on forests, forms of joint forest management are being developed.

Mangroves

Mangroves form the main vegetation along stretches of tropical coasts. Large mangrove thickets, or forests on stilts, often grow in shallow waters along bays, lagoons, and river mouths. The thousands of roots catch silt (mud deposits) which piles up in the water. At the mouths of streams, the roots slow down the current and help settle the silt. Thus, mangroves may aid in building up dry land. The roots also form a breeding place for many fish and other marine life. In some places, the trees are no bigger than bushes. In other places, they grow between 30 and 40 metres high. Mangrove wood is used by people for building and fuel. Mangrove leaves are used as thatch and the bark is used to tan leather (which it dyes bright red). Cellulose from mangrove wood is used to make rayon, a synthetic material. The wood is also used to make paper. Mangrove forests are important to fishermen as a breeding place for many fish.

Mangrove forests are being:

- Cut down for their wood and woodchips
- Damaged by pollution, especially oil.
- Destroyed to build houses and canals industry
- Cleared for rice cultivation.
- Smothered by the refuse from mining activities

☞ 1.5 Activity 6 – field study

Examine an area of mangrove forest or rainforest. Sit still for a while and make a list of the living creatures you see. Make a second list of signs of usage by people. Make a third list of evidence of pollution.

Talk to elderly people in the area to identify what changes have taken place in the forest you studied.

The mining industry

The use of many minerals has increased greatly throughout the world. Some minerals, such as bauxite (the mineral from which aluminium is obtained) and salt, are plentiful. However, the proved reserves of other minerals such as copper, lead, nickel, and zinc may be depleted within 100 years. The mining and refining of minerals often results in destruction of scenic lands and wildlife habitats, and in air and water pollution.

Most minerals can be profitably mined only where they occur in large deposits. Industries first develop the highest-grade and most easily minable ores. When these are depleted, lower-grade and harder-to-mine ores are then developed. Many of these deposits can only be mined with advanced technology and large amounts of energy. Some deposits require so much energy to mine and refine that they cannot be profitably developed.

Deposits of minerals are unevenly distributed throughout the world and the need for minerals continues to influence international relations. Many countries must import large amounts of various minerals.

Minerals can be conserved in a number of ways. Industries can reduce waste by using more efficient mining and processing methods. In some cases, industries can substitute plentiful materials for scarce ones. Some mineral products can be recycled. Although bauxite is plentiful, it can be expensive to refine. Recycling aluminium products does not require the large amounts of electricity needed to refine bauxite. Products made from many other minerals, such as nickel, chromium, lead, copper, and zinc, can also be recycled.

Managing energy resources and fossil fuels

About 95 per cent of the energy used throughout the world comes from oil, coal, and natural gas. These substances are called fossil fuels because they developed from fossilized remains of prehistoric plants and animals. Large deposits of fossil fuels take millions of years to form. The earth has a limited supply of fossil fuels. However, the worldwide use of fossil fuels has nearly doubled every 20 years since 1900. As the supply dwindles, the cost of fossil fuels keeps rising.

Many nations are working to develop other sources of energy to reduce their dependence on fossil fuels. However, every source of energy has some disadvantages that make its development difficult. Until other sources of energy are further developed, nations must conserve fossil fuels to make the supply last as long as possible. Most of the responsibility for conservation rests with industrialized nations because they consume the majority of the world's energy.

The development and use of energy causes many environmental problems. For example, strip mining of coal destroys plant life and exposes the land to erosion. Blowouts of offshore oil wells and leaks from tankers produce oil spills that pollute the oceans. The burning of fossil fuels pollutes the air and results in the formation of acid rain, which can kill fish in lakes and streams.

☞ 1.5 Activity 7

Brainstorm the ways in which individuals, communities, industries and governments can conserve energy.

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