GGH1502

World Issues: A Geographical Perspective

MO001/2018

Semesters 1 & 2

Department of Geography

IMPORTANT INFORMATION:
This document contains important information about your study material.
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LEARNING UNITS

LEARNING UNIT 0

0.1 INTRODUCTION

Geography is the study of the spatial distribution of phenomena on the earth's surface and the interaction between people and their environment. The "environment" includes the totality that surrounds people – both the natural and the human environments. Geography is a human science with humankind as the central point of reference. This is why geographers limit their studies to the human-environment system – that section of the earth that constitutes the home of humankind. Geographers do not study all aspects of the environment, but limit their study to a specific group of interconnected facts. Geography is one of the few scientific disciplines in which the relationship between people and their environment is the primary focus. The geographer's interest in how things on earth are arranged or organised spatially and how they are connected in space and time gives us a useful platform for studying environmental change caused by people.

Knowledge of the causes, consequences, and distribution patterns of current world issues is particularly enriching for anyone who regards him or herself as a responsible world citizen. We trust that you will find the study matter in this module interesting and stimulating and that, with the knowledge that you acquire, you will perhaps be able to contribute to finding solutions to the distressing issues confronting us as citizens of the globe.

We trust that you have already received and studied Tutorial Letter 101 to familiarise yourself with the content and structure of module GGH1502. The MO001 comprises of 13 learning units that correspond to the chapters in your prescribed book by Middleton (2013). Every learning unit is based on a chapter of the prescribed book. I suggest that you systematically work through this MO001 and complete all the activities given to you. Doing so will help you to understand the content. You cannot do the course without the prescribed book. The purpose of the MO001 is to help you work through the prescribed book.

0.2 PRESCRIBED BOOK

The material in each learning unit corresponds to the learning outcomes and is based on the prescribed book. The prescribed book is Middleton, N. 2013. The global casino: An introduction to environmental issues. 5th edition. London: Routledge. The material is divided into different sections, each with its own heading. In order to simplify things for you, the headings are identical to those in the prescribed book. Begin each learning unit by reading the introduction and the learning outcomes. Learning outcomes state the skills and knowledge that you will be expected to demonstrate. Once you have reached these learning outcomes, you will have mastered the material in the learning unit. Now, systematically study the relevant sections in the prescribed book together with the MO001.

The following subheadings will guide you through the study material:

Reading activity

The chapter and the specific sections you need to study are indicated under this subheading.
Reading organiser

The reading organiser is a "planning tool" to help you summarise the material in the different sections of the prescribed book. The purpose is to highlight the essence of the specific section you had to read. The length of the discussions depends on the depth to which the topic is discussed in the prescribed book and the difficulty of the material.

Textbook activity

At the end of sections of study material you are given textbook activities which refer to specific sections in the prescribed book. Ensure that you do each activity before you proceed with the next section of the study material.

Did you know?

The "Did you know?" sections contextualise the content of each learning unit and include interesting information, which is for noting only and which you are not expected to learn.

Cartoon

Most of the cartoons illustrate the paradox or irony of environmental issues. The messages of the cartoons are meant to demonstrate the different views on and reasons for environmental degradation.

Sources to consult:

A list of sources you need to consult appears at the beginning of each learning unit, and consists of the following:

- **DVD:** As you progress through the study material, you will be instructed to watch a specific clip relating to the particular learning unit. The DVD is divided into clips. The number of the clip that you need to watch, is indicated in each learning unit under the heading "Sources to consult".
- **Atlas:** An atlas is essential to enable you to reach some of the learning outcomes of this module. Refer to Tutorial Letter 101 for more information. Use your atlas to find out where all the places, countries and phenomena you are learning about are located.
- **PowerPoint:** A PowerPoint presentation contains a synopsis of the whole learning unit. It can assist you with revision. It is available under additional resources on myUnisa.
- **Satellite image:** Satellite images enable you to see how resources have changed on both spatial (place/extent) and temporal (time) scales. The satellite images are available under additional resources on myUnisa.
- **YouTube videos:** It is available under additional resources on myUnisa.
LEARNING UNIT 1: THE PHYSICAL ENVIRONMENT

Did you know?

Our world can be divided into eight distinct biomes. Biomes, a term coined in 1967 by pioneer environmentalist Dr Dietrich Malinger, are ecological "districts" that have a distinct climate and topography. Not only does each biome look and feel different; each biome is also the habitat of a distinct set of plant and animal life.

The balance between organisms within a biome is very fragile and is easily disrupted. A meteorite impact is an extreme way of destroying a biome, but destruction of biomes is also continuously occurring as the result of human activities and occupation.

Sources to consult:

- **DVD:** Clips 1 & 2
- **Podcast:** 1 Biomes
- **Atlas:** World map on natural vegetation, annual rainfall, average temperature, morpho-climatic regions (biomes)
- **Prescribed book:** Chapter 1, "The physical environment", on pages 1–23 in Middleton
- **Additional Resources on myUnisa:** PowerPoint and a YouTube video

1.1 INTRODUCTION

Climate is the reason why one area of the world is a desert, another a grassland, and a third a rainforest. Climate is the characteristic condition of the atmosphere near the earth's surface at a certain place on earth. Two of the most important factors determining an area's climate are air temperature and precipitation. World biomes are controlled by climate. The climate of a region will determine what plants will grow where and which
animals will inhabit it. All three components, namely climate, plants, and animals, are interwoven to create the fabric of a biome (Strahler & Strahler 2006).

A biome is a large geographical area of distinctive plant and animal groups that are adapted to that particular environment. The climate and geography of a region determine what type of biome can exist in that region. Major biomes include deserts, forests, grasslands, tundra, and several types of aquatic environments. Each biome consists of many ecosystems, the communities of which have adapted to the small differences in climate and the environment of that biome.

All living things are closely related to their environment. Any change in one part of an environment, such as an increase or decrease of a plant or animal species, causes a ripple effect of change in other parts of the environment.

The earth includes a huge variety of living things, from complex plants and animals to very simple, one-celled organisms. However large or small, simple or complex, no organism can live alone. Each depends, in some way, on other living and non-living things in its surroundings.

1.2 LEARNING OUTCOMES

After completing this learning unit, you should be able to

- distinguish between the four spheres as described
- indicate the relationship between climate, location, amount of solar radiation and vegetation
- distinguish between the eight biomes on earth, and describe and indicate each on a world map
- distinguish between the different time scales and spatial scales that geographers use in their study of the natural environment

1.3 CLASSIFYING THE NATURAL WORLD

Reading activity

Study the section “Classifying the natural world” on pages 1–8 in Middleton.

Reading organiser

- The natural world of the human environment can be divided into the following four subsystems:
  - the lithosphere
  - the atmosphere
  - the hydrosphere
  - the biosphere
- Geographers do not study the individual aspects of these subsystems; the emphasis falls rather on the interaction between people and phenomena within these subsystems, and on the way in which interactions vary in space and over time.
- People and their activities have influenced all these subsystems over time, just as aspects of the natural subsystems have influenced human activities.
- There is a dynamic interaction between the four natural subsystems of the human environment.
- The atmosphere surrounding the earth is a mixture of gases that extends to a height of approximately 480 km above the earth’s surface.
• The hydrosphere is the water realm of the earth and includes the following:
  o oceans
  o surface water (in lakes, rivers and streams)
  o groundwater (in soil and rocks)
  o water vapour (in the atmosphere)
  o ice
• The solid outer section of the earth's crust is known as the lithosphere. Weathering occurs where the lithosphere is exposed to the atmosphere. This gives rise to the formation of soil, which, together with oxygen and water, is fundamental to life on earth.
• The atmosphere, lithosphere and hydrosphere function together to create the environment of the biosphere.
• The biosphere embraces all living organisms on earth, including humankind, and extends from the depths of the ocean right up to the lower layers of the atmosphere.
• Ecology is the study of the relationships and interactions between living organisms as well as those between the organisms and their natural environment.
• The environment and the collection of living organisms on earth (in the biosphere) that interact with one another and with their non-living environment, can be described as the ecosphere.
• From a biological viewpoint, ecosystems are regarded as the result of the relationships and interactions between biotic (living) and abiotic (non-living) components.
• There is a delicate balance between the different components in an ecosystem, and a disturbance in one of these components affects the others.
• There are eight biomes described by ecologists, each with specific characteristics and each occurring in specific parts of the world.
• Certain criteria are applied to differentiate between morpho-climatic regions on a global scale.
• How does geographic location determine biome type?
• How does the amount of solar radiation determine biome type?
• How do temperature range and amount of precipitation influence a biome?

Textbook activity

• With the aid of appropriate examples, distinguish between the four subsystems of the natural environment.
• Explain what an ecosystem is.
• Indicate what a morpho-climatic region is, and what criteria are used to differentiate between various types of regions on a global scale. Describe the characteristics of each of the eight biomes or morpho-climatic regions distinguished on pages 3–8 in Middleton.

1.4 TIME AND SPATIAL SCALES

Reading activity

Study the sections "Timescales", "Spatial scales" and "Time and space scales" on pages 12–19 in Middleton.
Reading organiser

- Our knowledge and perception of the influence of humans on the natural environment vary depending on the period and the spatial extent according to which we measure it.
- Time scales range from the geological time scale, which is measured in millions of years, to human time, which is measured in days, years and decades.
- The effects of human activities on the natural environment and environmental change manifest differently according to the time scale that is used.
- In a study of environmental change, choosing a suitable spatial scale is just as important as choosing an appropriate time scale.
- Spatial scales range from the microscopic to the macro level of the world.
- Humans are the central point of reference in geography, therefore geographers focus their studies on spatial and time scales that are significant to humans.

Textbook activity

- How old is the earth, and how long have modern humans (homo sapiens) been living on earth?
- "Although natural processes have changed the earth over thousands and millions of years, some of these processes have had a drastic and immediate effect on people and their environment." Explain what this statement means.
- Explain what the dynamic equilibrium in a natural system means. Give appropriate examples to explain the concept of feedback, and to illustrate the distinction between positive and negative feedback.
- With the aid of an appropriate example, explain what a threshold in the natural environment is. What effect does time lag have on exceeding a threshold?
- Study the five typical changes in figure 1.11 on page 16 in Middleton.
- What type of change to the ecosystem do you think the following events or conditions would bring about?
  - a nuclear bomb explosion that destroys everything within a radius of 50 km; exposes people, animals and plants over a large area to serious nuclear radiation and eradicates certain plant and animal species
  - serious droughts that ravage the southern parts of the African continent every nine years
  - a volcanic eruption
  - the continuous burning of fossil fuels, resulting in a gradual rise in the concentration of carbon dioxide in the atmosphere
  - the total deforestation of an area of 1,000 square kilometres in the tropical rain forests of Africa
  - the extinction of the dominant species in an ecosystem
  - veld fires in the Kruger National Park started by lightning every few years
  - veld fires that are started at least once a year along major highways as a result of people’s negligence
  - the wrecking of an oil tanker, causing many kilometres of the coastline to be covered in a layer of crude oil
- Give appropriate examples to illustrate how the significance of human impacts on the environment decreases as the spatial scale increases.

1.5 CONCLUSION

Knowledge of the composition and functioning of the subsystems of the natural environment alone is not sufficient for an understanding of global environmental problems.
from a geographical perspective. The geographer's field of study is the human environment, and therefore people's interaction with both the natural and the human environments. We should, therefore, also investigate the components and the functioning of the human environment.
LEARNING UNIT 2: THE HUMAN ENVIRONMENT

Did you know?

“Since 1950, the richest fifth of humanity has doubled its consumption of energy, meat, timber, steel and copper per person and quadrupled its car ownership, while the poorest fifth of humanity has increased its general consumption hardly at all. Since 1972, the main driving force leading to pressure on land and water resources has been an increase in food production. In 2008, some 2.5 billion more people needed food than in 1972. The trend in recent years has shown population growth drawing ahead of food production in some regions of the world, particularly Africa. Some commentators believe that China may soon become a major food importer.

In 2006, the Food and Agriculture Organization (FAO) estimated there are still 820 million hungry people in developing countries – 20 million more than in 1996. In addition, there are 25 million hungry people living in transition countries and another 9 million in industrialised countries, bringing the total number of malnourished people in the world to 854 million.

Humanity will have to undergo a "revolution in thinking" in order to deal with the doubling of urban populations in Africa and Asia. By 2030, 5 billion people (over 60 per cent of the world's population) are expected to live in towns and cities. Some 600 million city dwellers are currently without adequate shelter and over 400 million do not have access to the simplest latrines” (People & Planet 2011).
Sources to consult:

- **Podcast**: 2 World views
- **Atlas**: Map on population growth
- **Additional Resources on myUnisa**: PowerPoint and a YouTube video

2.1 INTRODUCTION

The danger of environmental change and degradation is inherent in people's use of natural resources. Environmental pollution is, therefore, not a new problem of the 21st century, but an old problem that is now growing in intensity and size because of growing population numbers and the ever-increasing rate of resource consumption. The cumulative effect of human activities, as we see it in modern industrialisation and population growth, has now begun to endanger the life-sustaining function of the natural system. Due to modernisation and industrialisation, the use of fossil fuels, for instance, has increased along with the release of noxious gases, which increases air pollution.

The change in the world's climate is also a sign of environmental degradation. In addition to the atmospheric problems, there are the degradation of natural forests, the extermination of species and the loss of biodiversity, the exhaustion of soil and water resources, and the accumulation of waste in the natural environment.

Because environment deterioration is such a complex problem, we do not usually see the warning signs in time. In many instances, the damage has already been done by the time the problem becomes obvious. Today most informed people are, however, aware of conditions in the human-environment system, of environmental issues and of the survival crisis that the world is facing. They realise that the current social, economic and political systems in the world do not operate in favour of the environment, and that we are using the earth in an unsustainable way.

2.2 LEARNING OUTCOMES

After completing this study unit, you should be able to

- compare the various environmental schools of thought
- evaluate the reasons for the differences between the "rich North" and the "poor South"
- analyse why some environmental schools of thought are classified as technocentric and others as ecocentric
- explain why certain environmental problems have begun to gain popular political acknowledgement in the past couple of decades
- explain why people have to change their life and world views

2.3 HUMAN PERSPECTIVES ON THE PHYSICAL ENVIRONMENT

**Reading activity**

Study the sections "Human perspectives on the physical environment" and "Human forces behind environmental issues" on pages 24–30 in Middleton.
Reading organiser

- Perceptions and evaluations of resources, and adaptation to them, differ from person to person, from place to place and from time to time in the human-environment system.
- Environmental issues stem from the abuse of natural resources.
  - Five drivers which lead to change in ecosystems:
    - Demographic drivers (The Malthusian perspective)
    - Socio-political drivers (The organisation of society)
    - Economic drivers (The flow of capital)
    - Scientific and technological drivers (The Boserup theory)
    - Cultural and religious drivers (Cultural norms)

Textbook activity

- Based on the information you have just read, interview a person older than 60 years about his or her attitude towards conservation. You can ask the following questions:
  - Do you think your generation's attitudes are significantly different from your parents’?
  - If it has change what do you think can be the reasons?
  - Why do you think there is a gap between what people say regarding conservation and how they act?
  - Reflect on the following questions before you continue with your next activity:
    - Why do you think there is such a gap between what people say and what they do regarding conservation?
    - Why do you suppose people "loath to change their lifestyles"?
    - Do you agree that "energy use is a reflection of the strength of our economy"?
    - What is the definition of a "consumer"?
    - What is the definition of "responsible citizen"?
    - Can a person be both when it comes to energy consumption? How?

2.4 HUMAN-INDUCED IMBALANCES

Reading activity

Study the sections "Human-induced imbalances" on pages 30–39 in Middleton.

Reading organiser

- Human activities display an uneven spatial pattern.
- Theories on why environmental issues occur (table 2.3).
- Ownership and the 'tragedy of the commons'
- Imbalances between richer and poorer nations.
- Certain areas of the world are economically and technologically advanced while others are less developed.
- Differences in standard of living and the level of economic development between people in the so-called developed (or "rich") and those in the developing (or "poor") countries of the world.
- Developed countries are inclined to dominate developing countries economically, which gives rise to a process of underdevelopment and dependence.
- The economies of developing countries are based largely on a single primary commodity or a few commodities (such as coffee, cotton, copper or gold), which are exported to developed countries.
• Developing countries have a high commodity concentration index, and their economies usually include only a few forms of economic activity.
• Developed countries tend to dominate developing countries and to exploit them to the extent that the latter actually have very little control over their own economic affairs.
• Transnational corporations (TNCs), which have their origins in developed countries, are regarded as the instruments of this economic dominance and exploitation.
• A TNC is an individual business which, besides producing in its country of origin, is also responsible for production in other countries.
• TNCs are usually very large companies whose operations extend across national borders and whose global operations are usually controlled centrally from one of the countries in the rich North.
• The global turnover and flow of goods, capital and information between TNCs are becoming increasingly important, and are already starting to exceed that of individual states in the world.
• TNCs are regarded as the instruments of development in the South, but the industrialisation and economic development processes that they initiate, often give rise to environmental problems in developing countries.
• The spatial patterns of exploitation and dependence can be observed on all geographical scales – from the global to the local.
• Many of the factors that play a role in uneven global spatial patterns are also significant on a national scale (within individual states).
• In both the North and the South urban and rural areas within individual states differ with regard to their levels of economic development.
• Inhabitants of rural areas in the South are usually the worst off economically, which influences their interaction with the natural environment.
• The poor and disadvantaged, particularly in the South, are both the victims and the agents of environmental degradation.

Textbook activity

• Debate the following statement: 'Inhabitants of rural areas in the South are usually the worst off economically, which influences their interaction with the natural environment.'
• Explain the ways in which the ownership of resources is important in determining how they are used.

2.5 INTEREST IN ENVIRONMENTAL ISSUES

Reading activity

Study the section "Interest in environmental issues" on pages 40–43 in Middleton.

Reading organiser

• Note the various views of environmentalists during the last half of the 20th century (table 2.5).
• The ecocentric and cornucopian (technocentric) view on the environment.

Textbook activity

• Is the current worldwide concern about environmental issues unique to our time? Give two examples.
• Into which two groups can environmental schools of thought be divided? Give a description of the difference between the groups.
• Which schools of thought do you support and what is your life and world-view?
• Are people's life- and world-views constant and unchangeable?

2.6 CONCLUSION

The causes of the environmental, resource and social problems confronting the world are complex. They are associated with population growth; rural-urban population distribution; poverty; structural imbalances or inequalities in the political, economic and social arenas; the overutilization and misuse of resources; a loss of biodiversity; the inability of humankind to consider the needs of future generations in its present utilisation and exploitation of the environment; and the faith of humankind in technology.

Today, people dominate the human-environment system in terms of numbers, spatial distribution, technology and resource utilisation. Despite this dominant position, approximately one-fifth of the world's population is impoverished, experiencing critical living and environmental conditions. On a global scale, the gap between the rich and the poor, and between rich and poor countries is increasing. One out of every five people in the world enjoys a good quality of life, another three have an acceptable quality of life, while the fifth person lives in poverty. Environmentalists believe that the present forms of economic growth in the countries of the North are unsustainable, and that total resource consumption in the world will have to increase seven times if all people on earth are to enjoy a quality of life similar to that enjoyed by the average resident of the USA. However, we live in a finite world with limited quantities of natural resources. The human-environment system would not be able to support the present world population if all people were on the same level of development as that of the world's rich countries.
LEARNING UNIT 3: SUSTAINABLE DEVELOPMENT

Did you know?

“In western Africa, just south of the Sahara Desert, lies the landlocked nation of Burkina Faso. Despite the limited natural resources in this arid savannah, the nation experienced a 200 per cent increase in urban population between 1975 and 2000. Much of that growth occurred in the capital city of Ouagadougou, where unplanned settlements sprang up along the city’s perimeter. Between 1960 and 1993, Ouagadougou experienced a 14-fold increase in area.

UNEP found that, in the 1980s, Ouagadougou’s growth resulted predominantly from rural-to-urban migration. After that time, the population increased primarily from natural growth — birth rates exceeding death rates.

The growth led to an explosion of unplanned settlements. Unplanned settlements may conflict with sustainable development goals, and they make it harder for the government to provide basic services, such as drinking water.

Despite growing urbanisation, however, UNEP found that Burkina Faso made progress in some key areas of environmental sustainability. Protected areas increased slightly from 1990 to 2005, and per capita carbon dioxide emissions dropped slightly over roughly the same period” (NASA Earth Observatory 2008).

Sources to consult:

- **Podcast**: 3 Sustainable development
- **Satellite image**: Urbanisation of Ouagadougou, Burkina Faso under additional Resources on myUnisa
- **Prescribed book**: Chapter 3, "Sustainable development", on pages 45–64 in Middleton
- **Additional Resources on myUnisa**: PowerPoint and a YouTube video
3.1 INTRODUCTION

Since the Industrial Revolution, it has been generally accepted that industrialisation is the path to modernisation and progress for humankind. Industrialisation has, however, been accompanied by environmental degradation. People initially believed that environmental degradation was an acceptable price to pay for economic progress. However, in 1987, in their publication *Our common earth*, also known as the Brundtland report, the World Commission on Environment and Development (WCED) came to the conclusion that economic development could not continue at the expense of the natural environment. They proposed a new type of development, which they called "sustainable development". With sustainable development, the needs of the current generation are satisfied without endangering the ability of future generations to satisfy their needs. Sustainable development requires that the use of resources be regulated in such a way that the greatest possible return is ensured for the greatest number of users over the longest period.

"Sustainable development" has become a very popular term, and means different things to different people. Sustainable economic development, for example, is defined as maintaining an optimal level of interaction between the biological system (the biosphere), the economic and the social systems. Sustainable development requires economic production to take place in harmony with natural resources – never at the cost of the environment and environmental resources, which are essential for maintaining life on earth.

When the term was first used, the emphasis was on human needs rather than on the interaction between the socioeconomic and the natural systems. Today it is accepted that sustainable development has to do with maintaining a balance between satisfying human needs (economic development) and preserving the natural environment in which people live and on which they depend to satisfy their basic needs. Sustainable development is economic development that increases wealth but avoids environmental degradation. It is not easy, however, to define sustainable development in a way acceptable to everyone.

3.2 LEARNING OUTCOMES

After completing this learning unit, you should be able to

- explain the term "sustainable development" and its importance
- discuss how economic principles and environmental economics can influence sustainable development
- compare the benefits and disadvantages of scientific and technological developments

3.3 SUSTAINABLE DEVELOPMENT

*Reading activity*

Study the section "Sustainable development" on pages 50–52 in Middleton.

*Reading organiser*

- The priorities as described in the World Conservation Strategy document.
- The differences between the various world views on sustainable development.
- The meaning of maximum sustainable yield.
- Three generally accepted principles of sustainable development.
Textbook activity

- According to the World Conservation Strategy, which three priorities should be included in all development programmes in order to make them sustainable?
- What is the difference between the economic and the deep ecology world views on sustainable development?
- Distinguish between ecological and economic sustainability using appropriate examples.
- What does maximum sustainable yield mean?
- What are the three generally accepted principles of sustainable development?
- Now that you have read all the different meanings of sustainable development, briefly write down what you think the main principles of sustainable development are against the background of your own life and world view.
- What are the main principles of sustainable development if the priorities of the natural environment are taken as our point of departure?

3.4 VALUING ENVIRONMENTAL RESOURCES AND GROWTH AND DEVELOPMENT

Reading activity

Study the sections "Valuing environmental resources" and "Growth and development" on pages 54–58 in Middleton.

Reading organiser

- The root cause of environmental degradation according to economists.
- The two types of values according to which the elements of the natural environment are classified.
- The view of the World Commission on Environment and Development (WCED) on sustainability.
- Economic growth versus the qualitative improvement of the human population.
- The rules that need to be applied for sustainable development to succeed in terms of inputs and outputs, according to cycle C in figure 3.4 on page 49 in Middleton.
- The adaption of gross national product (GNP) to meet the requirements of sustainable development.

Textbook activity

- What is the root cause of environmental degradation according to economists?
- Explain in your own words what environmental economics entail, and why application of the principles of environmental economics are seen as a way of slowing down environmental degradation.
- Are the principles and approaches of environmental economics perfect and without problems? Give reasons for your answer.
- According to which two types of values are the elements of the natural environment classified? Give specific examples to illustrate your answer.
- Some people argue that parts of the natural environment lie beyond the scope of environmental economics. In environmental economics, only the prices of products are considered, and not the value people attach to their environment. Explain this statement.
- Can people be compensated in monetary terms for something that has an intrinsic value for them? Give at least one example of an element in the natural environment
that has value for you that cannot be expressed in terms of money – something that you and your community would not give up for all the money in the world.

- Is economic growth (the quantitative expansion of the economic system) essential for development (the qualitative improvement of the human population)? What is the view of the WCED?
- Which two types of reaction did the WCED get to their call for sustainable development?
- Discuss the rules that need to be applied for sustainable development to succeed in terms of inputs and outputs and according to cycle C in figure 3.4 on page 49 in Middleton.
- How do we have to adapt the measure of GNP to meet the requirements of sustainable development?

3.5 POPULATION AND TECHNOLOGY

Reading activity

- Study the section "Population and technology on pages 58–64 in Middleton.

Reading organiser

- Three factors that can be used to keep the throughput of energy and matter in the natural system within the system's capacity.
- Control over the throughput in the system.
- The term "carrying capacity".
- Malthus's and Boserup's theories.
- Elements in the natural environment are constant and limited, and occur in given amounts.

Textbook activity

- What three factors can be used to keep the throughput of energy and matter in the natural system within the system's capacity?
- Is sustainable development the same as control over the throughput in the system? Give reasons for your answer.
- What does "carrying capacity" mean? Can we successfully apply the concept to human population growth? Give reasons for your answer.
- Explain how Boserup's theory differs from Malthus's theory.

3.6 CONCLUSION

Geographers are interested in the relationship between socioeconomic development and the natural environment, in people's impact on the natural environment, in the nature and consequences of environmental change, and in the repercussions of this change for current and future generations. We have to realise that we live in a finite world. Whether we are motivated by religious convictions or by a need to ensure the widest possible ecological choice for humankind, we remain responsible for leaving the earth in a habitable state for our descendants. Each individual on earth counts, and if everyone does his or her bit to conserve the environment, we might be able to leave our children a better earth than the one we are living on now. However, this means that people will have to change their view of life and the world. We will have to put all our efforts into regulating the use of resources in such a way that we can ensure the greatest possible returns for the greatest number of consumers over the longest possible period.
Food for thought:

- The rich must live more simply, so that the poor may simply live.
- Is development without an increase in throughput really possible?
- South Africa is often described as a microcosm of the world, because it has both First-World and Third-World characteristics. With this in mind, what approach to development would be best for this country?
LEARNING UNIT 4: TROPICAL DEFORESTATION

Did you know?

“Africa and South America had the highest net annual loss of forests in 2010–2015, with 2.8 and 2 million hectares respectively, but the report notes how the rate of loss has "substantially decreased" from the previous five year period.

Since 1990 most deforestation has taken place in the tropics. In contrast, net forest area has increased in temperate countries while there has been relatively little change in the boreal and subtropical regions.

However, given global population growth, average per capita forest area has predominantly declined per person in the tropics and subtropics, but also in all the other climatic regions with the exception of the temperate” (FAO 2015).

Sources to consult:

- Podcast: 4 Tropical deforestation
- Satellite image: Gishwati forest under additional Resources on myUnisa
- Atlas: World map on different biomes and land use
- Prescribed book: Chapter 4, "Tropical deforestation", on pages 57–76 in Middleton
- Additional Resources on myUnisa: PowerPoint and a YouTube video
4.1 INTRODUCTION

Although deforestation has largely been stopped in the temperate latitudes of the northern hemisphere, it is occurring more and more in the tropics and thus reaching alarming proportions in that part of the world.

Despite the ongoing reduction in deforestation over the past 30 years, the process of deforestation remains a serious global ecological problem and a major social and economic problem in many regions. The rate of deforestation also varies widely by region, and despite a decline in some regions, the rate of deforestation is increasing mainly in developing tropical countries. Africa is suffering deforestation at twice the world rate, according to the UN Environment Programme (UNEP).

The decline in the rate of deforestation also does not address the damage already caused by deforestation and that the negative effects of deforestation are declining.

The reasons for deforestation in the humid tropics are complex and can be seen as the result of a series of related processes. Although it is widely accepted that forests are destroyed to increase the economic value of land, there is no agreement on what the causes of deforestation are. There are many causes for this phenomenon, such as corruption, an unequal distribution of wealth and power, population growth, and urbanisation.

The loss of tropical forests has consequences that vary from local to global. Deforestation presents multiple societal and environmental problems. The immediate and long-term consequences of global deforestation endanger life on earth. Some of these consequences include loss of biodiversity, disruption in the flow of water and nutrient cycles, the destruction of forest-based societies, and climatic disruption.

The conservation and management of forests in the humid tropics is an issue receiving increasing attention at all levels – from the local to the international. Many initiatives have already been launched, including action plans and "debt for nature swaps", which entails the writing off of foreign debt in exchange for conserving specific forested areas. Developing countries need to be convinced of the benefits of conserving forests before they are prepared to participate actively in conservation activities.

4.2 LEARNING OUTCOMES

After completing this study unit, you should be able to

- indicate the spatial distribution of the phenomenon of deforestation on a world map
- explain the reasons for the destruction of the tropical rainforests
- discuss the consequences of the destruction of the tropical rainforests
- suggest solutions to decrease deforestation rates
- explain how tropical rainforests can be utilised in a sustainable manner

4.3 DEFORESTATION RATES

Reading activity

Study the section "Deforestation rates" on pages 66–67 in Middleton.

Reading organiser

- The evolution from hunter-gatherers to more advanced economic systems was one of the first steps to deforestation.
Defining deforestation is problematic. Our knowledge of the rates at which deforestation is currently occurring is far from satisfactory. There are many examples of deforestation during the various periods in human history. Deforestation has largely been halted in the temperate latitudes of the northern hemisphere, but in the tropics there is an increase in deforestation. There is uncertainty regarding deforestation rates, partly because there is no standard definition of deforestation. Note the difference between deforestation and the degradation of forests. Contemplate the global distribution of the phenomenon of deforestation.

Textbook activity
- Study figure 4.1 on page 68 in Middleton. Use an atlas and write down three countries in Africa where deforestation is increasing.
- Study figure 1.1 on page 4 in Middleton. Use an atlas and write down the names of countries situated in the humid tropical biomes.
- In which biome/s is/are deforestation the most prevalent?
- Describe the relation between deforestation rates and the various biomes.

4.4 CAUSES OF DEFORESTATION

Reading activity
Study the sections "Causes of deforestation" and "Direct wartime impacts" on pages 67–72 and 471–479 in Middleton.

Reading organiser
- Note the causes (main factors) for deforestation in each of the following areas in the humid tropics: Latin America, Africa, South Asia and South-East Asia. See table 4.1 on page 69.
- Direct wartime impacts on deforestation include the cutting down of England's oak trees decades ago to build warships, and the extreme destruction of dense vegetation during the Vietnam War.
- Because of agriculture and commercial forestry, large areas of indigenous forest were also lost during the Vietnam War.
- The mangrove forests in Vietnam were halved during the war.
- Note the example of West Africa, and specifically Cote d'Ivoire, where deforestation can be traced to the government's view that indigenous forests are a source of income and foreign currency for reducing the country's enormous foreign debt.
- Commercial forestry and agriculture can also be regarded as primary causes of deforestation in the Philippines.
- The impacts of cattle ranging, mining, and slash-and-burn activities in the tropical rainforests of the Amazon should be examined.
- Government policy can play a role in deforestation, as was illustrated in the deforestation of the Amazon basin.

Textbook activity
- What are the main causes of deforestation in tropical Africa/Latin America/South Asia and South-East Asia?
- What led to the overexploitation of tropical rainforests in Cote d'Ivoire?
• When did large-scale deforestation begin in the Amazon basin, and what role did government policy play in this?
• Study the spatial pattern of deforestation in figure 4.4 on page 63 in Middleton. Explain the reason for the distinctive herringbone pattern.
• Do you think that the spatial patterns of deforestation in tropical Africa look like those in figure 4.4 on page 63? Give reasons for your answer.
• Explain why logging can be seen as one of the major causes for the demise of the African forest.
• To what extent does poverty contribute to the large-scale deforestation of the tropical rainforests?
• Do you agree that all deforestation is due to the need for land for use in agriculture, logging, infrastructure projects, and other human activities?

4.5 CONSEQUENCES OF DEFORESTATION

Reading activity
Study the section "Consequences of deforestation" on pages 72–80 in Middleton.

Reading organiser
• Deforestation has a huge impact on the natural and human environment, for example on hydrology, soil, climate, biodiversity, and indigenous people.
• Extinctions – loss of biodiversity of microbes (bacteria), plants, insects, animals, indigenous peoples, etc.
• Habitat fragmentation. This disturbs animals' habitat and may force them to enter habitats that are already occupied.
• The fragmentation of habitat can pose many problems, such as territorial conflicts, homelessness (loss of habitat), lack of food availability, migration disturbances, etc.
• Soil erosion occurs when trees and plants are removed; the rainwater washes nutrients in the topsoil away.

Textbook activity
• Study the list of consequences of deforestation as mentioned.
• Distinguish between the environmental and socio-economic impacts.
• Determine whether the impact will be on the climate, hydrology, biodiversity or people living in the area. Provide your answer in table format.

<table>
<thead>
<tr>
<th>Environmental impacts</th>
<th>Socio-economic impacts</th>
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4.6 THE MANAGEMENT OF TROPICAL FORESTS

Reading activity
Study the section "Tropical forest management" on pages 81–88 in Middleton.
**Reading organiser**

- Conservation legislation is often of absolutely no value in practice. Consider the role of socio-economic policy in solving the problem of deforestation.
- Many people depend on forests for their survival. Banning the utilisation of forests is not a viable solution for the problem.
- The meaning and influence of "eco-imperialism" as a reason for deforestation.
- The contribution of outsiders, for example the World Bank or other institutions, to deforestation.
- The pragmatic approach to the problem of deforestation requires surveys and extensive evaluations of the environment.
- Conservation can be seen as the only option.
- Sustainable forestry to avoid radically altering the structure of forests.
- The granting of longer concession periods could induce lower impact tree-felling.
- Greater emphasis on forestry products other than wood.
- Control of forestry resources through small-scale rather than national and international involvement.

**Textbook activity**

- Do you think that a ban on the utilisation of the rainforest will be a solution to the issue of deforestation? Give reasons for your answer.
- Money will solve the environmental issue of deforestation. The contribution of outsiders, for example the World Bank or other institutions, is therefore vital. Do you agree? Explain your answer.

**4.7 CONCLUSION**

We conclude with the short case study on the ‘Kinesi Village Farmers’ in Tanzania.

"Like many other places in Africa, the Kinesi village is threatened by the rate of tree loss. People are cutting trees mainly to make charcoal or for cooking. Goats and cows graze freely, threatening unprotected trees and exacerbating the already acute problem of deforestation. In cooperation with our local partner (Global Resource Alliance - a local community-based organization) we pursue a natural, holistic and sustainable approach to poverty reduction by environmental stewardship. We believe that empowering local communities to address pressing social, economic and environmental challenges according to their own vision and their own creative potential is the key to lasting solutions.

In the last one hundred years roughly half of the world’s forests have been cut down. The most extreme levels of deforestation have occurred within the boundaries of the poorest nations on earth. This destruction is having devastating consequences, and it is widely recognized that it is the poorest of the poor who will suffer the greatest impact. With this in mind, we seek to address two of the most significant problems on the planet by specifically targeting two interrelated issues, extreme poverty and deforestation" (WeForest 2013).
Did you know?

“Roughly half of Earth’s ice-free land surface — approximately 52 million square km (about 20 million square miles) — is drylands, and these drylands cover some of the world’s poorest countries. The United Nations Environment Programme (UNEP) notes that desertification has affected 36 million square km (14 million square miles) of land and is a major international concern.

Africa is the continent most affected by desertification, and one of the most obvious natural borders on the landmass is the southern edge of the Sahara desert. The countries that lie on the edge of the Sahara are among the poorest in the world, and they are subject to periodic droughts that devastate their peoples. African drylands (which include the Sahara, the Kalahari, and the grasslands of East Africa) span 20 million square km (about 7.7 million square miles): some 65 per cent of the continent. One-third of Africa’s drylands are largely uninhabited arid deserts, while the remaining two-thirds support two-thirds of the continent’s burgeoning human population. As Africa’s population increases, the productivity of the land supporting this population declines. Some one-fifth of the irrigated cropland, three-fifths of the rain-fed cropland, and three-fourths of the rangeland have been at least moderately harmed by desertification” (Pimm 2013).
5.1 INTRODUCTION

Desertification means the transformation of arable or habitable land into a desert because of a change in climate or destructive land use. This process leads to land degradation specifically in areas (ecosystems) characterised by a lack of water resources. These areas are referred to as drylands – see figure 5.1 on page 91 in Middleton.

Desertification occurs when the capacity of the land (an area, ecosystem or environment) to produce biomass declines to such a low level that it is no longer able to support its characteristic plant cover on a permanent basis.

This can be regarded as the eventual, catastrophic consequence of soil degradation, because once the soil has been irreversibly degraded, the productivity of the ecosystem is lost forever.

The drive to use larger soil surface areas (and new areas) for agricultural purposes has led to situations in many parts of the world where marginal and submarginal soils are utilised as areas for crop cultivation and grazing. Marginal areas are those areas in which crop production or animal husbandry in any year has only a 50 per cent chance of being successful. In submarginal areas, the probability of producing profitable outputs in any year is even lower than 50 per cent. The years in which outputs do not generate profits, are usually those years characterised by setbacks such as droughts, floods, cold and hail damage.

5.2 LEARNING OUTCOMES

After completing this learning unit, you should be able to

- define the term "desertification"
- classify and explain the causes of desertification
- describe the consequences of desertification
- locate the countries within the Sahel Region on a map of Africa
- analyse how population growth in the Sahel results in desertification

5.3 DEFINITION OF DESERTIFICATION

Reading activity

Study the introductory section, "Definition of desertification", and "Areas affected by desertification" on pages 91–94 in Middleton.

Reading organiser
Desertification is not exclusive to the present.
The link between soil utilisation and soil degradation.
At the United Nations Convention to Combat Desertification, desertification and the "spreading of deserts" were described.

**Textbook activity**

- Indicate whether you agree or disagree with the following statement, and give reasons to substantiate your viewpoint: "Desertification is a phenomenon that is unique to the present time."
- What is meant by the statement that the modern viewpoint on desertification accepts that there is a close association between soil utilisation and soil degradation?
- How were desertification and the "spreading of deserts" described at the UN Convention to Combat Desertification?

5.4 **CAUSES OF DESERTIFICATION**

**Reading activity**

Study the introductory paragraph under the heading "Causes of desertification" on pages 94–107 in Middleton.

Study the root causes of land degradation in table 5.2 on page 95 in Middleton.

**Reading organiser**

- These are the processes that cause desertification. At the root of this environmental problem, however, are the socio-economic and political situation of an area and the reasons why people misuse resources.
- The causes of desertification are summarised according to four processes, namely:
  - intensive grazing
  - overcultivation
  - overexploitation of vegetation
  - salinisation
  - drought

**Textbook activity**

- Discuss the root driving forces behind desertification. Illustrate your answer with at least three examples.
- Name and describe the physical processes contributing to desertification.

**INTENSIVE GRAZING**

**Reading activity**

Study the section "Intensive grazing" on pages 95–99 in Middleton.

**Reading organiser**

- Notice how frequently Middleton, in his discussion of overgrazing as a contributory cause of desertification, also refers to erosion.
- Soil degradation is a process and should not be considered in isolation.
- The term "piosphere" as an indicator of the localised impact of grazing on vegetation and soils. See figure 5.3.

**Textbook activity**

- Study figure 5.3 on page 97 in Middleton. Name the visible signs in the pasture that indicate that the veld has possibly been overgrazed.
- Why is this area referred to as a "pioshere"?
- Explain why a fixed carrying capacity for grazing has become an unpopular concept.
- Argue whether politicians should shoulder part of the blame for the deterioration in grazing areas.

**OVERCULTIVATION**

**Reading activity**

Study the section "Overcultivation" on pages 99 in Middleton. Note the references to the way in which certain practices lead to lowered outputs, erosion and eventually to desertification.

**Reading organiser**

- The agents of soil erosion in instances of overcultivation.
- Examples of where over-intensive agricultural practices took place.
- Negative impacts of overcultivation.

**Textbook activity**

- Point out the most common agents of soil erosion in cases of overcultivation.
- Name the three areas distinguished as examples of over-intensive agricultural practices (table 5.3 on page 99).
- Summarise the negative impacts of each of the following practices in telegram style:
  - shorter recovery period
  - mechanisation
  - utilisation of marginal soil
- Write a short paragraph to debate the following statement: "Gambling with the natural elements is not only a recipe for economic decline in the long term, but also has disastrous consequences for the environment, since the threshold of soil stability is lowered."

**OVEREXPLOITATION OF VEGETATION**

**Reading activity**

Study the section "Overexploitation of vegetation" on pages 100–101 in Middleton.

**Reading organiser**

- The main reasons for the destruction of natural vegetation.
- The collection of firewood can give rise to desertification.
- Reforestation in southern Niger in Sahelian Africa. Read Box 5.1 on page 101.
Textbook activity

- What are the main reasons for the destruction of natural vegetation?
- Name one region (not towns) highlighted in the prescribed section as an example of an area where the natural vegetation has been destroyed or is being overexploited.
- Identify on the world map where this region is, and write the contributory cause/causes of the deforestation down on the map.
- Explain how the collection of firewood can give rise to desertification. Also point out the factors that have a spatio-temporal effect on the collection of firewood.
- Discuss an example where positive changes in dryland cover have occurred.

SALINISATION

Reading activity

Study the section "Salinisation" on pages 101–104 in Middleton.

Reading organiser

- Countries in which the salinisation of irrigated areas is becoming critical.
- The association between these countries and the Aral Sea tragedy.
- The meaning of salinisation and the role of irrigation in salinisation.
- Major causes and effects of secondary salinization.

Textbook activity

- Table 5.5 on page 103 in Middleton pinpoints Turkmenistan, Kazakhstan and Uzbekistan as three countries in which the salinisation of irrigated areas is becoming critical. What is the association between these countries and the Aral Sea tragedy to which Middleton refers on page 173?
- Explain briefly what you understand by salinisation of soils, and explain how irrigation can lead to salinisation.

DROUGHT

Reading activity

Study the section "Drought" on page 105 in Middleton.

Reading organiser

- Three types of drought can be recognised: metrological, agricultural and hydrological.
- Drought and its effects on people vary depending on their coping capabilities.
- The impact of drought is more severe in some developing countries as in developed countries.
- Table 5.6 on page 105 illustrate the effects of some recent drought on livestock in African countries.

Textbook activity

- Describe the differences between metrological, agricultural and hydrological drought.
- Why is the impact of drought more severe in some developing countries than in developed countries?
5.5 UNDERSTANDING DESERTIFICATION

Reading activity

Study the section "Understanding desertification" on page 108–110 in Middleton.

Drought is the principle natural hazard faced by communities in drylands. It frequently occurs with desertification

Reading organiser

- The necessity of long-term monitoring of specific problem areas in order to find appropriate solutions to the problem of desertification.
- Where does desertification take place?
- How does desertification take place?
- Why does desertification take place?
- The distinction between those impacts that can be attributed to normal fluctuations in the natural environment (e.g. drought cycles) and those that have resulted from human activities.

Textbook activity

Read the case studies "The US great plains" and "The Sahel" on pages 108–110 in Middleton and then do the following activities:

- Explain why the Sahel region of North Africa was so severely stricken by wind erosion during the 1970s and 1980s. (Hint: Your answer should show that you understand the interaction between the various processes of soil degradation.)
- Discuss how the social, political and economic conditions contributed to the Sahel catastrophe of the 1970s.
- Compile a list of examples to show that the underlying contributory causes of soil degradation are socioeconomic, political and cultural forces. In each case, write down the name of the country, town or region, as well as the underlying contributory cause. Mark all the countries, towns or regions on the world map.
- How would you criticise the statement that there is a cause-effect relationship between desertification and famine?

5.6 CONCLUSION

Read the by Keynote speech on desertification and drought by Mr. Arvid Solheim Director, the Development Fund, as it is a synopsis on the causes and problems of desertification.

“... The developing countries in the South are tremendously more vulnerable and already suffering serious consequences of desertification and drought caused by climate change. National food security is severely threatened, partly by reduced crops nationally, partly by the rapidly rising prices of food and feed on the world market. Drought, combined with slow economic development, and high prices on imports, may reverse positive trends we have seen in many poor countries lately, and send national economies into recession. The cost of imports of basic foodstuffs to the world’s 37 Low Income Food Deficient Countries increased 20 per cent only last year, and the tendency is continuing. Spreading social unrest, as has been seen in Mexico, Morocco, and Mauritania to mention some, is one of the consequences, migration pressure on Europe is another? UNEC-Europe has a strong obligation to get strongly involved in the fight against desertification, drought and hunger, both as a key policy maker internationally, a major donor to developing countries in Africa
and elsewhere, and in our own self-interest in a globalized world. In order to reach the MDGs, which really is a minimum of what must be expected of the global society, Europe must act, now! Today there is a growing recognition among many key players, of the importance of recognizing the important role of small scale farmers and pastoralists as providers of national food security. As you know, 70 per cent of Africa’s poor population lives in rural areas, many in drought-prone countries. They are small scale farmers, nomadic or sedentary herders, forest dwellers. The growing urban populations depend on a well-functioning national market of food, complemented by imports. Simultaneously we can observe growing environmental damage and pollution due to unsustainable industrial farming, over-exploitation of soils and pasture. A special effort is needed to boost national food production, without increasing negatively the environmental footprint of agriculture and animal husbandry. Europe must contribute through targeted policies towards food security and environmental management. Policy reform in the agricultural sector must be supported, and of crucial importance is the strengthening of civil society and local democracy. Only when local population has control of local resources and access to functional and fair national markets, will local food Europe plus USA & Canada, and Russia and Central Asia including Israel and Turkey – production increase in a sustainable way. For decades pastoralists and subsistence farmers, living far from urban centers, been kept without political influence and national priorities. Drylands have been perceived as less productive and less important when it comes to biodiversity, and the contribution of these areas to national economies has been poorly understood. The pastoralists’ knowledge and capacity to adapt to changing climatic conditions and maintain ecological balances has been underestimated. The increasingly difficult situation strengthened by climate change and treats to food security, makes it more necessary than ever to address these issues. Systems and coping strategies must come in place that allows for increased adaptation to changing conditions, and resilience in food production systems. Land issues, subsidies of farm inputs, infrastructure development (irrigation and market access) and import restrictions are some of the most important elements in such policy reform. Specifically, actions towards climate/weather monitoring and early warning systems are important. Land rights that ensure access for vulnerable groups to land and other natural resources, improved land use through crop rotation and range management, water management, irrigation systems and water harvesting, all these points requires adequate state extension systems as well as formal education in these fields. ECE countries should and must do a particular effort in supporting and strengthening the UNCCD, which has not received adequate priority for a number of years. NAPs which has been developed by most affected countries, needs funding and political backing from donors. The 10 year strategic Plan adopted last year must be supported and promoted, making its implementation possible and feasible. An urgent prerequisite for this is to agree on clear indicators of success of the plan. I would like to call your attention to the spreading desert around the Aral Sea. This formerly productive lake is now a desert, spreading enormous quantities of dust and salt in the atmosphere and surrounding areas. UNCCD mechanism should be used extensively to reclaim this important area. We must as well be very aware, that the extraordinary efforts to reduce CO2 emissions from rainforests and wetlands may divert funds from ecosystem management towards humid forests only, something that will further reduce available funding for drylands management and development in semi-arid areas. Furthermore, is critical for Europe to promote and adopt trade policies in bilateral, WTO and EU negotiations that will help poor countries to develop strong national food production and markets. Exports of subsidized agricultural products must be eliminated, as well as the dumping of EU food on the markets in developing countries. Developing countries must be allowed to design trade policies that protect their national markets and promote national food production”. (Solheim 2008).
LEARNING UNIT 6: OCEANS AND COASTAL PROBLEMS

Did you know?

“Four years after the biggest oil spill in U.S. history, several species of wildlife in the Gulf of Mexico are still struggling to recover. In particular, bottlenose dolphins and sea turtles are dying in record numbers, and the evidence is stronger than ever that their demise is connected to the spill.

The Deepwater Horizon oil rig exploded on April 20, 2010, killing 11 people and spewing more than 750 million liters of oil into the Gulf of Mexico. Since then, various government agencies and non-profit organisations, including the National Wildlife Federation, have been studying the region's wildlife to track the impacts of the oil” (Dell'Amore 2014).

Sources to consult:

- YouTube videos: https://www.youtube.com/watch?v=8Uax5FRWnvs
- Podcast: 6 Coastal Issues
- DVD clip 3
- Atlas: World map on mangrove forests and coastal developments
- Prescribed book: Chapter 6, "Oceans", on pages 126–134 in Middleton, and chapter 7, "Coastal issues", on pages 125–128. Certain parts in chapters 6 and 7 do not form part of the study material. Study only the parts referred to in this learning unit.36
- Additional Resources on myUnisa: PowerPoint and a YouTube video
6.1 INTRODUCTION

The oceans occupy 71 per cent of the earth's surface, contain 97 per cent of the water on earth, are the initial source of most of the water that occurs on land, play a fundamental role in the functioning of the earth’s climate, supply people with food and other resources, and serve as a dumping site for waste products.

Since most of the pollutants that end up in the oceans are from land-based sources, the most serious impacts of this type of pollution frequently occur in coastal waters, particularly in parts alongside areas with high population and/or industrial concentrations.

Coastal habitats, in particular mangroves, salt marshes, sea grass beds and coral reefs, are being increasingly threatened by human activities. This threat manifests in direct destruction (e.g., for urban expansion), overutilisation of the resources that occur in these areas (e.g., abalone, crayfish, shellfish and kelp), pollution and erosion.

6.2 LEARNING OUTCOMES

After completing this study unit, you should be able to

- explain how the oceans are threatened by pollution
- name the main sources of marine pollution
- explain how coastal areas are affected by pollution
- explain how mangroves are affected by human activities
- explain the association between level of development and type of water pollution

6.3 POLLUTION

Reading activity

Study the sections titled "Pollution" on pages 126–135 and 142–145 in Middleton.

Reading organiser

- The sources of materials polluting coastal waters.
- Pollutants that break down easily over a period of days and those that can take centuries to break down.
- The threats that oil and petroleum spills pose to the coastal ecology.
- The threats that pollution by heavy metals and inorganic chloride compounds pose to the coastal waters and ecology.
- The various ways in which the oceans are polluted by oil.
- The role of shipping and air transport in polluting the open sea.
- The various international conventions on the dumping of waste in the ocean.
- The effectiveness, or otherwise, of these conventions.
- Pollutants can be divided in biodegradable and non-biodegradable. See table 7.3 on page 142.
- Human activities increased nutrient flows to the coast in numerous ways. See table 6.1 on page 127.

Textbook activity

- What perceptions contribute to the pollution of the oceans?
- Who owns the oceans?
- How does shipping pollute the oceans?
• How do ships contribute to water pollution? How often does this occur?
• What happens to waste materials that are dumped into ocean waters?
• How are waste materials in the oceans regulated?
• Where do the raw materials polluting the coastal waters come from?
• In which parts of coastal waters could pollution have particularly serious consequences? Give reasons for your answer.
• Distinguish between non-conservative and conservative marine pollutants.
• Describe the human activities that have increased the nutrient flow to coastal environments.
• What is the impact of coastal eutrophication?
• Describe the possible effect of global warming on coastal eutrophication.
• Discuss the effect of the longevity of certain pollutants in the ocean, in spite of being diluted by water.

6.4 HABITAT DESTRUCTION

Reading activity

Study the section "Mangroves" on pages 152–155 in Middleton.

Reading organiser

• What the mangroves consist of, where they occur and why their survival is important.
• The reasons why mangroves are being destroyed.
• Examples of the destruction of mangroves on a global scale.
• The importance to conserve mangroves.

Textbook activity

• Why are mangroves an endangered habitat along the coast of West Africa?
• Name an example of a region where mangroves have been destroyed by warfare related activities.
• Why is it important to conserve mangroves?

6.5 CONCLUSION

The following newspaper article from the Mail & Guardian, written by Julio Godoy, reiterates the fact that high nitrogen levels in oceans can become a major environmental issue.

"Ocean fertilisation" or extreme pollution?

Julio Godoy, Bonn, Germany

May 30 2008 16:05

When some multinational companies dump chemicals into the sea, they call it "ocean fertilisation". This practice is near the top of the agenda at the United Nations conference on biological diversity in Bonn that ends on Friday.

"Ocean fertilisation simply means dumping into the ocean particles of iron, nitrogen or urea allegedly to transform the ecological balance of particular marine habitats, to encourage additional phytoplankton growth, and increase absorption of carbon dioxide," says Saskia Richartz, ocean expert at Greenpeace.
Practically all developing countries want the UN conference to approve a global moratorium on ocean fertilisation until scientific evidence can prove that the practice does not bring new pollution risks. But some industrialised countries, led by Australia, want to avoid a strong ban.

Phytoplankton collectively account for half of the carbon dioxide absorbed annually from the Earth’s atmosphere by plants. Through photosynthesis, plankton captures carbon and sunlight for growth, releasing oxygen into the atmosphere.

The supposedly scientific hypothesis behind ocean fertilisation is that dumping "nutrients" such as iron, nitrogen and urea into seawater would lead to growth of new phytoplankton that would absorb more carbon dioxide, thus reducing the main cause of global warming and climate change.” (Godoy 2008)
LEARNING UNIT 7: RIVERS, LAKES AND WETLANDS

Did you know?

“Africa’s wetland ecosystems are estimated to cover more than 131 million hectares. They deliver a wide range of ecosystem services that contribute to human well-being such as nutrition, water supply and purification, climate and flood regulation, coastal protection, feeding and nesting sites, recreational opportunities and increasingly, tourism.

Wetlands exist in every country and in every climatic zone, from the polar regions to the tropics. They are distributed around the world and cover an area that is 33 per cent larger than the USA. Africa has 131 million ha of wetlands, varying in type from saline coastal lagoons in West Africa to fresh and brackish water lakes in East Africa” (Wetlands International 2012).

Sources to consult:

- **Podcast**: 7 Rivers, lakes and wetlands
- **DVD clip**
- **Satellite images**: Declining Water Levels in Lake Chad; Shrinking Water Resources: Lake Alemaya and Restored Wetlands around Diawling National Park: Mauritania under additional Resources on myUnisa.
- **Atlas**: World map on industrial countries and river pollution
- **Prescribed book**: Chapter 8, "Rivers, lakes and wetlands", on pages 166–185 in Middleton
- **Additional Resources on myUnisa**: PowerPoint and a YouTube video
### 7.1 INTRODUCTION

Rivers represent an important source of fresh water to people; however, water is seldom available in the places where it is required. In the high and low latitude regions of the world, there is usually a surplus of river water, while in large parts of the middle latitudes and the subtropics the demand for water exceeds the supply. In the semi-arid, sub-humid and seasonally dry parts of developing countries, that are largely characterised by rising population numbers, the pressure placed on water supplied by rivers is among the highest in the world.

Rivers do not come under pressure only because their water is used by humans. The problem is that the utilisation of river water is also frequently accompanied by pollution through a number of sources.

Rivers are not affected by pollution only, but also by human activities which alter their patterns of flow. Examples of these include the channelling of rivers, the diversion of river channels and also the damming of rivers. Although people try to optimise their utilisation of rivers as a resource through these activities, injudicious attempts can have negative implications for the environment in the long term.

Although much of the fresh water that is used by people comes from rivers, rivers are not the only source of fresh water. In fact, more fresh water occurs collectively in all the lakes of the world than in all the rivers. As in rivers, the water in lakes is also affected by human activities, and this effect mostly manifests as deterioration in the quality of the water.

Pollution often has a much more serious impact on the water in lakes than it has on river water. The reason for this is that the water in lakes is often stagnant, so that pollutants are not diluted as effectively as in the case of rapidly flowing rivers. This makes lakes more sensitive than rivers to the harmful effects of pollution. Lakes are, however, not affected by pollution only, but also by changes in the flow patterns of the rivers that feed them. The withdrawal of large quantities of water from rivers for the purpose of irrigation can, for instance, result in much less water eventually flowing into lakes than was previously the case.

The prevention of damage to lakes is not only the best option in the long term, but also the cheapest, particularly if we take into account the costs to repair the damage already done or to halt it. This is easier said than done in practice, however, and there are numerous factors restricting the effective management and maintenance of lakes.

Regarding wetlands, numerous attempts are being made to conserve or restore them, thanks to a growing awareness of their importance over the past two decades.

### 7.2 LEARNING OUTCOMES

After completing this learning unit, you should be able to

- discuss the impact of human activities on rivers
- explain how the damage caused by pollution to rivers can be reversed
- discuss relevant considerations in the management of rivers
- explain how lakes are affected when the flow patterns of rivers are altered by people and give an example
- explain how the indigenous aquatic life of a lake is affected by the introduction of exotic species and give an example
• explain how eutrophication is accelerated by pollution and what the final outcome is for the aquatic life in lakes
• discuss the relevant considerations that are applicable in managing lakes
• explain what a wetland is and why it is of value to people and nature
• explain where and why wetlands are destroyed as a result of human activities
• explain what is being done and suggest what can be done to protect wetlands

7.3 RIVER POLLUTION

Reading activity

Study the section “River pollution” on pages 166–169 in Middleton.

Reading organiser

• Six forms of water pollution.
• Consequences of the dumping of organic waste in water for aquatic life.
• Results of thermal pollution for aquatic life.
• Results of dumping inorganic waste in water.
• Spreading diseases through dumping sewage into water.
• The lack of data on water quality.
• Evolution of water pollution in industrialised countries over the past 100 years.
• The form that water pollution takes in industrialising countries.
• The sector of a society or community usually worst affected by water pollution.
• The reasons why water pollution problems cannot be resolved easily.
• The variation in the quality of river water between high, middle and low-income countries.
• Research findings concerning the main sources of pollution of rivers in the USA.
• Pollutants resulting from agricultural activities ending up in rivers.
• The link between rising nitrate levels (nitrate is a form of nitrogen) in river water and increased use of fertilisers.
• The way in which rivers in both rich and poor countries are polluted by sewage.
• The role of economic and political factors in attempts to repair the damage caused by river pollution.
• Success achieved in the rehabilitation of rivers such as the Rhine and the Thames.

Textbook activity

• Name three types of fluid organic waste that pollute water. Indicate the source of each of these types of waste.
• Explain how aquatic life is affected by organic waste.
• Name three examples of liquid inorganic waste.
• Which types of water pollution proved to be a serious problem during the Industrial Revolution?
• Which types of water pollution replaced this particular form of water pollution as the major threat to human existence on earth for the remainder of the 19th century?
• Name the worst harmful effects of water pollution.
• Name the pollutants that are dumped in rivers as a result of agricultural activities.
• What can the nitrate levels in rivers over the past few decades be attributed to, and what are the consequences thereof?
• Do you think that it is possible to reverse the damage that pollution causes to rivers? Substantiate your answer by referring to an example.
7.4 LAKES

Reading activity

Study the section "Lakes; lacustrine degradation" on pages 172–178 in Middleton.

Reading organiser

- The California examples of firstly Lake Owens, which has dried up completely, and secondly Lake Mono, which is drying up, both as a result of the diversion and withdrawal of water from the rivers feeding them.
- The circumstances surrounding the drying up of the Aral Sea in Central Asia, and the implications for both the people living there and the environment.
- Consequences of the introduction of exotic species (both fauna and flora). See Box 8.1 on page 177.
- The impact of water pollution.
- Eutrophication in lakes and what the results are for aquatic life.

Textbook activity

- What were the ecological implications of the introduction of the exotic Nile perch (a type of fish) into Lake Victoria?
- What were the economic implications?
- What do you think should carry more weight in decisions about introducing exotic species into lakes: the ecological implications or the economic implications? Briefly substantiate your viewpoint.
- Which human activities can increase eutrophication in permanent bodies of water such as lakes and dams? How do these human activities affect aquatic life?
- Explain how lakes are affected when the flow patterns of rivers are altered by people and give an example

7.5 LAKE MANAGEMENT

Reading activity

Study the section "Lake management" on pages 178–179 in Middleton.

Reading organiser

- Experience gained in the management of the North American Great Lakes.
- Effective management of lakes requires the integration and reconciliation of political, economic and ecological factors.
- Importance of finding a balance between ecological interests and the interests of the users of lakes.

Textbook activity

- Name the various considerations that should play a role in the management of lakes.
- Explain the role of legislation in the conservation/management of lakes. Can lakes be protected/managed without legislation?
7.6 WETLANDS

Reading activity

Study the introductory paragraphs of the sections on "Wetlands" and "Wetland destruction" on pages 179 and 183 in Middleton.

Reading organiser

- The various reasons why wetlands are of particular importance to both humans and the environment.
- The global extent of the destruction of wetlands.
- Parts of the world in which the destruction of wetlands is prevalent.
- Examples that illustrate the various causes of wetland degradation and destruction.

Textbook activity

- Name and briefly discuss at least one example of each of the following factors leading to the destruction of wetlands:
  - agriculture
  - disease prevention
  - mining
  - urban expansion
  - water utilisation
  - the exploitation of energy sources (eg collection of wood for fuel)
- Why do wetlands generally have a positive effect on the quality of water?
- What can be regarded as the main cause of the destruction of wetlands in the world?
- What happened to the numerous wetlands in and around Mexico City? Why did this happen?

7.7 WETLAND PROTECTION

Reading activity

Study the section "Wetland protection" on pages 183–185 in Middleton.

Reading organiser

- The situation regarding the conservation of wetlands in the USA.
- International attempts to conserve wetlands, namely the Ramsar Convention.
- The degree of success of the Ramsar Convention.
- Problems concerning the conservation of wetlands in developing countries.

Textbook activity

- Which international convention has as its goal the protection of wetlands?
- Discuss the degree of success of the Ramsar Convention.

7.8 CONCLUSION

"Speaking from the banks of the Rhône in Geneva, a Ramsar site of international importance, Secretary General of the Ramsar Convention, Dr. Christopher Briggs, said: "Wetlands provide services worth an estimated US$ 15 trillion worldwide - including food, water, and climate regulation - demonstrating just how vital they are to humans and the"
environment alike and highlighting the need to conserve them. At the same time, the economic cost of the destruction of carbon-rich mangroves, which are being cleared 3 to 5 times faster than terrestrial forests, is at US$ 42 billion in economic damages annually.’ said Achim Steiner, United Nations Under-Secretary-General and UN Environment Programme Executive Director.

‘The Ramsar Convention has further helped bring a shift in thinking, from the perception that wetlands are unproductive and valueless to an understanding that wetlands supply multiple values to society. There are now 2,186 designated Ramsar sites covering over two million hectares across the globe, but further challenges lie ahead as development continues to encroach on these crucial ecosystems,’ he added. It is essential to educate others about the vital role of wetland plays in our lives (UNEP 2015)”.
LEARNING UNIT 8: BIG DAMS

Did you know?

“A number of large dam projects in Africa have been funded by the European Investment Bank. An example is the 115 metre high Maguga Dam situated in Swaziland, which is the fifth highest dam in Southern Africa after the Katse and Mohale (Lesotho), the Kariba (Zimbabwe) and the Cabora Bassa (Mozambique). Construction began in 1998 and was completed in 2002. The 870 metre long reservoir has a storage capacity of 332 million square metres of water. The Maguga Dam affected some 125 homesteads by inundating either their arable land and/or their structures.

Another example is the Lesotho Highlands Water Project, which includes five dams, 200 kilometres of tunnels blasted through the Maloti Mountains, and a 72 MW hydropower plant. It is one of Africa’s largest infrastructure projects. The project's primary purpose is to transfer water to South Africa’s industrial heartland. Two dams and the hydropower component were completed at a cost of approximately US$ 3.5 billion” (Pottinger 2007).

Sources to consult:

- **Podcast**: 8 Big dams
- **Satellite images**: Impacts of Challawa Dam under additional Resources on myUnisa
- **Atlas**: World map: big dams
- **Prescribed book**: Chapter 9, "Big dams", on pages 191-208 in Middleton
- **Additional Resources on myUnisa**: PowerPoint and a YouTube video
8.1 INTRODUCTION

People have been building dams for at least the past 5,000 years of humankind's existence on earth, to enable them to make optimal use of water resources. The first dams were built to control floods and to provide water for irrigation and for domestic consumption. At a later stage, additional functions such as storing water over long periods, generating hydroelectric power and regulating river flow were added to the list.

The modern era of large dams dates back to the 1930s, and was heralded by the construction of the 221 metre high wall of the Hoover dam on the Colorado River in the USA. Over the past 40 years there has been a marked increase in the rate at which large dams have been constructed all over the world, and in their scale. While a total of 7,408 large dams all over the world had been registered by the International Commission on Large Dams by 1960, this number had increased to 36,562 by 1986. Although most of the new large dams have been built in the 112 temperate latitudes, countries in the tropics and in the subtropics (such as Brazil, Mexico, India, Nigeria and Venezuela) are also beginning to build large dams.

It is estimated that the total river runoff that is regulated globally by large dams increased from 10 per cent in the 1970s to 13.5 per cent in the early 1990s. The present figure is probably in the region of 15 per cent. There is no doubt that these large dams have numerous advantages, and that dam building projects are also frequently highly successful. Large dams make it possible to generate hydroelectric power and to manage and regulate river runoff, and they also offer protection against droughts and floods. Although socioeconomic objectives have been achieved through the construction of many large dams, both the construction work and the reservoirs themselves are often associated with negative impacts on the environment. These negative impacts have made the construction of new dams a highly controversial issue that attracts worldwide attention.

8.2 LEARNING OUTCOMES

After completing this learning unit, you should be able to

- discuss the various environmental impacts that are associated with big dam walls and their reservoirs
- demonstrate and explain by means of examples the effects the construction of a big dam has on upstream and downstream areas
- evaluate the political impacts of big dams

8.3 ENVIRONMENTAL IMPACTS OF BIG DAMS

Reading activity

Study the section "Environmental impacts of big dams" on pages 191–204 in Middleton: the dam and its reservoir (pp 191–198); the upstream and downstream area (pp 198–204).

Reading organiser

- The dam and its reservoir.
- Loss of vegetation, animal life and other resources in the area that is flooded.
- Change in the water quality that occurs when river water is dammed.
- Consequences of damming and the flooding of areas for people's health.
- Possible resettlement of people and the associated problems.
- The accumulation of sediments in the reservoir.
- The way in which the groundwater level is affected.
• Size of reservoirs can create new geomorphological processes. See table 9.5 on page 197.
• Possible consequences for local climatic conditions.
• The upstream area and downstream area
• The example of Wadi Allaqi in Egypt.
• A dam wall as an obstruction interrupting the flow of the river.
• Dams bring about a total change in the hydrological system of the river. See Box 9.1 on page 202–203.
• There are several consequences for the:
  o water quality
  o volume and speed of the water
  o sediment load carried by the river
  o plant and animal life
  o coastal erosion
  o delta areas
  o marine and lake fish populations
  o flow of nutrients from the ocean

Textbook activity

• Study the graphs in figure 9.5 on page 199 in Middleton and answer the following questions:
  o What trend did the average annual sediment concentration in the three rivers respectively show from 1960 to 1980?
  o Explain the reason for this phenomenon.
  o Describe possible impacts of these dams on the downstream areas.
  o Describe possible impacts of these dams on the upstream areas.
  o Describe the impacts of the dam on the reservoir.

8.4 POLITICAL IMPACTS OF BIG DAMS

Reading activity

Study the section "Political impacts of big dams" only page 208 in Middleton.

Reading organiser

• Characteristics of good and bad dams from an ecosystem standpoint.

Textbook activity

• Distinguish between the characteristics of good and bad dams from an ecosystem standpoint.

8.5 CONCLUSION

We conclude this study unit with a case study on Maguga Dam in Swaziland, as it illustrates the environmental and social impacts of a big dam.

Case study

"Report compiled by the Komati Basin Water Authority (KOBWA). The main aim of the Maguga Reservoir in the Komati River is to supply irrigation water to downstream farmers in both Swaziland and South Africa. The construction and inundation have had critical
environmental impacts. These impacts can be grouped into two broad categories, namely environmental and social.

**Environmental impacts**

**Impact on vegetation**

The vegetation surrounding the reservoir comprises of different habitats, namely forests, thicket, closed grasslands, as well as closed and open woodlands. In total, 643 indigenous plant species have been recorded in the Maguga dam basin. These represent about 20 per cent of Swaziland's known flora. The reservoir resulted in the loss of plant species used for timber. In total about 77,000 m³ of timber was lost due to flooding. Of this 800 m³ is kiaat, a tree species, that is used for furniture and carving.

Aside from these plant species, other plant species threatened by the reservoir were of medicinal value. The local residents therefore consulted herbalists on the medicinal plants found in the area, and these were translocated and propagated in a community-owned nursery.

**Impact on birds**

The environmental impact assessment (EIA) indicated that a total of 195 species of birds were found in the area to be submerged by the reservoir. The species composition varied according to habitat – 44 per cent were woodland species, 20 per cent grassland species, 17% forest species and 12 per cent wetland species. Of these, 86 per cent are present throughout the year. A total of thirteen (13) bird species are endemic to Swaziland, Lesotho and South Africa, and nine (9) of these species have red data status for the aforementioned countries.

**Impact on mammals**

About forty six (46) mammal species were identified in the inundation zone, compared to the total of fifty two (52) species found in the whole of Swaziland. One species, the woodland mouse, had never been found in Swaziland. A further eight (8) others had never been recorded before in the Middleveld of Swaziland, and three (3) of these had been listed as "practically extinct outside reserves". They are the Cape hydrax, (*Procavia capensis*) grey duiker (*Sylvicapra grimmia*) and the grey rhebuck (*Pelea capreolus*).

**Impact on reptiles and amphibians**

The Maguga environmental impact assessment (EIA) indicated that thirty four (34) reptile species and twelve (12) amphibian species were resident in the area to be inundated. Reptiles such as crocodiles, snakes and lizards such as the chameleon, are feared by residents. This fear and the accompanying threat to these species are compounded by beliefs and superstitions that result in them being used by traditional healers. Of all the reptile species found at Maguga, the Swazi thick-tailed rock gecko and the Barberton girdled lizard are of significant conservation value. These species had to be caught and released in suitable habitats outside the inundation area.

**Impact on fish**

The fish community of the Komati River is dominated by species adapted to flowing water conditions.

In total, twenty two (22) fish species were recorded at Maguga, and two (2) of these species would be critically threatened by the creation of the reservoir. These were the
Phongolo rock catlet (*Chiloglanis emarginatus*) and the Incomati rock catlet (*Chiloglanis bifurcus*). The construction of the dam would also create a major obstacle to the movement of migratory fish species such as eels. With respect to the above-mentioned fish species, the impact of the dam was regarded as minimal, as the species were found in other reaches of the river. The environmental impact assessment (EIA) and mitigation plan specified methods to mitigate the impacts of the reservoir on fish species.

**Impact on aquatic invertebrate communities**

Environmental studies indicated that the creation of the reservoir would alter the temperature of the river. This would impact on the aquatic invertebrate communities (such as bilharzia’s vector snails, mosquitoes and blackfly), which would result in an increase in their population. The studies therefore proposed methods to both monitor and control these invertebrate communities.

**Social impacts**

**Impact on archaeological sites**

Archaeological visibility in the area inundated was high. A total of twenty (20) archaeological sites were recorded, ranging from sites from the Early Stone Age to sites from the Iron Age. In addition to these sites, a total of 184 graves were also identified. Given the religious, cultural and traditional practices associated with graves in Swaziland, all these graves had to be exhumed and relocated outside the area to be inundated. Secondly, the construction and inundation of the Maguga Dam impacted on one rock painting site. The rock art/painting was successfully removed, and is currently stored at the national museum in Swaziland.

**Impact on community health**

Large construction projects such as the Maguga Dam attract large numbers of people seeking employment. These job-seekers are generally males who leave their partners behind in search of employment. They often find new sexual partners in the job area, and this contributes significantly to the spread of STIs/HIV/AIDS. The project therefore put together various ways to curb the spread of STIs/HIV/AIDS.

The professional staff of the consultant and contractor could bring their spouses/partners with them. It was believed that this would help integrate the staff with the residents of Pigg's Peak.

Secondly, the project committed itself to not housing general labourers, but rather to sourcing them from the neighbouring communities. In this way, employees would sleep at home and only travel to work. This was intended to reduce the chances of employees engaging in new liaisons whilst away from home.

Thirdly, a trauma unit manned by a professional medical consultant was set up on site. This trauma unit provided health services to workers, their relatives and the general public.

The treatment of sexually transmitted diseases and HIV/AIDS counselling was a priority at the clinic. Furthermore the Family Life Association of Swaziland (FLAS) was contracted to provide HIV/AIDS education and information to the workforce. A properly constituted, well-equipped and well trained Health Intervention Team (HIT) was set up within KOBWA to work with the Hhohho Regional Aids program to educate and counsel people in the project area on STIs/HIV/AIDS. This health intervention team was later absorbed by the ministry
of health, and currently provides training and counselling on HIV/AIDS at the Piggs Peak government hospital.

Lastly, to minimise the long-term impacts of the project on community health, the project constructed two clinics within the project area. The clinics were handed over to the government of Swaziland for operation and maintenance. The clinics are operational and serve areas even beyond the project” (KOBWA 2009).
LEARNING UNIT 9: CLIMATIC CHANGE

Did you know?

“The weather isn’t the only thing global warming will impact: rising sea levels will erode coasts and cause more frequent coastal flooding. Some island nations will disappear. The problem is serious because up to 10 per cent of the world’s population lives in vulnerable areas less than 10 m (about 30 feet) above sea level.

Sea levels crept up about 20 cm (7.9 inches) during the twentieth century. Sea levels are predicted to go up between 18 and 59 cm (7.1 and 23 inches) over the next century, though the increase could be greater if ice sheets in Greenland and Antarctica melt more quickly than predicted. Higher sea levels will erode coastlines and cause more frequent flooding” (NASA Earth Observatory, s.a.).

Sources to consult:

- Podcast: 9 Climate change
- DVD clip
- Atlas: World map of carbon dioxide emissions
- Prescribed book: Chapter 11, "Climatic change", on pages 210–233 in Middleton
- Additional Resources on myUnisa: PowerPoint and a YouTube video
9.1 INTRODUCTION

The climatic conditions on earth today are different from those of 1,000 years ago. Similarly, the climatic conditions of 1,000 years ago were different from those of 10,000 years ago. Thus the earth's climate has always been (and still is) subject to change. These changes are linked to natural causes such as variations in the earth's orbit around the sun.

It is generally accepted that the last glacial period reached its maximum intensity approximately 21,000 years ago, and that since then, the earth's climate has gradually warmed up. Since approximately 200 years ago, and particularly since the Industrial Revolution, a new role player has taken the lead on the stage of climatic change: humankind.

We know that various human activities affect the atmosphere in some way or another. People do not deliberately set out to change the atmosphere and the climate; their impacts should rather be seen as a result of the size of the human population and the extent of the associated human activities in the world today.

9.2 LEARNING OUTCOMES

After completing this learning unit, you should be able to

- describe the various human activities affecting the atmosphere
- name the greenhouse gases and explain the greenhouse effect
- explain why the increasing concentrations of greenhouse gases in the atmosphere could lead to global warming
- describe the rising trend in atmospheric temperatures over the past 100 years
- explain how forecasts can be made about the impact of global warming on humankind and the environment
- discuss the possible impacts of global warming
- discuss the steps that are being taken on a global scale to address climatic change

9.3 QUATERNARY CLIMATE CHANGE

Reading activity

Study the section "Quaternary climatic change" on pages 239–241 in Middleton.

Reading organiser

- The occurrence of various relatively hotter and colder periods in the earth's history.
- What glacial periods and interglacial periods are.
- How information about the history of the earth's climate is obtained.
- How climatic change is explained in terms of variations in the amount of solar energy received by the earth.
- The reasons Milankovitch gives for the occurrence of glacial periods and interglacial periods.
- The ways in which temperatures have varied over the past 1,000 years, 20,000 years and 1,000,000 years respectively.

Textbook activity

- Describe the long-term variations in the earth's orbit that can lead to climatic change (as calculated by Milankovitch).
• How can we obtain information about climatic changes that took place a long time ago?
• What happens to temperatures during glacial and interglacial periods?
• Describe the outstanding characteristics of the global temperature pattern over the past 18,000 years.

9.4 HUMAN IMPACTS ON THE ATMOSPHERE

Reading activity
Study the section "Human impacts on the atmosphere" on pages 240–244 in Middleton.

Reading organiser
• The inadvertent nature of the changes brought about by human activities in the atmosphere and in climatic conditions.
• Examples of various human activities affecting the atmosphere and the climate.
• The role of the ozone layer in the climatic conditions experienced on earth, and the way in which this layer is affected by human activities.
• The way in which changes to the land surface lead to changes in the albedo, and how these in turn influence the climate.
• How changes to the hydrological environment can influence the climate.
• How the climate can be affected by humans on a microscale (i.e. in your immediate surroundings), a mesoscale (i.e. in your region) and on global scale.

Textbook activity
• Name a few human activities associated with changes in the composition of the atmosphere.
• Where does the ozone layer occur, and what does it consist of?
• Which important functions are performed by the ozone layer?
• How is the ozone layer affected by human activities?
• Explain how deforestation can affect climatic conditions.
• Name some of the activities you participate in daily that might have some effect on the atmosphere and climatic conditions.
• Give an example of how people can modify the regional (mesoscale) climate.

9.5 GREENHOUSE TRACE GASES

Reading activity
Study the section "Greenhouse trace gases" on pages 244–247 in Middleton.

Reading organiser
• Main natural greenhouse gases that contribute to the heating of the atmosphere.
• Natural and human (anthropogenic) sources/origins of greenhouse gas pollutants.
• Trends in their release into the atmosphere.
• The relatively large heating potential of CFCs.
• The lifetime of gases in the atmosphere.
• Consequence for the earth if these gases were not present.
• Radiative forcing of greenhouse gases (see figure 11.2 on page 246).
• Rate at which these gases have been increasing since pre-industrial times.
• Cement manufacturing and deforestation as the main anthropogenic (human) sources.
• Long-term trends in both the emission and the atmospheric concentration of carbon dioxide.
• Variations in the amount of carbon dioxide on a global scale.
• Role of industrialisation and food production in methane emissions.
• Role of anthropogenic sources as opposed to natural sources.
• CFCs and other halocarbons are not from natural origins, but are exclusively caused by human activities.
• Concentration of the carbon dioxide content of the atmosphere during the geological history of the earth.

Textbook activity

• Name the main greenhouse gases.
• What does CFC stand for?
• How did these gases land up in the atmosphere?
• Are they natural constituents (ingredients) of the atmosphere?
• Do they result exclusively from air pollution caused by people, or are they the result of a combination of natural elements and air pollution?
• How would it be on earth if there were no greenhouse gases in the atmosphere?
• Briefly explain how the different radiative influences impact on global warming or cooling on earth (see figure 11.2).
• Explain how air pollution can lead to a rise in temperature of the atmosphere.

9.6 GLOBAL WARMING

Reading activity

Study the section "Global warming" on pages 247–249 in Middleton.

Reading organiser

• How present global temperatures compare with temperatures over the past millennium.
• The size of the observed rise in global temperature over the past millennium.
• Reason(s) given for this temperature increase.
• Discrepancies in the rising global temperature trend.
• Spatial variation in the rising temperature trend throughout the world.

Textbook activity

• What evidence is there to demonstrate the connection between the carbon dioxide content of the atmosphere and temperature conditions over the past millennium?
• When was the rising trend in temperature over the past 100 years interrupted?
• What has the temperature increase over the past 100 years been?
• Has this rise in temperature been uniform throughout the world, or has it varied from place to place?

9.7 PREDICTING IMPACTS

Reading activity

Study the section "Predicting impacts" on pages 249–251 in Middleton.
Reading organiser

- Limitations of General Circulation Models (GCMs).
- How forecasts are handicapped by the complexity of the climatic system.
- Problems involved in making provision for feedback loops in GCMs.
- The performance of Atmospheric-Ocean General Circulation Models (AOGCMs).

Textbook activity

- What aid(s) do we have for making forecasts about the climate?
- Name the three limitations of GCMs.
- Name one example of a feedback loop that affects climate. Briefly explain how it works.
- Do you think that we should be concerned about the temperature increases forecast by means of GCMs? Briefly substantiate your viewpoint.

9.8 THE IMPACTS

Reading activity

Study the section "The impacts" on pages 251–262 in Middleton.

Reading organiser

- Climatic explanations for historical events.
- Spatial variation in the intensity of expected impacts in different parts of the world, and particularly in how people’s way of life may be affected.
- Evidence of observed ecological changes linked to the recent warming of climate (table 11.6 on page 252).
- The impact on:
  - agriculture and food production
  - rainfall, moisture availability and flood occurrence
  - high latitudes (see figure 11.6 on page 255)
  - sea ice, permafrost and glaciers
  - soil and geomorphologic processes
  - a rise in sea level (see figure 11.8 on page 260)
  - extreme weather events (see table 11.8 on page 262)

Textbook activity

- Explain how food production may be both positively and negatively influenced by global warming.
- Provide three examples of evidence of ecological changes which occurred due to warming climates.
- Briefly explain the feedback mechanisms associated with the loss of declining sea ice.
- Explain why global warming is expected to lead to a rise in sea level. By how much is the sea level expected to rise? How might people be affected by changes in sea level?
- Identify the trend in the variations in sea level at Brest, France from 1807 to 2011 (see figure 11.8 on page 260).
- Discuss the impacts of climate change on small island developing states (SIDS).
- Provide four examples of extreme weather events of the 21st century (see table 11.8 on page 262).
• Why will not all places on earth be affected to the same extent by global warming?
• Which parts of the world would be most seriously affected by global warming? Briefly mention how these regions would be affected.

9.9 RESPONSES TO GLOBAL CLIMATE CHANGE

Reading activity

Study the section "Responses to global climate change" on pages 263–268 in Middleton.

Reading organiser

• Concepts of “mitigation” and “adaptation”.
• Debate between developed and developing countries as to who should take the greater responsibility for combating global warming.
• The contents of each of the following international agreements: the Montreal Protocol, the UN Framework Convention on Climate Change (UNFCCC), and the Kyoto Protocol.
• Examples of the "no-regrets" initiatives to counteract global warming (see table 11.10 on page 265).
• The general belief that economic growth is inextricably bound up with an increase in energy consumption.
• Two future scenarios of the emission of carbon dioxide based on the global demand for energy.
• Adaptive responses to climate change (see table 11.11 on page 267).

Textbook activity

• Differentiate between the concepts “mitigation” and “adaptation” with respect to climate change. Briefly discuss the extent (scale) of each of these concepts.
• Who, in your opinion, should take responsibility for combating global warming: the developed countries or the developing countries, or both? Substantiate your answer.
• Why do you think the USA and Canada do not support the Kyoto Protocol?
• Discuss the benefits of three examples of the "no-regrets" initiatives under the Kyoto Protocol.
• Describe the adaptive measures which the government of the Maldives identified to reduce the impacts of climate change (see table 11.11 on page 267).
• In 2015, the Paris Agreement was reached between 195 countries in order to keep the global temperature from rising to below 2ºC. Do you think this agreement is realistic and achievable?

9.10 CONCLUSION

We conclude with the addresses of President Peter Christian of Micronesia, Prime Minister Manasseh Sogovare of Solomon Islands and Prime Minister Gaston Browne of the Caribbean State of Antigua and Barbuda at the United Nations General Assembly.

“I speak as an islander who has walked the shores of many atoll islands, where there was once sandy beaches and coconut trees. Now there are none. I am told this will continue,” President Peter Christian of Micronesia told the Assembly on the fourth day of its 70th annual General Debate.
“While we wait in fear for the predicted and inevitable sea level to rise, other effects of
global warming, like stronger ocean currents and more frequent typhoons, continue to
wash away shorelines and topple trees, not waiting around for the sea to rise above the
land.”

Mr. Christian voiced hope that the international climate change conference in Paris in
December would resolve the disagreements over allowable emissions of greenhouse
gases by industrial nations.

“We must become more cohesive in our actions to bring a useful conclusion to help
mitigate the threat of sinking islands and prevent the potential genocide of Oceanic
peoples and cultures,” he declared.

Solomon Islands’ Prime Minister Manasseh Sogovare said the issue was existential. “It
impacts on everyone, but the poorest and marginalised populations often bear the greatest
burden.

He noted that Solomon Islands tourism, fisheries and the livelihood of 85 per cent of its
people are at risk from ocean acidification. Sea level rise already has seen land
inundation, loss of biodiversity, threat to food security and the resulting relocation of
populations from low lying islands to other parts of the country.

Prime Minister Gaston Browne of the Caribbean State of Antigua and Barbuda chided the
industrial world for its long-standing emission of globe warming gases for which the less
developed islands are now paying the price.

“The sadness is that these disasters are not occurring in these islands through their own
fault,” he said. “They are happening because of the excesses of larger and more powerful
countries, who will not bend from their abuse of the world’s atmosphere, even at the risk of
eliminating other societies, some older than their own,” he said (UN News Centre 2015).
LEARNING UNIT 10: ACIDIFICATION

Did you know?

Sulphur dioxide is a pungent, toxic gas found in Earth’s atmosphere. In addition to harming human health, the gas affects the environment by reacting with water vapor to produce acid rain. Sulphur dioxide also can react in the atmosphere to form aerosol particles, which can cause outbreaks of haze and other climate problems.

The good news for people living in the eastern United States is that levels of sulphur dioxide dropped by about 80 per cent between 2005 and 2014, according to a new analysis of satellite data. The reduction in sulphur dioxide coincided with the implementation of several control strategies. Many power plants and other facilities that burn large quantities of coal have installed flue gas desulphurisation devices or “scrubbers.” These technologies can reduce emissions from a given source by 50 to 90 per cent. Other emissions reductions came from switching from coal with relatively high sulphur content to lower-sulphur fuel. In some other cases, coal-fired power plants were shuttered and replaced with natural gas or other cleaner energy sources such as solar or wind.

Certain laws and regulations encouraged the changes. The 1990 Clean Air Act Amendment and other state regulations mandated significant reductions in sulphur dioxide emissions. Meanwhile, market-based cap-and-trade programs, such as the Acid Rain Program and the Clean Air Interstate Rule, were particularly effective (NASA Earth Observatory 2015).

You won’t get far...Eh, eh! My acid will get you.
I have the wind behind me.
Sources to consult:

- **Podcast**: 10 Acidification
- **Satellite images**: Sulphur Dioxide Down over the United States under additional Resources on myUnisa
- **Atlas**: World map: Distribution of Acid Rain
- **Prescribed book**: Chapter 12, "Acidification", on pages 270–291 in Middleton
- **Additional Resources on myUnisa**: PowerPoint and a YouTube video

### 10.1 INTRODUCTION

Acid rain, which a Scottish chemist described as far back as 1852, is widely regarded as one of the most critical problems of the industrialised world. What people have taken centuries to build up, and what has come into being through centuries of natural evolution, can be degraded, ravaged and/or destroyed by acid rain within a few years.

Acid rain is associated with the emission of sulphur and nitrogen during the burning of fossil fuels such as coal and oil in power stations, industrial steam boilers or generators, and motor vehicle engines. When these pollutants come into contact with water vapour, oxygen and sunlight in the atmosphere, a diluted mixture of sulphuric and nitric acid is formed. In highly industrialised regions, hydrogen chloride also forms part of this acid mixture.

When this acid mixture is washed out of the atmosphere (e.g., when rain falls), or drops to the earth's surface in the form of particulates, it ends up in rivers and lakes, affects soils and plants, and even has an effect on human-made structures. The impacts are largely negative. The acid level in rivers and lakes increases, which affects aquatic life negatively. Vegetation is also damaged through the effects of acid precipitation.

The effects of acid rain are not confined to areas where the pollutants from which it is derived are released. Surrounding areas and even areas that are far from the source areas of pollution are affected. The strong winds that occur in the higher levels of the atmosphere play an important role in this respect. The fact that the pollutants are often emitted from high chimney stacks into wind currents in the higher levels of the atmosphere adds to the problem. Besides the nature, extent and spatial distribution of the acid rain problem, it is also important for you to know what the consequences of acid rain are for people and the environment.

The best approach to adopt in combating and/or controlling acid rain is that prevention is better than cure. According to this approach, the most obvious strategy for combating acid rain would be to reduce the pollutant emissions that cause acid rain. A large number of methods could be used to achieve this objective; however, some are considerably more expensive than others. The socioeconomic and political situations in some countries make it very difficult to reduce pollutant emissions in practice. Due to the fact that pollutants that are released into the atmosphere cannot be contained within city, provincial or political boundaries, there are many complications in controlling acid rain.

It is important to realise that combating and control measures do not necessarily result in immediate improvements and the recovery of the environment. In fact, such beneficial results could be delayed by other environmental influences.
The impacts of acid rain have no benefit for either humans or the environment. In some cases, permanent or irreversible damage is done to the environment. It could be very expensive to repair such damage.

10.2 LEARNING OUTCOMES

After completing this learning unit, you should be able to

- explain what acid rain is and how it originates
- explain in which parts of the world acid rain occurs
- briefly discuss the impact of acid rain on the environment
- briefly discuss the steps being taken to combat acid rain

10.3 DRIVERS OF ACIDIFICATION

Reading activity

Study on the introductory paragraphs of chapter 12 and the section "Drivers of acidification" on pages 271–274 in Middleton.

Reading organiser

- The historical background to the problem of acid rain.
- The difference between the wet and dry deposition of acid.
- What the pH scale is.
- Natural factors influencing the acid content of the atmosphere.
- Acidification of soil and acid mine drainage.
- The anthropogenic (human) sources of air pollution leading to acid rain.
- Ocean acidification

Textbook activity

- Distinguish between dry and wet deposition of acid (see figure 12.2 on page 272).
- Which factors, besides air pollution, can lead to a change in the pH of rainwater?
- Which factors contribute to the occurrence of acid rain?
- Describe the impact of ocean acidification on marine life.

10.4 GEOGRAPHY OF ACID DEPOSITION

Reading activity

Study the section "Geography of acid deposition" on pages 274–275 in Middleton.

Reading organiser

- The magnitude of the anthropogenic (human) contribution to the acid content of the atmosphere equals the natural contribution at present.
- Those parts of the world where the acid rain problem is most serious.
- The shift in both the source areas of pollutants and the deposition pattern of acid rain in Europe over the past 100 years.
- The numerous acid rain "hotspots" that are developing all over the world.
- Trends in the emission of pollutants giving rise to acid rain.
- The distribution of the acid rain problem cannot be contained within political borders.
Pollutants giving rise to acid rain are often carried across great distances in the atmosphere, with the result that they eventually affect areas far from their initial emission points.

The role of high chimney stacks in the distribution of air pollutants leading to acid rain.

**Textbook activity**

- Explain why the acid rain problem is not distributed evenly across the world.
- Name the parts of the world where the problem of acid rain is becoming serious.

### 10.5 EFFECTS OF ACID RAIN

**Reading activity**

Study the section "Effects of acid rain" on pages 275–278 in Middleton.

**Reading organiser**

- The ability of ecosystems to neutralise incoming acid up to a specific critical stage.
- The meaning of the following terms regarding the effects of acid rain on ecosystems:
  - buffering capacity
  - critical load
  - threshold
- The acid content of soil and water can also be affected by human activities other than those that cause acid rain.
- Characteristics of ecosystems that affect their risk of acidification (see table 12.2 on page 276).

**Textbook activity**

- Explain the meaning of the following terms regarding the effects of acid rain on ecosystems:
  - buffering capacity
  - critical load
  - threshold
- Briefly describe three characteristics of ecosystems that can affect their risk of acidification (see table 12.2 on page 276).

### 10.6 AQUATIC ECOSYSTEMS

**Reading activity**

Study the section "Aquatic ecosystems" on pages 278–280 in Middleton.

**Reading organiser**

- Tolerance of fish for water with higher than normal acid levels varies from species to species.
- Fish species gradually decline as their ability to reproduce is affected.
- Mobilisation of metals by acid deposition.
- The effects of the acidification on the ecology of water bodies.
Textbook activity

- Discuss the consequences of acidification on aquatic ecosystems.

10.7 TERRESTRIAL ECOSYSTEMS

Reading activity

Study the section "Terrestrial ecosystems" on pages 280–284 in Middleton.

Reading organiser

- Five ways in which vegetation can be affected by acid rain.
- Loss of lichens and mosses as a result of acid rain in many of the industrialised regions of Europe.
- Various factors that could be responsible for the deterioration of forests.
- Symptoms shown by trees that have been damaged by acid rain.
- Recent examples of and reasons for the deterioration of forests in Europe (see table 12.4 on page 283).

Textbook activity

- Discuss the consequences of acid rain on plants.

10.8 HUMAN HEALTH

Reading activity

Study the section "Human health" on page 284 in Middleton.

Reading organiser

- The impact of acid rain on the human respiratory and cardiovascular systems.
- Consequences of drinking water polluted by acid rain.

Textbook activity

- Discuss the consequences of acid rain on human health.

10.9 MATERIALS

Reading activity

Study the section "Materials" on pages 284–285 in Middleton.

Reading organiser

- Accelerated corrosion of metals as a result of acid rain.
- Accelerated erosion of the brick or stonework of buildings as a result of acid rain.
- The rate at which metals deteriorate as a result of acid rain.
- Well-known buildings/monuments/statues in die world that have been damaged by acid rain.
- Effects of acid rain on material, paper and glass.

Textbook activity

- Illustrate the corrosive effects of acid rain on any monument, citing examples.
10.10 COMBATING THE EFFECTS OF ACID RAIN

Reading activity

Study the sections "Combating the effects of acid rain", "Political aspects of emissions reduction" and "Environmental recovery" on pages 285–291 in Middleton.

Reading organiser

- Energy conservation and use of renewable energy instead of burning fossil fuels.
- Technology that could reduce the emission of pollutants from power stations and industrial sources.
- End-of-pipe approach and emission trading programmes.
- Some governments are hesitant to initiate expensive anti-acid rain programmes.
- The need for an integrated team approach by all the countries in a region.
- Combating and control measures focused on the major emitters of pollutants.
- Countries notorious for releasing large quantities of sulphur dioxide and nitrogen oxides into the atmosphere.
- Trends in the release of sulphur dioxide and nitrogen oxides in the above-mentioned countries (see table 12.5 and figure 12.8 on pages 288–289).
- Countries where emissions of these pollutants are increasing.

Textbook activity

- Name three technologies that could be used to try to limit emissions of industrial pollutants causing acid rain.
- In which country did emissions of sulphur dioxide increase between 200 and 2010? To what can this trend be attributed?
- Why did emissions of nitrogen oxides either remain practically constant or increase during the period 1980–1990?
- During which year did the sulphur dioxide concentration in Tokyo decline to below 50µg.m⁻³? (See figure 12.8 on page 289).
- How long could it take for lakes to recover from the damaging effects of acid rain?

10.11 CONCLUSION

"Concern about increasing ocean acidification has often focused on its potential effects on coral reefs, but broader disruptions of biological processes in the oceans may be more significant, according to Donald Potts, a professor of ecology and evolutionary biology at the University of California, Santa Cruz, and an expert in coral reef ecology and marine biodiversity.

Ocean acidification is one of the side-effects of the rising concentration of carbon dioxide in Earth's atmosphere due to the burning of fossil fuels. The oceans can absorb enormous amounts of carbon dioxide from the atmosphere, but as the gas dissolves it makes the water more acidic. Increasing acidity can make life difficult for corals and other marine organisms that build shells and skeletons out of calcium carbonate.

Scientists fear that acidification will slow the growth of these organisms and cause calcium carbonate structures to dissolve. Potts agrees that dissolving shells will certainly be a problem for many marine organisms, but he thinks the disruptions will run much deeper.
"It's not just a question of coral reefs, and it's not just a question of calcification," he said. "What we are potentially looking at are disruptions of developmental processes and of populations and communities on many scales."

The term "acidification" refers to a slight lowering of the pH of ocean water, pushing it closer to the acidic end of the scale, although it is still slightly alkaline. A small decrease in pH affects the chemical equilibrium of ocean water, reducing the availability of carbonate ions needed by a wide range of organisms to build and maintain structures of calcium carbonate.

Many phytoplankton -- microscopic algae that form the base of the marine food web -- build calcium carbonate shells to protect themselves from microscopic predators called ciliate protozoa. A disruption of the ability of phytoplankton to build their shells could have ripple effects throughout the marine food web, Potts said.

"It's going to change the dominant organism in the food chain, and there's a very real danger that it may short-circuit the food chains," he said. In other words, ciliate protozoa gorging on unprotected phytoplankton may flourish at the expense of other organisms higher up the food chain.

But calcification of shells is not the only biological process affected by acidification," Potts added. "All biochemical physiological reactions are potentially going to change," he said. Developing organisms are most likely to be affected, due to their low range of environmental tolerances, but it is unclear what the ecological ramifications will be.

Ocean acidification may not affect all parts of the oceans equally. Within 100 kilometres (62 miles) of shore, the pH of ocean water is more variable than in the rest of the ocean. Fresh water and wind from the land can carry chemicals that alter the pH of near-shore water, making it either more acidic or more alkaline. There may be organisms in this region that are already starting to adapt to changes in ocean acidity, Potts said.

"We should be thinking in terms of triage," he said. "We want to be predicting where are the organisms that are most likely to survive or survive the longest, and this is where we should be concentrating our conservation and management efforts, given finite resources" (Science daily 2008).
LEARNING UNIT 11: FOOD PRODUCTION

Did you know?

“Drought is among the most devastating of natural hazards – crippling food production, depleting pastures, disrupting markets, and, at its most extreme, causing widespread human and animal deaths. Droughts can also lead to increased migration from rural to urban areas, placing additional pressures on declining food production. Herders are often forced to seek alternative sources of food and water for their animals, which can create conflict between pastoral and farming communities.

In recent years, droughts have resulted in some of the most high-profile humanitarian disasters – including the recent crises in the Horn of Africa (2011) and the Sahel (2012) regions, which threatened the lives and livelihoods of millions of people. In the past, droughts were not always so disastrous and are often part of a regular climate cycle, as was the case in the Horn of Africa’s drylands and in the Sahel. However, the greater frequency of droughts and more erratic nature of rains in many countries, combined with underlying economic, social and environmental vulnerabilities have meant that droughts have an increasingly destructive impact on at-risk populations” (FAO 2015).
**Sources to consult:**

- **Podcast:** 11 Food Production
- **Atlas:** World map: Food security
- **Prescribed book:** Chapter 13, "Food production", on pages 293–318 in Middleton
- **Additional Resources on myUnisa:** PowerPoint and a YouTube video

### 11.1 INTRODUCTION

The provision of enough food for every person on earth is one of the greatest challenges of the 21\textsuperscript{st} century. Food is one of humankind's most basic needs, and since the beginning of their existence on earth people have been involved in producing and making enough food available for everyone. In 1798, Malthus warned that a growing population would need increasing food supplies, but that the supply of food in the natural environment was limited. He believed that population numbers would always grow more rapidly than food supplies, which would give rise to cycles of mass starvation. This would, in turn, reduce population numbers.

In the past 200 years, we have been able to increase world food supplies more rapidly than population numbers have increased. We know that population numbers have grown considerably and that there are more than six billion people in the world today. The question we have to ask is how we have been able to increase the food supply so drastically. The answer is to be found in human culture and technology.

New areas have been opened up for farming, crops have been spread and established across the world, there have been major improvements in transport and storage facilities, new pesticides and fertilisers have become available, and farming has become increasingly commercialised. Technology is being used more and more in agriculture and especially in food production. This technology includes selective breeding and cultivation, the development of biotic fertilisers and pesticides, the improvement of farming implements and the use of biotechnology.

Although global food production has increased over the past few decades and the per capita production of food is currently sufficient to meet the basic nutritional needs of everyone on earth, the world is not without problems related to food. Whereas per capita food production has increased in developed countries, it has decreased in many developing countries. In some countries, population numbers have exceeded those countries' ability to produce enough food for their people. In a world where enough food is produced for everyone, there are still areas where people are hungry and even starving.

Although agriculture and technology make it possible for us to meet our food needs, they are also responsible for many of the world's environmental problems. Agriculture uses more of the earth's natural resources, creates more pollution and is responsible for more environmental degradation than any other human activity. This is a situation requiring our urgent attention. The global food and agricultural system should be economically, socially and ecologically sustainable. It should be managed in a sustainable manner to ensure that environmental degradation is kept to a minimum while enough food is produced to meet the needs of an ever-increasing world population.
11.2 LEARNING OUTCOMES

After completing this learning unit, you should be able to

- explain the relationship between food, population numbers and technology
- explain the development of agriculture through the three agricultural revolutions
- describe the change in agricultural systems during the past 200 years
- explain what the Green Revolution and Blue Revolution entailed, and what their impacts were
- discuss and explain the spatial distribution of hunger in the world
- describe the impact of food production on the natural environment
- explain why it is necessary to practice sustainable agriculture

11.3 AGRICULTURAL CHANGE

Reading activity

Study the introductory paragraph and the section "Agricultural change" on pages 293–299 in Middleton.

Reading organiser

- The earliest humans who took their food directly from the natural environment (hunter-gatherers).
- Domesticating of natural plants and animals by people.
- Over time people increasingly gained control over food supplies.
- The reason for opening up more and more new areas for agriculture.
- The three agricultural revolutions: the Neolithic Revolution, the Industrial Revolution and the Green Revolution.
- Impact of each revolution on the environment.
- The increase of control over the natural environment.

Textbook activity

- What was the first agricultural revolution and where did it begin? Identify these areas on your world map.
- Using an example, explain what domestication means and how it gave humans greater control over food sources.
- Discuss the various ways in which we have increased the world's food supplies in the past 200 years and their effect on the natural environment.
- In which biomes do human agricultural activities have the greatest effect?
- Why are these biomes affected worst?
- Where are these biomes found on the world map?
- Explain the meaning of the Green Revolution and the impact on world food production.
- Explain how developments in livestock farming have contributed to food availability and environmental change in the world.
11.4 FERTILISER USE, IRRIGATION, AGRICULTURAL PESTS, PESTICIDES AND ALTERNATIVES TO PESTICIDES

Reading activity

Study the sections "Fertilizer use", "Irrigation", "Agricultural pests", "Pesticides" and "Alternatives to pesticides" on pages 299–308 in Middleton.

Reading organiser

- The use of chemical fertilisers and pesticides in the agricultural systems of the world.
- The effect of chemical fertilisers and pesticides on the natural environment.
- The impact of irrigation on the natural environment.
- The effect of pesticides on the natural environment (see table 13.4 on page 305).
- Five alternative methods for controlling pests, which can be used instead of chemical pesticides in the food production system.

Textbook activity

- Discuss the use of chemical fertilisers in agriculture.
- What effects do chemical fertilisers have on the natural environment?
- What is the effect of irrigation on the natural environment?
- Discuss the use of chemical pesticides in the agricultural systems of the world. What effects do chemical pesticides have on the natural environment? Also refer to aspects discussed in previous learning units.
- List five main alternative approaches to chemical pest control.
- Explain the benefits of alternative methods for controlling pests.

11.5 BIOTECHNOLOGY

Reading activity

Study the section "Biotechnology" on pages 308–312 in Middleton.

Reading organiser

- The meaning of the term "biotechnology".
- Examples of how biotechnology can help solve the world's food problems.
- Biotechnology in the developing countries of the world.
- Human and environmental problems associated with the use of biotechnology in food production.
- The link between biotechnology and preserving the earth's biodiversity.

Textbook activity

- What does the term "biotechnology" mean?
- Explain by means of an example how biotechnology can help to solve the world's food problems.
- Can biotechnology be used to solve food problems in the developing countries of the world? Give reasons for your answer.
- Discuss the human and environmental problems associated with the use of biotechnology in food production.
- What is the link between biotechnology and preserving the earth's biodiversity?
11.6 FOOD SECURITY AND SUSTAINABLE AGRICULTURE

Reading activity

Study the sections “Food security” and "Sustainable agriculture" on pages 312–315 in Middleton.

Reading organiser

- Food security is dependent on supply and demand.
- Two types of food insecurity: ‘chronic’ and ‘transitory’.
- Food crises in Ethiopia and Eritrea.
- Improved cereals for India’s poor farmers (see Box 13.1 on page 313).
- What sustainable agriculture involves.
- Life cycle assessment (LCA) of sustainable food production.
- The relationship between population numbers, food supplies and the natural environment over the centuries.

Textbook activity

- Explain by means of an appropriate example what sustainable agriculture involves.
- What are the benefits of producing food sustainably?
- Look at your own way of life and give at least two ways in which you could cut down on food wastage.
- Explain what the relationship between population numbers, food supplies and the natural environment has been over the centuries.

11.7 AQUACULTURE

Reading activity

Study the section "Aquaculture" on pages 315–318 in Middleton.

Reading organiser

- What is aquaculture?
- How aquaculture can help solve the world's food problems (see figure 13.12 on page 317).
- The environmental impact of aquaculture and the Blue Revolution.

Textbook activity

- Explain what aquaculture is.
- Describe how aquaculture can help solve the world's food problems.
- Identify the trend in the production of shrimp and prawns in Thailand between: (a) 1995–2000; and (b) 2005–2010 (see figure 13.12 on page 317).
- What are the environmental impacts of aquaculture and the Blue Revolution?

11.8 CONCLUSION

Each of us has a role to play in bringing about the shift from unsustainable to sustainable agriculture on a local, national, and global level. The greatest challenge facing us at the beginning of the 21st century is how to produce enough food for everyone on earth, at the same time ensuring that each person on earth can meet his or her own food needs. This means that poverty has to be reduced and population growth rates stabilised, to ensure
that the number of people in the world will not increase. The next challenge is to provide enough food in a system in which the natural environment is protected against misuse and degradation.
LEARNING UNIT 12: SOIL EROSION

**Did you know?**

“The soil covering the surface of the earth has taken millions of years to form and we must learn to respect it. Soil is formed at a rate of only 1 cm every 100 to 400 years and it takes 3 000 to 12 000 years to build enough soil to form productive land. This means that soil is a non-renewable resource and once destroyed it is gone forever. If we disregard this, a time will come when there would not be enough soil left to sustain life on earth, because the soil is a necessary growth medium for plants, a home for certain insects and animals, as well as a medium from which we get minerals, such as gold. It is important therefore to treat soil, especially topsoil, as a living entity” (Department of Agriculture 2008).

**Sources to consult:**

- **Podcast:** 12 Soil erosion
- **DVD clip**
- **Satellite images:** Dust Storm off West Africa under additional Resources on myUnisa
- **Atlas:** World map: Soil erosion
- **Prescribed book:** Chapter 14, “Soil erosion,” on pages 278–294 in Middleton
- **Additional Resources on myUnisa:** PowerPoint and a YouTube video
12.1 INTRODUCTION

Soil is one of humankind's most important natural resources because all food production depends on soil productivity. However, soil is probably the resource that is the least appreciated. In fact, reports on soil erosion do not reach the front pages of newspapers. World issues such as pollution, hunger, war and the threatened survival of endangered species such as the rhinoceros and the koala bear are much more newsworthy than soil degradation. Nevertheless, soil degradation — or the loss of soil productivity — is a critical global problem. It is an enormous issue confronting humankind at the beginning of the 21st century. In this study unit, we concentrate on what soil degradation is, under what conditions it occurs, where it occurs in the world and how to control it.

"Soil degradation" is a term referring to the loss of soil productivity. Soil that has been degraded is soil that has already deteriorated to such an extent that its present or future capacity to support human existence and survival has been reduced or destroyed. The capability to sustain productivity in the agricultural sector in particular is being seriously threatened by soil degradation. However, the irony of the matter is that it is in fact farming practices that have, until recently, been the main cause of the degradation of soil resources.

Erosion is a natural process that we cannot stop and without which the earth's relief variation, the deltas and the present outlines of continents would never have developed. Soil erosion taking place at the rate that nature intended is not however responsible for the alarming worldwide degradation of soil resources. The latter is the result of accelerated erosion, which is erosion taking place at much faster rates as result of human activities.

12.2 LEARNING OUTCOMES

After completing this learning unit, you should be able to

- explain what soil degradation is and the processes through which it occurs
- describe the causes and results of soil degradation
- explain how soil degradation is interwoven with socioeconomic conditions
- evaluate the complexities involved in lessening the impact thereof

12.3 FACTORS AFFECTING SOIL EROSION

**Reading activity**

Study the introductory paragraphs of this chapter on pages 319–320 in Middleton, and the section "Soil erosion drivers" on pages 320–321.

**Reading organiser**

- Pay particular attention to the distinction between balanced erosion as a natural geomorphologic process, and accelerated erosion caused by people.
- Figure 4.1 on page 320 illustrates factors that cause soil erosion and their interaction.
- Soils are an integral part of the support system for ecosystems and human communities. Soils are important to society in several ways.
- Wind and water as the two main agents of erosion.
- Wind erosion transfers soil particles by means of surface creep, saltation and suspension.
- In the case of suspension, the source area and the area of deposition may be thousands of kilometres apart.
Erosion by water is caused by both the impact that falling raindrops have on soil particles (rain splash) and water runoff.

When a water droplet strikes the soil, soil particles are disturbed and set in motion. If the rainfall rate (intensity) exceeds the infiltration capacity of the soil, the water starts flowing over the land surface as overland flow. Overland flow consists of narrow, shallow layers of water that converge only periodically in places.

Overland flow also initiates erosion known as rain-wash. Lower down along the runoff slope, the overland flow converges. The greater erosive force leads to the formation of runoff grooves or rills with steep sides that are only a few centimetres deep.

Where and when soil erosion takes place, is determined by the interaction between the force of the eroding agent (water or wind) and the erodibility of the soil surface.

The erosivity factor refers to the ability of the agent of erosion to erode the soil surface.

Erodibility, on the other hand, concerns the degree to which the soil surface can resist this erosive onslaught or otherwise.

**Textbook activity**

- Give reasons to explain why people probably attach the least value to soil as a resource base.
- Give a short description of the extent of soil erosion on a global scale.
- Study figure 14.2 on page 321 in Middleton. Make a list of the variables that play a role in soil erosion by water, and explain how these variables influence erosion.
- Identify the two natural surfaces (excluding tarred or paved surfaces) in your living or work environment which, in your opinion, stand the least and the greatest chance respectively of being eroded.

### 12.4 MEASURING SOIL EROSION

**Reading activity**

Study the section "Measuring soil erosion" on pages 321–324 in Middleton.

**Reading organiser**

- The various assumptions on which the measurement and forecasts of soil erosion are based.
- The lack of global data on erosion and the initiative that was launched to address the problem.
- Only note how the universal soil loss equation model can be implemented.

**Textbook activity**

- To what are we referring when we state that techniques that were developed to measure erosion often do not measure erosion as such, but are in fact a measurable consequence of erosion?

### 12.5 IMPACTS OF EROSION

**Reading activity**

Study the sections, "On-site effects" and "Off-site effects" on pages 324–328 in Middleton.
Reading organiser

- Erosion has an impact on the environment at the place where soil particles are lifted and carried (entrained), along the entire route over which they are transported, and at the place where the transported material is deposited.
- Lifting and carrying or entrainment is the first phase in the erosion process. This is where the soil particles are disturbed and set in motion. The entrainment of material has on-site effects affecting the land surface in the source area.
- The reduction of an area's capacity to support plant growth is certainly the most important on-site effect of soil erosion.
- Seriously eroded areas are known as badlands and are frequently characterised by deep erosion gullies. The removal of the topsoil exposes the deeper-lying hardpans and duricrusts in the soil. Water cannot infiltrate these dense, impervious layers, and plant roots cannot penetrate them, with the result that plants are unable to grow there.
- Impacts of the transportation and deposition of material are experienced beyond the source area, and are known as off-site effects. In fact, deposition could occur thousands of kilometres from the source area.

Textbook activity

- Describe the negative effects that wind erosion could have on agriculture and the nature of the soil.
- "The deposition of transported material influences human activities in a negative way only." Indicate whether you agree or disagree with this statement and substantiate your viewpoint.

12.6 ACCELERATED EROSION

Reading activity

Study the section "Accelerated erosion" on pages 328–334 in Middleton.

Reading organiser

- The role of human activities in the acceleration of erosion.

Textbook activity

- Name five reasons why the natural erosion rates for two different areas might differ.
- Name two of the most common human activities that give rise to accelerated erosion.
- What motivates people to remove or destroy vegetation?
- Explain what the prime cause of accelerated erosion is and the impact thereof on soil.
- Name two examples of human activities that lead to the destabilisation of natural land surfaces, and briefly explain how each of these activities destabilises the surface in question.
- Describe the long history of accelerated erosion associated with parts of the Caribbean.
12.7 SOIL CONSERVATION

**Reading activity**

Study the section "Soil conservation" on pages 334–337 in Middleton.

**Reading organiser**

- The three categories for classifying soil protection techniques.
- The basic differences between these categories.

**Textbook activity**

- Describe the three categories for classifying soil protection techniques and indicate what the basic differences between these categories are.
- A friend bought a small farm and plans to cultivate vegetables under irrigation on a moderate slope. Advise your friend on low-cost soil conservation techniques that he or she should consider.

12.8 IMPLEMENTATION OF SOIL CONSERVATION MEASURES

**Reading activity**

Study the section "Implementation of soil conservation measures" on pages 337–340 in Middleton.

**Reading organiser**

- Although we know how erosion starts, what factors it is affected by, and how it can be controlled, soil conservation projects in the developing world in particular seldom yield the desired results.
- The main reason that can be offered as an explanation, is that the projects are frequently based on faulty assumptions by both donor organisations and host governments.
- On the donor side, high expectations create illusions among people. If these expectations are not realised, the project, together with the necessary cooperation at grass-roots level – on which success depends – loses its momentum.
- Attention must focuses on the central reasons for people misusing soils. Haiti is a good example.

**Textbook activity**

- Explain shortly the underlying driving forces of the large-scale soil degradation in Haiti.

12.9 CONCLUSION

The conclusion we can come to with regard to erosion, is that mistakes have frequently been made in the past by not taking into account underlying socioeconomic and political considerations, as well as the cultural forces and drive for survival that motivate people to use soil in an unsustainable way.
LEARNING UNIT 13: BIODIVERSITY LOSS

Did you know?

The two domestic cats that were taken to the weather station on Marion Island provide a perfect example of what happens when a new species is introduced to an island, which in this case led to the extermination of endemic island species. The cats’ numbers increased to such an extent that they later became a very real threat to the survival of many bird species on the island. An extermination campaign eventually had to be launched against the cats to save the situation.

Sources to consult:

- Podcast: 13 Biodiversity Loss
- Satellite images: Invasive Plants: Lake Chivero, Zimbabwe under additional Resources on myUnisa
- Atlas: World map of biodiversity loss
- Prescribed book: Chapter 15, "Biodiversity loss", on pages 341–367 in Middleton
- Additional Resources on myUnisa: PowerPoint and a YouTube video

13.1 INTRODUCTION

The loss of biodiversity has various implications. One of the most direct implications is that the extinction of plant and animal species inevitably damage the functioning of ecosystems in some way. The removal of a single species from a food chain can have far-reaching consequences. The possibility of using undiscovered species for food, fuel, medicine or fibre, obviously disappears when species go extinct. The extinction of species also detracts from our knowledge and understanding of how nature functions. Above all, the extinction of plant and animal species has an ethical component: do people have the right to take away other species’ right to life?

Ecosystem modification and species extinction are as old as the earth itself, and can be ascribed to phenomena such as volcanic eruptions, climate change (eg ice ages and prolonged droughts) and veld fires. Today, however, people play a key role in the threat to biodiversity.
The risk of extinction is not equally great for all species and in all parts of the world. Some species face a greater risk of extinction because, for example, they can only live in specific conditions, while others only occur in very small numbers.

Most of the threats facing flora (plants) and fauna (animals) at present can be linked in some way to human influences. Human actions threatening biodiversity can be divided into deliberate actions, such as hunting and trade in animal products (e.g. rhinoceros horn) and unintentional actions, for example putting land to different uses and thereby destroying or modifying habitats.

In many countries, particularly those with high population densities, the demand for land for activities such as agriculture, settlement and industries has become so strong, that the natural habitats of animals and plants have already largely been destroyed.

In addition to causing habitat loss and modification, people are implicated as the main role-players in the extermination of species through the blatant, thoughtless, selfish and short-sighted way in which they exploit and often overexploit species for their own benefit and sometimes purely for pleasure.

Accurate estimations of the biological, social and economic impact of the loss of biodiversity are complicated by a lack of information and certainty about many aspects. For this reason, it is probably safest to apply the "precautionary principle", in other words to err in our efforts to reverse trends in species extermination and biodiversity loss rather than to err by doing nothing about the problem.

An alternative approach to preserving biodiversity, is to try to protect threatened species individually (ie on a species level). This includes efforts to stop the hunting of and trade in threatened species.

Although conservation aims are usually achieved best in nature, this is not always practically possible, especially in the case of species whose numbers are very small and which, in addition, do not occur in conservation areas. In such cases, the species can be conserved in artificial conditions, for example by transferring fauna to zoos, game farms or aquariums and by cultivating flora in botanical gardens.

13.2 LEARNING OUTCOMES

After completing this learning unit, you should be able to

- explain what "biodiversity" means
- name six fundamental causes of the loss of biodiversity due to human activities
- explain how threatened species are classified
- explain how the loss and modification of habitats, specifically deforestation, contribute to the loss of biodiversity
- explain how the overexploitation of biotic resources contributes to the loss of biodiversity
- briefly discuss the efforts being made to counteract the loss of biodiversity

13.3 UNDERSTANDING BIODIVERSITY

Reading activity

Study the two introductory paragraphs of the chapter on page 341, and the section "Understanding biodiversity" on pages 342–343 in Middleton.
Reading organiser

- The definition of biodiversity.
- What each of the following means:
  o genetic diversity
  o species diversity
  o ecosystem diversity
- The natural dynamics of species.
- The reason(s) why the biodiversity issue is currently in the spotlight.
- Humankind's role in the loss of biodiversity.
- The lack of knowledge about biodiversity, the world's biomes (natural regions) and ecosystems, and the consequences of this lack of knowledge.
- Trends in the loss of biodiversity.

Textbook activity

- Briefly describe the meaning of biodiversity.
- Briefly define the conclusions of the United Nations Conference on Environment and Development, which was held in Rio de Janeiro in 1992.
- Describe the trend over time as regards the extinction of species because of human activities.

13.4 THREATS TO BIODIVERSITY

Reading activity

Study the section "Threats to biodiversity" on pages 343–344 in Middleton.

Reading organiser

- The various natural phenomena and circumstances that can lead to the extinction of species.
- Scientific evidence for species' extinction in the history of the earth.
- The five direct drivers that cause the loss of biodiversity as a result of human activities.

Textbook activity

- Briefly explain how climate change can lead to the extinction of species.
- Substantiate the following statement: "The uncontrolled increase in the number of people on earth is a threat to the survival of certain species."

13.5 THREATENED SPECIES

Reading activity

Study the section "Threatened species" on pages 344–345 in Middleton.

Reading organiser

- Factors determining the risk of extinction of certain species.
- The difference between K-strategist and r-strategist species.
- The role of keystone species and how their extinction can lead to a chain reaction of extinctions of other species.
• How data on species' risk of extinction are classified on the Red Data List. See table 15.2 on page 345.

Textbook activity
• Briefly explain the difference between a vulnerable and an endangered species.
• What is the Red Data List?
• Describe how data on species' risk of extinction is classified on the Red Data List.

13.6 THREATS TO FLORA AND FAUNA

Reading activity
Study the section "Threats to flora and fauna" on pages 345 in Middleton.

Reading organiser
• Species often face different threats simultaneously.
• The threats to species vary over time.
• The chain of events that culminated in the extinction of New Zealand mistletoe.
• Species have become extinct because of human activities over centuries and not only in the past few decades.

Textbook activity
• Which activities of the earlier African colonists caused the numbers of various species of fauna to decline?

13.7 HABITAT LOSS AND DEGRADATION

Reading activity
Study the section "Habitat loss and degradation" on pages 345–348 in Middleton.

Reading organiser
• The extent of habitat loss in the world, with reference to different continents, countries and natural regions (biomes). The giant panda as an example of a species whose survival is threatened by habitat loss.
• The consequences of the fragmentation of habitats for species.
• The dung beetles of the Amazon forest as an example of a species that is affected by the fragmentation of habitats.
• The changes that occur in habitats as a result of pollution through human activities. Note in particular water pollution, air pollution and the role of poisons in agriculture.

Textbook activity
• What is the approximate extent of habitat loss in the tropical parts of Africa and Asia?
• Why are pandas a threatened species?
• Why are dung beetles a valuable species? What is threatening the survival of dung beetles in the Amazon basin?
• What is DDT, what is it used for and how does it affect raptors?
13.8 CLIMATE CHANGE

**Reading activity**

Study the section "Climate change" on pages 348 in Middleton.

**Reading organiser**

- Numerous ecological changes have been attributed to changes in climate change. See table 11.6 on page 252.
- The example of polar bears, harlequin frog, golden toad.
- The processes of climate change and habitat loss are happening concurrently.

**Textbook activity**

- Explain the impact of climate change on the polar bears, harlequin frogs and the golden toad.

13.9 POLLUTION

**Reading activity**

Study the section "Pollution" on page 349 in Middleton.

**Reading organiser**

- Most significant is pollution in its various forms regarding threats to flora and fauna.
- Examples: agrochemicals, acidification, 'dead zones', atmospheric pollutants

**Textbook activity**

- Why has "dead zones" in coastal waters increased over the past 100 years?

13.10 OVEREXPLOITATION

**Reading activity**

Study the section "Overexploitation" on pages 349–351 in Middleton.

**Reading organiser**

- Scientific evidence of the overexploitation of fauna from the Stone Age to the Late Pleistocene.
- Overexploitation of fauna in Roman times.
- The dodo and the North American passenger pigeon as examples of fauna that became extinct because of overexploitation.
- The elephant and certain whales as examples of fauna that were threatened because of the relatively high prices obtained for their products on international markets.
- In the case of flora species, there is a connection between overexploitation and market demand.
- Examples of the extinction of flora because of overexploitation.
Textbook activity

- Discuss the impact of overexploitation and illustrate by means of relevant examples.

13.11 INVASIVE ALIEN SPECIES

Reading activity

Study the sections "Invasive Alien Species" on pages 351–352 in Middleton and pages 372–376 (first two paragraphs), "Impacts on the Biosphere".

Reading organiser

- Increased trade, travel and transport have facilitated the spread of invasive alien species.
- On page 373 it is stated that the movement of people has assisted biological invasions both deliberate and unintentional.
- Examples of plants and animals deliberately transported for subsistence and commercial purposes are: pigs, chickens, yams, taro, coconuts, potatoes and maize.
- Unintentional dispersal is when species are transported by automobiles, aircrafts and ships. Examples include alewife, lamprey, zebra mussel and little red fire ant.

Textbook activity

- Describe the impact of the introduction of the alewife, and lamprey on the Atlantic salmon, lake charr/lake trout.
- Explain how the unintentional dispersal of the zebra mussel has an impact on the Great Lakes.

13.12 ISLAND SPECIES

Reading activity

Study the section "Island species" on pages 352–355 in Middleton.

Reading organiser

- The reasons why species on islands are particularly vulnerable to extermination.
- Madagascar as an example of an island where many fauna species have already become extinct, probably because of indiscriminate hunting.
- How the introduction of goats affected ecosystems on St Helena.
- How new, exotic fauna threaten endemic (indigenous) fauna on islands.
- Hawaii as an example of an island where some species became extinct long before the arrival of colonists.
- Examples of cases where the introduction of a single new species to an island lead to the extinction of a whole series of endemic island species.

Textbook activity

- Use your atlas to make sure that you know where the following islands, referred to in chapter 15 in Middleton (pp 306–307), are situated:
  o Hawaii
  o Madagascar
  o St Helena
13.13 CONSERVATION EFFORTS

Reading activity

Study the introductory paragraphs of the section "Conservation efforts" on pages 356–357 in Middleton.

Reading organiser

- Make sure you understand the various arguments for and against preserving biodiversity. Note that people have different views on biodiversity, and that these views (that are actually perceptions) change over time.
- Despite different perceptions of biodiversity, most people agree that it is necessary to protect habitats against the causes of destruction, modification and fragmentation. This is because these three processes together are the main threat to biodiversity.

Textbook activity

- Why is biodiversity valuable to humans?

13.14 HABITAT PROTECTION

Reading activity

Study the section "Habitat protection" on pages 357–361 in Middleton.

Reading organiser

- Percentage of the earth's surface where habitats are currently protected.
- Spatial variation in the percentage of protected or preserved areas (ie how this percentage varies from country to country).
- Relative representation of the various biomes in the areas that are protected.
- Variation in the type and quality of conservation and management in the various areas and the reasons for this variation.
- Conflict between the aims of conservation and the aims of local populations in and around protected areas.
- An illustration of the above is conflict around efforts to prevent the extinction of the tiger in Asia.
- Some reasons why the conservation of habitats is generally problematic.
- The importance of knowledge and information to effective conservation of habitats.

Textbook activity

- What percentage of the earth's surface is currently covered by conservation areas?

13.15 BANS ON HUNTING AND TRADE

Reading activity

Study the section "Bans on hunting and trade" on pages 361–362 in Middleton.
Reading organiser

- The role of legislation and international agreements in banning the hunting of and trade in threatened species.
- Factors diluting the effect of legislation, agreements and treaties.
- Problems surrounding efforts to protect the African elephant, and the role of legislation and agreements in this regard.
- The role of the Convention on International Trade in Endangered Species (CITES) in stopping the trade in threatened species.
- The argument that a total boycott on products from threatened species is the only long-term solution.

Textbook activity

- What are Ramsar and CITES?
- Why did the price of ivory fall so drastically in 1989? What was the effect of this on the illegal hunting of elephants in Africa?

13.16 OFF-SITE CONSERVATION PRACTICES

Reading activity

Study the section "Off-site conservation practices" on pages 363–365 in Middleton.

Reading organiser

- Off-site conservation complements conservation in nature but will never be able to replace conservation in nature.
- The main functions of off-site conservation are to create research opportunities and to provide individual members of threatened species for re-establishment in the wild.
- Advantages and disadvantages of off-site conservation.
- Problems in implementing off-site conservation programmes.

Textbook activity

- Compare the advantages and disadvantages of off-site conservation. Illustrate your answer by means of examples of the implementation of off-site conservation.

13.17 CONVENTION ON BIOLOGICAL DIVERSITY

Reading activity

Study section "Convention on biological diversity" on page 366–367 in Middleton.

Reading organiser

- Make sure that you are aware of the aims of the Convention on Biological Diversity and of how these aims are to be achieved.
- The stipulations of this convention regarding the sustainable use and conservation of biodiversity.

Textbook activity

- Explain why the sustainable use and conservation of biodiversity make demands on countries.
13.18 CONCLUSION

We conclude with a speech of the Executive Secretary for the Convention on Biological Diversity Braulio Ferreira de Souza Dias, on World Environment Day, 5 June 2014.

“Islands constitute less than 5 per cent of the Earth's landmass yet provide habitat for 20 per cent of all bird, reptile and plant species. Islands harbour more than 50 per cent of the world's known marine biodiversity, 7 of the world's 10 coral reef hotspots and 10 of its 34 conservation hotspots.

Residents of islands understand the linkage between healthy ecosystems and biodiversity and human well-being. Biodiversity-based industries such as tourism and fisheries account for over half the GDP of the economies of Small Island Developing States. Coral reefs alone provide an estimated US$ 375 billion every year in goods and services, globally.

Yet the biodiversity of islands is at risk. Due to the vulnerability of their endemic biota and their intense human use, islands have higher extinction rates. For example, 64 per cent of all recorded extinctions in recent human history happened on islands. Extinction rates for mammals are 177 times higher in island ecosystems than the average globally.

Moreover, the special characteristics of islands and island biodiversity also make them highly vulnerable to a large range of potential impacts from climate change. Climate change and ocean acidification threaten marine resources, such as coral reefs that are suffering the effects of bleaching, pollution and other stressors. Projected sea-level rise poses a high risk for low-lying islands and their coastal resources, such as corals, mangroves and reef fish.

Resilient and healthy ecosystems are a cost-effective way of managing some of the adverse impacts of climate change, such as increased storm surge flooding and erosion. For example, it is estimated that coral reefs and seagrasses protect 5.5 per cent of Jamaica's GDP from sea-level rise and hurricanes. St. Lucia's marine protected areas have produced significant gains to fish stocks and have also shown that protecting coral reef ecosystems assists in their recovery in the aftermath of natural disturbances such as hurricanes.

When appropriately designed, ecosystem restoration and management of terrestrial and coastal biodiversity including seagrasses, salt marshes, mangroves and forest ecosystems, can also increase carbon sequestration and decrease emissions from ecosystem degradation, thereby contributing to climate change mitigation. The negative impacts of climate change are projected to compound biodiversity loss through invasive species. Climate change is likely to increase opportunities for invasive species because of their adaptability to disturbance and to a broader range of biogeographic conditions and environmental controls.

From the preservation of marine and coastal resources to climate change mitigation and adaption, from the production of renewable energy to the development of sustainable tourism, islands offer many lessons in resilience and sustainability. As discussions in the United Nations are progressing to frame new sustainable development goals, the experience and knowledge of islands can contribute significantly to the conservation and sustainable use of our planet's biodiversity and natural resources” (UNEP News Centre 2014).
REFERENCE LIST


