



UNITED REPUBLIC OF TANZANIA



BIODIVERSITY CONSERVATION

**A Learning Resource Guide for Teachers in
Ordinary Level Secondary Education in Tanzania**



VICE PRESIDENT'S OFFICE

FEBRUARY 2013

PREFACE

Survival of any society depends directly or indirectly on environmental resources. Our environment is experiencing degradation everyday due to clearance of forests, unsustainable use of wetlands and overexploitation of some plants and animal species. This degradation leads into rapid decline of biodiversity. In order to ensure long-term health of our planet, we need to develop an informed population to understand the need and importance of protecting the existing biodiversity. Environmental education therefore is one of the best tools to achieve this goal.

Through Environmental Education, students can be agents of change as well as future decision makers on sustainable use of biodiversity. These students are therefore; part of an important target group for environmental education. Such education will make them become active and responsible environmental champions to be able to value our biodiversity. It is our responsibility to develop students with a sense of ownership of their local natural environment and be able to act locally while taking into account the global context of their decisions, now and in the future.

For students to learn more about their local environment, teachers are encouraged to spend as much time as possible on practices to make use of the natural environment that exists in their areas. Such areas include school compounds, nearby forests, rivers, lakes, oceans and some protected areas.

This Guide is designed for teachers and students with the objective of enabling them to internalize the concept and importance of biodiversity conservation in the context of the various subjects taught at the Ordinary Level Secondary

Education. The Guide highlights the relevance, teaching methodology, teaching aids and hands-on activities for each subject to facilitate the understanding of biodiversity concepts and principles on theoretical and practical perspectives.

We hope this Guide will aid the target groups be exposed to the wonderful diversity of life around them with thoughtful discussions about their role in conserving biodiversity for the benefit of the current and future generations.



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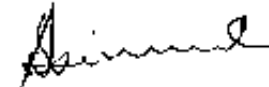
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ACRONYMS

EE	Environmental Education
ESD	Education for Sustainable Development
DANIDA	Danish International Development Agency
SADC-REEP	Southern African Development Cooperation - Regional Environmental Education Programs
SIDA	Swedish International Development Agency
VPO	Vice President's Office
WESSA	Wildlife Environmental Society of South Africa
WWF	Worldwide Fund for Nature

CHAPTER ONE

INTRODUCTION

1.1 What is Biodiversity?

Biodiversity comes from the term 'biological diversity'. Biodiversity is a term given to the variety of all forms of life on Earth including plants, animals and micro-organisms and their interrelationship ('**Bio**' means life and **Diversity** means variety). Biodiversity includes a variety of **ecosystems, species** and **genes**, and the ecological processes that support them (Figure 1).



Figure 1: Ecosystem and species diversity

There are three levels of biodiversity namely:-

- (a) **Species diversity:** This refers to the variety of types of plants, animals, and micro-organisms.



Figure 2: Biodiversity in Lake Manyara

(b) Genetic diversity: This refers to the variety of genes within a species of plant or animal. Healthy plant and animal populations have a genetic variety, that is, they are not all from the same small number of parents. Genetic diversity serves as a way for populations to adapt to changing environments. Example of genetic variations in dogs is the difference in skin colour, ears, eyes and body shape.

(c) Ecosystems diversity: This refers to the variety of natural systems which provide the homes or habitats and services for all organisms. Examples of ecosystems diversity are forests, mountains, rivers, lakes, wetlands, oceans and deserts.

1.2 Importance of Biodiversity

Biodiversity is vital for supporting all life forms on Earth. Biodiversity is the foundation of healthy functioning ecosystems

upon which all life depends. Biodiversity provides the following ecological services: soil formation; nutrient, nitrogen, oxygen and carbon cycling; energy production; flood and erosion control; clean air; clean water; breaking down pollutants; pest and disease control; food and medicines.

Biodiversity also provides raw materials for construction and industrial production as well as opportunities for recreation, tourism, scientific research and education, and source of cultural identity

1.3 Education for Sustainable Development (ESD) and Biodiversity

Education for Sustainable Development (ESD) is a concept that focuses on how education can contribute to sustainable development. It aims to help people to develop the attitudes, skills and knowledge to make informed decisions for their benefit and others, now and in the future.

Biodiversity is the source of economic sustenance and ecological security. However, human activities such as fishing, agriculture, tourism and mining threaten biodiversity endowment particularly when undertaken in unsustainable manner. In this regard, imparting relevant knowledge and skills to the population is necessary to ensure effective biodiversity conservation and hence the need for ESD becomes relevant and important.

1.4 Objective and Justification of the Guide

The overall objective of the Guide is to assist the process of teaching and learning biodiversity concepts in Ordinary Level Secondary Education in the country.

The current syllabus for Ordinary Level Secondary Education does contain some aspects of relevance to biodiversity conservation.

However, they are inadequate to help students understand clearly the concept and importance of biodiversity conservation to our life. This Guide therefore serves as a quick reference to help teachers broaden their understanding and hence impart the knowledge to students and encourage good practices in the conservation of biodiversity within their environment.

1.5 Preparation Process of the Guide

The preparation of this Guide involved the Vice President's Office in collaboration with the Ministry of Education and Vocational Training. The draft Guide was reviewed in a National Stakeholders Workshop that gathered a wider spectrum of stakeholders including Government Ministries and Agencies, Curriculum Development Institute, Secondary Schools, UNESCO National Commission and Non-Governmental Organizations. Comments by stakeholders were then incorporated in the Final Guide.

1.6 Scope of the Guide

This Guide targets students and teachers at Ordinary Level Secondary Education (O-Level) in the country. It is designed to be used along with the current O-Level syllabus. The Guide include topics in the subjects where biodiversity conservation aspects can be taught and these are: Geography; History; Mathematics; Biology; Physics; Chemistry; English Language; and Civics. Therefore the Guide provides direction to teachers and students in the teaching and learning biodiversity conservation. This includes lecture notes, methodology, guiding questions, quizzes and assignments which are intended to consolidate students' involvement and understanding of biodiversity conservation aspects related to respective subject.

CHAPTER TWO

BIODIVERSITY IN GEOGRAPHY

2.1 Introduction

Geography is the study of interactions between humans and their environment (landscapes, climates, water sources, plants, and animals) and other entities. The contents and methodologies of teaching geography have a great role to contribute to the teaching of Biodiversity. The knowledge of geography contributes to understanding of the processes which affects biodiversity in the environment. The subject helps to stimulate learners' interest to manage and conserve biodiversity.

Through geography, teachers can engage students in the areas of biodiversity using a wide range of topics including soil science, water resources management, tourism and forestry. A diverse of methodologies can be used to enhance learners' understanding and participation in the conservation of biodiversity.

2.2 Biodiversity in Soil Science

2.2.1 Teaching Notes

Soil biodiversity reflects the mix of living organisms in the soil. These organisms interact with one another and with plants and small animals forming a network of biological activities which encourages the existence of biodiversity.

Soil is the most biologically diverse part of Earth. The soil biodiversity includes beetles, springtails, mites, worms, spiders, ants, nematodes, fungi, bacteria, and other organisms. These organisms improve the entry and storage of water, control erosion, plant nutrition, and break down of organic matter. A wide variety of organisms provides

checks and balances to the soil food web through population control, mobility, and survival from season to season. Loss of soil biodiversity can be caused by the removal of plants or vegetation on the soil. The situation will cause soil erosion which results to loss of soil organisms.

Soil conservation is done through planting vegetation on the bare land or conservation of natural vegetation. This encourages micro-organism populations in the soil and increase soil nutrients. The area covered by natural or planted vegetation will be protected from soil erosion caused by surface run-off.



Figure 3: Degraded land due to tree felling in Mamsera village Rombo, Kilimanjaro



Figure 4: Vegetation cover in Udzungwa Mountains

2.2.2 Teaching Methodology

The teacher may use the following methodologies when teaching Biodiversity in Soil Science.

- a) Lecturing;
- b) Guided discussion; and
- c) Learning by doing or activity out of class.

2.2.3 Learning Resources

In order to facilitate the teaching and learning of biodiversity through soil science, the teacher may use the following resources.

- i) Text books and reference books on soil biodiversity;
- ii) Diagrams and pictures which display various soil profiles showing organisms found in the soil; and
- iii) Video or power point slides on soil biodiversity.

2.2.4 Lesson Activity

The teacher will guide students to discuss on:

- i) Importance of biodiversity in the soil;
- ii) Human activities which cause soil erosion; and How soil erosion can be controlled.

The teacher will also guide students to:

- i) Plant trees or grass on bare land and areas affected by soil erosion in the school compound; and
- ii) Examine section of a land/soil to assess the availability of living organism (including plants, animals and micro-organisms).

The teacher may also present to students a power point presentation or a video of a cross section of soil profile showing soil Biodiversity.

2.2.5 Evaluation

The teacher will provide students with an exercise to identify and name micro-organisms found in the soil and their functions.

2.3 Biodiversity in Tourism

2.3.1 Teaching Notes

Tourism is sum of phenomena and relationship arising from the travel and stay of non resident in so far as they do not lead to permanent residence and are not connected to any earning activity or is the journey and stay which take place outside the normal place of residence and work for pleasure and interest.

Tourism basically depends on attractions (unique biodiversity), availability of infrastructure, accommodation and transport. Major tourist attractions includes: National parks, World heritage sites, Nature reserves, marine parks and reserves and historical sites.

Tourism contributes significantly to the national revenues and therefore maintenance of species and habitat diversity is very important. It also provides employment opportunity, income generation and poverty alleviation to the indigenous and local communities. However, if tourism activities are not carried out properly may result into environmental degradation and loss of biodiversity. Biodiversity is a vital element of tourism. Tanzania has a wide range of wildlife in National Parks and Game Reserves.

In teaching Tourism industry, the teacher should introduce the students to the importance and contribution of biodiversity in the development of Tourism in Tanzania.



Figure 5: Tourism in Tarangire National Park in Manyara Region

2.3.2 Teaching Methodology

The following methodologies may be used by the teacher when teaching Biodiversity in Tourism:

- i) Guided discussion;
- ii) Brainstorming;
- iii) Audio-visual presentation; and
- iv) Field trips.

2.3.3 Learning Resources

In teaching of biodiversity in Tourism, the teacher may use the following resources.

- i) Text books and reference books on biodiversity and Tourism;
- ii) Diagrams/illustrations and photographs of tourist attractions; and
- iii) Video tapes/films or power point slides of various biodiversity ecosystems related to Tourism industry.

2.3.4 Lesson Activities

The teacher will guide students to:

- i) Identify and explain the role of biodiversity in the tourism industry;
- ii) Discuss the tourism practices that affect biodiversity;
- iii) Brainstorm the benefits of tourism industry to the economy of the country;

In order for students to have a better understanding of Biodiversity concept through Tourism, the teacher will;

- i) Present a short video showing wild animals in a tourist attraction;
- ii) Prepare a field trip for students to visit the nearby tourist attraction; and
- iii) Guide students to use books, magazines and pictures/ photographs of biodiversity found in tourists attractions such as insects, plants, birds and wild animals.

2.3.5 Evaluation

The teacher will provide students with an assignment to assess their ability to explain the significance of unique ecosystems and biodiversity to the tourism industry.

2.4 Biodiversity in Water Management

2.4.1 Teaching Notes

Tanzania has large water bodies such as Indian Ocean, Lake Victoria, Lake Tanganyika, Lake Natron, wetlands such as Ihefu and numerous rivers which are vital habitats for various aquatic plants and animals including fish, birds, crocodiles, hippos and millions of micro organisms. The interactions of these organisms are important for their existence and the ecosystem.

Water supply is very crucial for both human and economic activities. Main sources of water are ocean, lakes, rivers,

swamps, wetlands and ponds. Human, ecological need and economic use of water includes domestic consumption, industrial activities, transportation activities, power generation and ecological services. Water bodies also harbours vast of aquatic species which require healthy aquatic ecosystem. Therefore Water management is crucial for maintaining these environmental goods and services.

Water management includes conservation of catchment areas, water bodies and sustainable use for economic development. This implies that water bodies are protected from source pollution, encroachment and conversion to other land uses. Destructions and/or poor management of water bodies and catchments area may results into deterioration of aquatic systems and loss of biodiversity.



Figure 6: Fishing in Lake Victoria

2.4.2 Teaching Methodology

The teachers may use the following teaching methodologies to introduce students to the concept of Biodiversity in Water Management:

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-
- i) Lecturing;
 - ii) Guided discussions;
 - iii) Audio-visual presentation; and
 - iv) Field trips.

2.4.3 Learning Resources

The required teaching and learning resources in teaching biodiversity in Water Management include;

- i) Text books and reference books on biodiversity and Water Management;
- ii) Diagrams and pictures on Biodiversity in Water bodies; and
- iii) Video showing various fresh water and marine organisms.

2.4.4 Lesson Activities

During the teaching and learning process, the teacher will engage students to:

- i) Identify various aquatic organisms in fresh water and marine ecosystems; .
- ii) Explain the causes of water pollution and the effects to biodiversity;
- iii) Discuss human activities which can cause extinction of some organisms in the water sources; and
- iv) The significance of water management with regards to biodiversity conservation.

To enhance students' understanding of the concept, the teacher will also;

- i) Use audio-visual materials to show students various flora and fauna found in water bodies; and
- ii) Prepare a field trip to the nearby water body and help students identify the available Biodiversity.

2.4.5 Evaluation

The teacher will prepare an exercise to evaluate students understanding of the concept of Fresh water and Marine Biodiversities and suggest ways to conserve them.

2.5 Biodiversity in Forestry

2.5.1 Teaching Notes

A forest is a dense growth of trees, plants, and underbrush covering a large area. Tanzania is endowed with vast natural forest resources. The forests are vital sources of energy, timber, wood and pulp, medicines and construction materials. Forests and woodlands are important habitat for a diverse of plants, animals and micro-organisms forming forest biodiversity which offer important ecological goods and services.

Human activities such as agriculture, lumbering, hunting and expansion of settlements and infrastructures are threatening forest ecosystems. Bush fires are also responsible for destructions of forests ecosystems and biodiversity. Therefore, Forests management is important for the conservation of resources available in the forests.



Figure 7: Tropical Forest on the slopes of Mount Kilimanjaro



Figure 8: Forest clearance for Agriculture

2.5.2 Teaching Methodology

The following methodologies may be used by the teacher when teaching Biodiversity in Forestry resources:

- i) Lecturing;
- ii) Guided discussion;
- iii) Brainstorming;
- iv) Audio-visual presentation; and
- v) Field trips.

2.5.3 Learning Resources

Biodiversity in Tourism can be taught by using the following teaching and learning resources:

- i) Text books and reference books on biodiversity and Forestry;
- ii) Diagrams/illustrations and pictures of forest ecosystems; and
- iii) A video showing forest resources.

2.5.4 Lesson Activities

During the lesson the teacher will introduce the concept of Biodiversity to students through the following activities:.

- i) The teacher will guide students to discuss forest biodiversity;
- ii) The teacher will guide students to visit a nearby forest or woodland to see and identify various flora and fauna;
- iii) The teacher will guide students to plant various types of trees in the school compound; and
- iv) Using a video or film to show students various ways of extracting timber from forests.

2.5.5 Evaluation

The teacher will engage students to brainstorm on the following questions:

- i) Describe the importance of forests;
- ii) Explain different ways of extracting forest resources, their advantages and disadvantages; and
- iii) Explain why it is important to conserve the forest biodiversity

CHAPTER THREE

BIODIVERSITY IN HISTORY

3.1 Introduction

In History, we look back through time to see how the interactions of different societies and their environment have shaped the environment and societies. In this approach we learn cultural aspects of societies in the past and the way in which technologies and innovations have helped societies to struggle against nature as well as changing the ways of living in particular physical environment settings to the present and future. Biodiversity can therefore be taught in history subject along the topics such as African Societies, culture and social organisations.

3.2 Teaching Notes

Pre-colonial African political organizations developed in different forms depending on the availability of natural resources and environment. Biodiversity played a great role in shaping the traditions, customs, beliefs, norms and values of people. It also determined the main social and economic activities and modes of production in obtaining the basic needs. Some societies became hunters and gatherers; others became pastoralists, crop cultivators and fishermen, all because of the biodiversity available in a particular area. African societies used biodiversity components such as forests for worships in their beliefs and others for initiation ceremonies.



Figure 8: An African Hunters and Gatherers society



Figure 9: An African Crop cultivators society

During pre-colonial period, some African societies became centralized political organizations while others were decentralized political organization.

3.3 Teaching Methodology

In History, teaching Biodiversity may involve the following methodologies:

- i) Guided discussion;
- ii) Audio-visual presentation; and
- iii) Field trips.

3.4 Learning Resources

The following teaching and learning resources may be used by the teacher when teaching Biodiversity in History.

- i) History text books and reference books;
- ii) Diagrams/illustrations and photographs of Biodiversity aspects in History; and
- iii) Video of various historical events.

3.5 Lesson Activities

During the lesson, the teacher may introduce students to the following:

- i) Guide students to discuss the nature and characteristics of Pre-colonial African societies;
- ii) The role of biodiversity in determining the culture and socio-economic activities of pre-colonial African societies;
- iii) Social and political organizations that developed in different parts of Tanzania due to geographical and environmental factors; and
- iv) Use video tapes to show students historical events.

3.6 Evaluation

The teacher will give an assignment to students to explain how Pre-colonial African societies developed social and political organization based on various economic activities determined by environmental resources including the available biodiversity.

CHAPTER FOUR

BIODIVERSITY IN MATHEMATICS

4.1 Introduction

In mathematics, basic concepts such as addition, subtraction, multiplication are very crucial in developing students' minds to understand the ways in which we use the biodiversity resources to avoid depletion or extinction of species.

The concepts of mathematics are also important in understanding the environmental risks such as loss of biodiversity, overpopulation, global warming, and pollution. It is also through the mathematical concepts that people determine the best means to conserve biodiversity and sustainable use of environmental resources. For example you can compute to know the number of animals that can be grazed sustainably in a particular area. Also you can compute to know the amount of fish which can be exploited sustainably in a particular water body.

4.2 Teaching methodology

- i) Teaching;
- ii) Guided question; and
- iii) Learning by doing

4.3 Learning Resources

- i) A map of Tanzania showing location of Lake Victoria
- ii) Picture of lake Victoria with Nile perch and Tilapia

4.4 Teaching Notes

In introducing mathematical concepts on additions and subtraction, the teacher will prepare lesson notes to guide

students to perform various mathematical calculations. For example, the introduction of new species in an ecosystem may lead to extinction of the indigenous species. The introduction of the Nile Perch (*Sangara*) in Lake Victoria led to extinction of other fish species (*Tilapia* and *Hypochromis*) in Lake Victoria.



Figure 10: Marine prey and predator relationship

4.5 Lesson Activities

Teacher will use concepts in Arithmetic to guide students to explain the importance of biodiversity and the concept of species extinction.

The teacher may use mathematical concepts to guide students to show the danger of extinction of some species in the ecosystem.

4.6 Guided Question

The teacher may use the following question to initiate the concept of loss of biodiversity in the ecosystem:

- a) 1 Nile perch feeds on 5 tilapia per day. How long will it take for 5 Nile perch to feed on 240,000 tilapia?

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- b) Population of Tilapia in Lake Victoria is 50,000,000. Every day 50 fishermen are catching 5000 tilapia.
- i) After how many days tilapia will be finished in the lake?
 - ii) What will be the effects of biodiversity within the lake ecosystems?
 - iii) How could it be controlled?

4.7 Learning by doing

- a) The teacher will guide students to do the following:
 - i) Measure the areas of school compounds and calculate the number of different species of plants and animals in each area.
 - ii) Create flower gardens with various geometric shapes and calculate the volume and areas covered by flowers.

- b) The teacher will guide students to collect data on the number and types of plants and animals available in the school compound or school grounds.

CHAPTER FIVE

BIODIVERSITY IN BIOLOGY

5.1 Introduction

The term biology is derived from the Greek word bios, “life” and the suffix -logia, “study of.” Therefore, biology can be defined as the study of living organisms. It is a natural science concerned with the study of life and living organisms, including their structure, function, growth, origin, evolution, distribution, and taxonomy. A good example where biodiversity can be taught in Biology is “food chain/web” concept.

5.2 Teaching Methodology

- i) Lecturing;
- ii) Guided question; and
- iii) Learning by doing

5.3 Learning Resources

- i) Chart/picture showing feeding relationship among organisms, and
- ii) Video showing feeding relationship among organisms

5.4 Teaching notes

A food chain is somewhat a linear sequence of links in a food web starting from a trophic species that eats no other species in the web and ends at a trophic species that is eaten by no other species in the web.

A food chain shows how each living thing gets its food. Some animals eat plants and some animals eat other animals. For example, a simple food chain links the trees & shrubs, the giraffes (that eat trees & shrubs), and the lions (that eat the

giraffes). Each link in this chain is food for the next link. A food chain always starts with plant life and ends with an animal.

Food chain/web is a succession/interdependence of organisms in an ecological community that constitutes a continuation of food energy from one organism to another as each consumes a lower member and in turn is preyed upon by a higher member. This is important for maintaining the balance in the ecosystem. If you remove one item in the chain you disturb the whole chain.

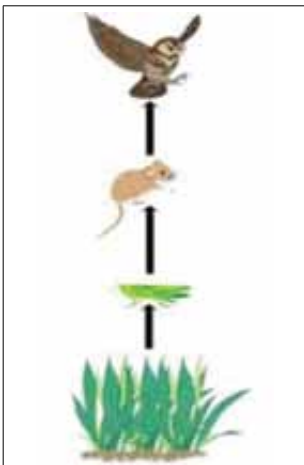


Figure 11: Food chain (just one path of energy)

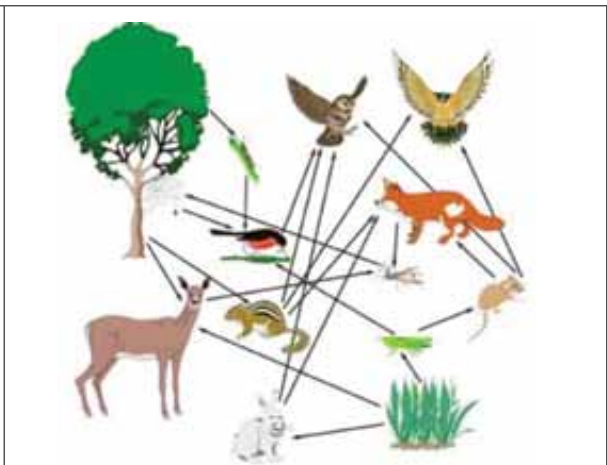


Figure 12: Food web (everything is connected)

5.5 Lesson Activities

The teacher should guide students to

- i) Show an interaction and interdependence of living organism in the **food chain/web**.
- ii) Explain the effects which will occur when one organism is removed from the chain/web.
- iii) Play a round of “drawing cards” s of different species in a food web. The disappearance of “drawing card” signals

-
-
- the extinction of that species. Students learn how the extinction of species affects others in the food chain/web.
- iv) Explain how plants and animals interact each other in the food chain/web;
 - v) Identify human activities which cause loss of species in a food chain/web;
 - vi) Explain how the disappearance of one species affects other species in a food chain/web;
 - vii) Choose a plot of the school compound and identify the existence of various organisms and explore their inter-relationships among them.

5.6 Evaluation

The teacher will ask students to perform hands-on/minds-on activities that will build students' understanding of food chain and food web.

CHAPTER SIX

BIODIVERSITY IN PHYSICS

6.1 Introduction

Physics (from Greek: *physis* “nature”) is a natural science that involves the study of matter and its motion through space and time, along with related concepts such as energy and force.

Biodiversity can be introduced in physics subject in connection with loss of biodiversity due to introduction of technologies that cause environmental degradation. In Physics, students are taught how energy is produced and used to run machines, lighting and heating. The outcome of energy use is the emission of excess carbon dioxide (CO_2) and other hazardous chemicals. The result of these chemicals is pollution on air, land and water. This cause the global warming and climate change. The outcomes of those actions on Earth are destructions of ecosystems which lead to loss of biodiversity.

Conservation of biodiversity including vegetation cover plays an important role in protecting catchments areas which provide water for hydropower generation.



Figure 13: Part of the Mtera Dam

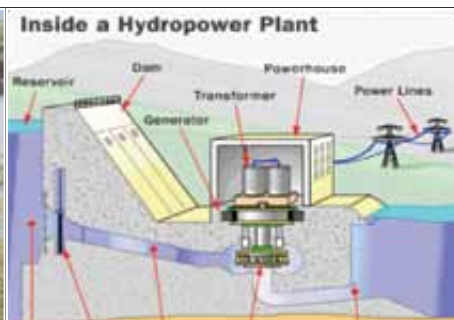


Figure 14: Hydroelectric power generation

The major sources of hydroelectric power in Tanzania includes Mtera, Kidatu, Kihansi, Pangani and Nyumba ya Mungu dams. Conservation of Biodiversity along Udzungwa Mountains, Rungwe mountains, and Ihefu wetlands will provide more water to those dams and hence they will produce more electricity. The increasing demand of electricity also puts pressure on the sources of water from the sources hence droughts and loss of aquatic organisms.

The burning of fossil fuels for power generation and in engines, increases carbon dioxide emission in the atmosphere causing global warming and climate change which threatens biodiversity.



Figure 15: Burning of fossil fuels



Figure 16: Chemical waste discharged from an industry

6.2 Teaching Methodology

- i) Lecturing;
- ii) Guided discussion; and
- iii) Learning by doing

6.3 Learning Resources

- i) Drawing/model showing how hydroelectric power works;

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- ii) Video showing how hydroelectric power works;
 - iii) Picture/chart showing how rainwater is harvested;
 - iv) Picture/chart showing how to make a Solar cooker.

6.4 Lesson Activities

- a) The teacher will lead students to;
 - i) Discuss the interconnections between electricity production and biodiversity conservation.
 - ii) Explain the effects of burning fossil fuels on various organisms.
 - iii) opt for different technologies that do not have negative effect on biodiversity (solar power, wind power and biogas)

- b) As a project, teacher will guide students to explore the design of different technologies which will not destruct biodiversity such as solar energy, natural gas and biogas. However, teacher will guide students to design rain water harvesting tanks.
 - i) How to make your own solar cooker; visit www.solarcooking.org/plans
 - ii) How to harvest rain water visit; www.rainxchang.com, www.kyaso.co.za

6.5 Evaluation

The teacher will give assignments to students to assess their understanding of different sources of energy and their advantages and disadvantages to biodiversity.

CHAPTER SEVEN

BIODIVERSITY IN CHEMISTRY

7.1 Introduction

Chemistry is the science of matter, especially its chemical reactions, but also its composition, structure and properties. Chemistry is concerned with atoms and their interactions with other atoms, and particularly with the properties of chemical bonds.

Biodiversity is one of the major sources of chemicals which can be extracted from forest ecosystems, water ecosystems, and micro-organisms. Chemicals have many uses in industries, hospitals, agriculture and domestic. Despite their significance in human activities, chemicals are very dangerous substances which can easily harm people and the environment. Improper use of chemicals may result into pollution of water bodies, land and air which may lead to human diseases and environmental degradation. Environmental pollution is also dangerous to ecosystems and biodiversity. Therefore, conservation of biodiversity is very important to ensure adequate production of chemicals as well as protecting species from environmental pollution.

Teaching of biodiversity in Chemistry subject can be done in various topics, but in this guide the focus will be on **soil** chemistry and **nitrogen cycle**.

7.2 Teaching Notes

Nitrogen Cycle

The nitrogen cycle is the set of biogeochemical processes by which nitrogen undergoes chemical reactions, changes form,

and moves through different reservoirs on earth, including living organisms.

The **nitrogen cycle** is the process by which nitrogen is converted between its various chemical forms. This transformation can be carried out by both biological and non-biological processes. Important processes in the nitrogen cycle include fixation, mineralization, nitrification, and denitrification.

The majority of Earth's atmosphere (approximately 78%) is nitrogen, making it the largest pool of nitrogen. Nitrogen in the air becomes a part of biological matter mostly through the actions of bacteria and algae in a process known as **nitrogen fixation**. Legume plants such as clover, alfalfa, and soybeans form nodules on the roots where nitrogen fixing bacteria take nitrogen from the air and convert it into ammonia, NH_3 . The ammonia is further converted by other bacteria first into nitrite ions, NO_2^- , and then into nitrate ions, NO_3^- . Plants utilize the nitrate ions as a nutrient or fertilizer for growth.

The reaction of ammonia and nitric acid produces ammonium nitrate which may then be used as a fertilizer. Animal wastes when decomposed also return to the earth as nitrates. To complete the cycle other bacteria in the soil carry out a process known as denitrification which converts nitrates back to nitrogen gas.

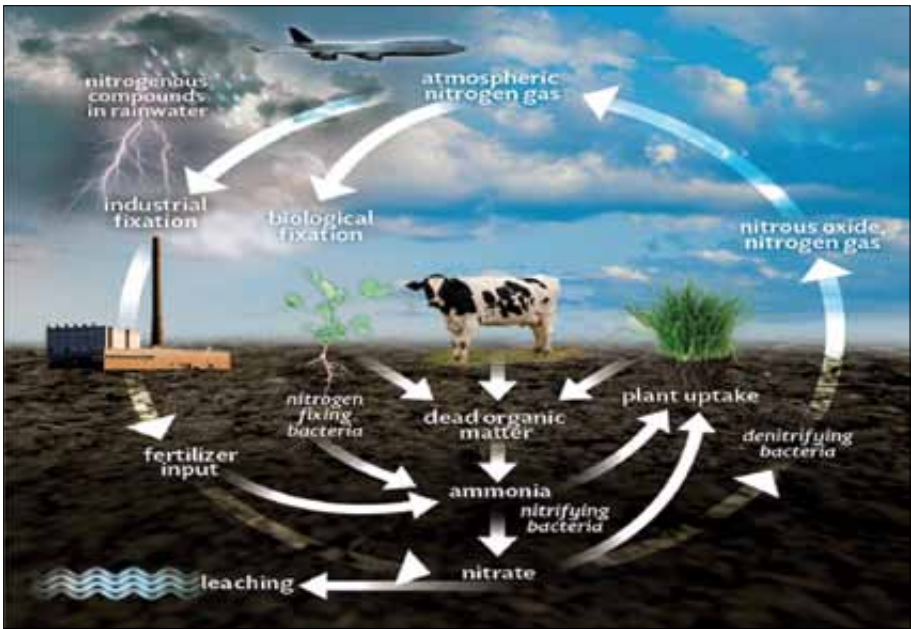


Figure 17: Nitrogen Cycle

7.3 Teaching Methodology

- i) Teaching;
- ii) Guided questions;
- iii) Story telling; and
- iv) Learning by doing.

7.4 Learning Resources

- i) Textbooks;
- ii) Picture/chart showing Nitrogen cycle; and
- iii) Pictures of plants and animals which produce chemicals.

7.5 Lesson Activities

The teacher will guide the students to;

- i) Explain the importance of biodiversity in soil
- ii) Explaining the role played by bacteria in Nitrogen cycle.

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- iii) Draw the nitrogen cycle with the major focus on the role of biodiversity.
 - iv) Identify plants and animals which produce chemicals used in their homes and farms.
 - v) Narrate the stories on the use of chemicals in their daily activities and show the effects of such chemicals on biodiversity.
 - vi) Choose a plot of the school compound and identify the existence of various organisms which produce chemical components with economic importance.

7.6 Evaluation

The teacher will ask students to draw and explain a diagram of nitrogen cycle.

CHAPTER EIGHT

BIODIVERSITY IN LANGUAGES

8.1 Introduction

Language may refer to a body of words and the systems for their use common to a people who are of the same community or nation, the same geographical area, or the same cultural tradition.

Language teaching and understanding helps to develop critical thinking and creative thinking to learners. By teaching biodiversity through language subjects, students will be particularly capable of making critical analysis of the importance of biodiversity in their communities.

Grammar, spelling and literature studies are important in the learning process. They hone the literacy and communication skills, and they also help learners see how language may reflect and shape values and attitudes; how it is used to construct things like gender and environment. Therefore language can play a great role in teaching biodiversity.

There are four main language subjects taught in O-Level Secondary Education, namely, Kiswahili, English, French and Arabic which can be used to teach biodiversity aspects by using different methodologies.

8.2 Teaching Notes

The teacher may prepare teaching notes which intend to introduce students to the roles of biodiversity in various language subjects in linking biodiversity with languages practise. Students may prepare composition related to biodiversity conservation for

instance prepares composition on conservation of Kihansi Spray Toads.



Figure 18: The Kihansi Spray Toad; one of the endangered species in Tanzania.

8.3 Teaching Methodology

The teaching methodologies which may be used by the teacher include;

- i) Lecturing;
- ii) Guided discussion;
- iii) Role play;
- iv) Story telling; and
- v) Learning by doing or activity out of class.

8.4 Learning Resources

Important resource materials for teaching and learning during the teaching process include the following;

- i) English text books and reference books and books on biodiversity conservation aspects;

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- ii) Diagrams and pictures which display various animals and plants;
 - iii) Video tapes on biodiversity.

8.5 Lesson Activities

During the lesson, the following activities may be used by the teacher to introduce the concept of Biodiversity in language teaching.

- a) The teacher will guide students to Make a composition on:
 - i) The types of energy they use at home and how it contribute to loss of biodiversity; and
 - ii) One of the components of biodiversity and its importance to economic development.

- b) The teacher will also guide students to:
 - i) Formulate phrases or sentences on grammar with the contents of biodiversity;
 - ii) Tell stories about various plants and animals and their interactions; and
 - iii) Compose a play/drama about biodiversity.

8.6 Assignment

The teacher will provide exercises and assignments which reflect aspects of biodiversity in various language topics.

CHAPTER NINE

BIODIVERSITY IN CIVICS

9.1 Introduction

Civics is the branch of political science that deals with civic affairs and the rights and duties of citizens. In civics students learn about the role of Judiciary, Parliament and Executive arms of the Government. In connection to Biodiversity Protection and Conservation students are taught about environmental conservation and the role of citizens in ensuring conservation of natural resources for a healthy society. Through civics, teachers can engage students in the areas of biodiversity through a wide range of topics, some of these topics are Economic activities Governance and Environmental conservation.

9.2 Teaching Notes

The environment is a complete surroundings including both natural things such air, water, land and plants. It also includes man made features such as buildings, roads and bridges. The environment is comprised of ecosystems that are made up of forests and water bodies in which there are various living organisms such as plants, animals and micro-organisms forming variety of biodiversity. These ecosystems are therefore important for economic and social benefits as well as ecological goods and services to the people.

Human Economic activities depend on the available resources in the environment. For example agriculture, fishing, mining, lumbering, beekeeping, hunting and tourism. However, excessive exploitation of environmental resources through human activities results to environmental degradation and loss of biodiversity.

Biodiversity conservation is important therefore for the benefit of present and future generations and sustainability of environment and human activities. Best practices in environmental conservation includes forest conservation and planting community forests.



Figure 19: A teacher is demonstrating tree planting to students

9.3 Teaching Methodology

The teaching methodologies which may be used by the teacher include;

- i) Guided discussion;
- ii) Brainstorming;
- iii) Field visits; and
- iv) Learning by doing or activity out of class.

9.4 Learning Resources

Required resource materials for teaching and learning during the process include the following;

- i) Civics text books and reference books and books on biodiversity conservation aspects;

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- ii) Diagrams and pictures which display various ecosystems and Biodiversity; and
 - iii) Video tapes on environmental conservation and biodiversity.

9.5 Lesson Activities

During the lesson the following activities may guide the teacher to introduce Biodiversity in teaching Civics through environmental conservation topic.

The teacher will guide students to discuss on:

- i) The types of biodiversity ecosystems in the environment;
- ii) Environmental resources available in different ecosystems;
- iii) Identify economic activities that depend on biodiversity; and
- iv) Practices that contribute in the destruction of biodiversity.

The teacher will also guide students to:

- i) Visits the nearby ecosystems and identify available biodiversity; and
- ii) Practice conservation practices in their school and home environment.

9.6 Evaluation

The teacher may give students assignments to evaluate their ability to describe the importance of biodiversity conservation.

RESOURCE MATERIALS

The following resource materials, websites and organisations are useful for teachers in integrating Biodiversity in the teaching and learning process.

1. URT (2010). Syllabi for Secondary Schools Form I - IV. Ministry of Education and Vocational Training
2. Teacher Educational Workbook for Environmental Sustainability, Eureka Rosenberg. (WESSA), www.wessa.org.za
3. Taxonomy and classification: the backbone to Biodiversity knowledge(WESSA)
4. People, biodiversity patterns & ecological processes: A learning resource booklet for the succulent Klein Karoo (WESSA), www.wessa.org.za
5. Enviro Facts (WESSA), www.wessa.org.za
6. Enabling Environmental Education Process in Teacher Education, (WESSA), www.wessa.org.za
7. O-level secondary education text books.
8. Convention on Biological Diversity, www.cbd.int
9. WWF Tanzania, Wildlife Conservation Society of Tanzania, Jane Godall Tanzania and UNESCO

GLOSSARY

Ecosystems	Biological community of interacting organism and their physical environment
Genes	Unit of heredity composed of DNA and RNA and forming part of a chromosome and determine a particular characteristics of an individual
Nitrogen Cycle	Inter conversion of nitrogen and its compounds in the form of nitrates in nature
Species	A categories in the system of classification of living organisms consisting of similar individual capable of exchanging genes of interbreeding
DNA	DeoxyriboNucleicAcid: A nucleic acid that contains the genetic instructions used in the development and functioning of all modern living organisms
RNA	RiboNucleicAcid: A single-stranded chain of alternating phosphate and ribose units with the bases adenine, guanine, cytosine, and uracil bonded to the ribose

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