NATIONAL OPEN UNIVERSITY OF NIGERIA

ENVIRONMENTAL AND SUSTAINABLE DEVELOPMENT
COURSE CODE: DES 211

FACULTY OF SOCIAL SCIENCES
DEPARTMENT OF ECONOMICS

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CONTENT

Introduction

Welcome to DES: 211 ENVIRONMENT AND SUSTAINABLE DEVELOPMENT.

DES 211: Environment and Sustainable Development is a two-credit and one-semester undergraduate course for Development Economics students. The course is made up of twelve units spread across twelve lectures weeks. This course guide gives you an insight to Environment and Development in a broader way and how to study the make use and apply environmental issues in achieving sustainable development. It tells you about the course materials and how you can work your way through these materials. It suggests some general guidelines for the amount of time required of you on each unit in order to achieve the course aims and objectives successfully. Answers to your tutor marked assignments (TMAs) are therein already.

Course Content

This course is basically on Environment and Sustainable Development because as you are aspiring to become a development economist, you must be able to apply the knowledge of environment and development to sustainable development problems. The topics covered include historical roots and current discourse on sustainable development, overview of theoretical perspectives of environment and development, Introduction to the theories of managing common pool resources and their implications for sustainable development, environmental challenges and types of resources (renewable and non- renewable resources).

Course Aims

The aim of this course is to give you in-depth understanding of the development as regards:

- Overview of the environment: Environment and ecosystem
- Human – environment relationship: Environment as an asset
- Environmental problem in a global context.
- Environmental challenges and the risks to food, energy and water security.
- Resource types and managing and conserving renewable and non-renewable resources.
- Historical background of sustainable development.
- Current issues on sustainable development.
- Overview of theoretical perspective of the environment and its sustainability.
- Bio-economy and sustainable development.
- Externalities and the market failure.
- Theories of managing common pool resources.
- Public goods and the free rider problem.

- Common resources and the tragedy of the common.

Course Objectives

To achieve the aims of this course, there are overall objectives which the course is out to achieve though, there are set out objectives for each unit. The unit objectives are included at the beginning of a unit; you should read them before you start working through the unit. You may want to refer to them during your study of the unit to check on your progress. You should always look at the unit objectives after completing a unit. This is to assist the students in accomplishing the tasks entailed in this course. In this way, you can be sure you have done what was required of you by the unit. The objectives serves as study guides, such that student could know if he is able to grab the knowledge of each unit through the sets of objectives in each one. At the end of the course period, the students are expected to be able to:

- Describe environment and ecosystem
- Discuss human – environment relationship： Environment as an Asset
- Explain global climate change: Science, Policy and Economics
- Explain greenhouse gas emissions and global climate change
- Describe international action on global climate change
- Discuss other global international challenges
- Explain environmental challenges and risk of food security
- Describe environmental challenges and risk of energy security
- Explain environmental challenges and risk of water security
- Discuss natural resources in context
- Know the types of natural (renewable and non-renewable) resources
- Understand how to manage and Conserve natural resources
- Understand the definition of sustainable development.
- Know the historical roots of sustainable development.
- Explain the criticisms of sustainable development.
- Discuss the development goals: Transition from MDGs to SDGs.
- Describe the MDGs and how successful they were.
- Understand what makes the SDGs different.
- Understand what will make the SDGs successful.
- Also know the challenges of SDGs.
- Explain population and human resources.
- Describe economic growth and sustainability.
- Discuss the challenges of sustainable development.
- Understand economic sustainability in development theory.

- Know the theoretical Underpinnings of Economic, Social, and Environmental Sustainability.
- Discuss the theoretical Perspectives on Urban sustainability.
- Describe **economic, environmental, and social trends.**
- Explain the k**ey features and principles of environment and sustainable development.**
- Know the concept of bio-economy and sustainable development.
- Understand bio-economy as green economy.
- Describe bio-economy as ecological economics.
- Discuss bio-economy as ecological economics.
- Know the principles of bio-economy.
- Explain bio-economy as a strategy.
- Understand the concept of sustainability.
- Describe advances in sustainable technology and development.
- Discuss externalities and the market inefficiency.
- Explain the types of externalities
- Know the various public policies toward externalities such as Command and Control Policies: Regulation, Market-Based Policy 1: Corrective Taxes and Subsidy, Market-Based Policy 2: Tradeable Pollution Permits.
- Understand history of common pool resources
- Know the theories of common resources
- Explain packaging of CPR design principles into common projects.
- Different the types of goods.
- Discuss the free rider problem of public goods.
- Describe some important public goods
- Understand common pool resources and the tragedy of the commons.
- Know congestion and over use.
- Discuss some important common pool resources.
- Explain some important common pool resources.

Working Through The Course

To successfully complete this course, you are required to read the study units, referenced books and other materials on the course.

Each unit contains self-assessment exercises called Student Assessment Exercises (SAE). At some points in the course, you will be required to submit assignments for assessment purposes. At the end of the course there is a final examination. This course should take about 15weeks to complete and some components of the course are outlined under the course material subsection.

Course Material

The major component of the course, What you have to do and how you should allocate your time to each unit in order to complete the course successfully on time are listed follows:

1. Course guide
2. Study unit
3. Textbook
4. Assignment file
5. Presentation schedule

Study Unit

There are 12 units in this course which should be studied carefully and diligently.

MODULE ONE: ENVIRONMENT, ENVIRONMENTAL CHALLENGES AND TYPES OF RESOURCES (RENEWABLE AND NON RENEWABLE)

UNIT 1 Overview of the Environment as an Asset
UNIT 2 Environmental Problems in a Global Context
UNIT 3 Environmental Challenges and Risk to Food, Energy and Water Security
UNIT 4 Renewable and Non-Renewable Resources

MODULE TWO: HISTORICAL ROOT, CURRENT ISSUES ON SUSTAINABLE DEVELOPMENT AND THEORETICAL PERSPECTIVES OF ENVIRONMENT AND DEVELOPMENT

UNIT 1 Historical Background of Sustainable Development
UNIT 2 Current Issues on Sustainable Development
UNIT 3 Theoretical Perspective of Environment
UNIT 4 Bio-economy and Sustainable Development

MODULE THREE: EXTERNALITIES, THEORIES OF MANAGING COMMON POOL RESOURCES AND SUSTAINBLE DEVELOPMENT

UNIT 1 Externalities and Market Inefficiency
UNIT 2 Theories of Managing Common Pool Resources
UNIT 3 Public Goods and the Free Rider Problem
UNIT 4 Common Pool Resources and the Tragedy of the Commons

Each study unit will take at least two hours, and it include the introduction, objective, main content, self-assessment exercise, conclusion, summary and reference. Other areas border on the Tutor-Marked Assessment (TMA) questions. Some of the self-assessment exercise will necessitate discussion, brainstorming and argument with some of your colleges. You are advised to do so in order to understand and get acquainted with historical economic event as well as notable periods.

There are also textbooks under the reference and other (on-line and off-line) resources for further reading. They are meant to give you additional information if only you can lay your hands on any of them. You are required to study the materials; practice the self-assessment exercise and tutor-marked assignment (TMA) questions for greater and in-depth understanding of the course. By doing so, the stated learning objectives of the course would have been achieved.

Textbook and References

For further reading and more detailed information about the course, the following materials are recommended:

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Assignment File

Assignment files and marking scheme will be made available to you. This file presents you with details of the work you must submit to your tutor for marking. The marks you obtain from these assignments shall form part of your final mark for this course. Additional information on assignments will be found in the assignment file and later in this Course Guide in the section on assessment.

There are four assignments in this course. The four course assignments will cover:

Assignment 1 - All TMAs' question in Units 1 – 4 (Module 1)

Assignment 2 - All TMAs' question in Units 5 – 8 (Module 2)

Assignment 3 - All TMAs' question in Units 9 – 12 (Module 3)

Presentation Schedule

The presentation schedule included in your course materials gives you the important dates for this year for the completion of tutor-marking assignments and attending tutorials. Remember, you are required to submit all your assignments by due date. You should guide against falling behind in your work.

Assessment

There are two types of the assessment of the course. First are the tutor-marked assignments; second, there is a written examination.

In attempting the assignments, you are expected to apply information, knowledge and techniques gathered during the course. The assignments must be submitted to your tutor for formal Assessment in accordance with the deadlines stated in the Presentation Schedule and the Assignments File. The work you submit to your tutor for assessment will count for 30 % of your total course mark.

At the end of the course, you will need to sit for a final written examination of three hours' duration. This examination will also count for 70% of your total course mark.

Tutor-Marked Assignments (TMAs)

There are four tutor-marked assignments in this course. You will submit all the assignments. You are encouraged to work all the questions thoroughly. The TMAs constitute 30% of the total score.

Assignment questions for the units in this course are contained in the Assignment File. You will be able to complete your assignments from the information and materials contained in your set books, reading and study units. However, it is desirable that you demonstrate that you have read and researched more widely than the required minimum. You should use other references to have a broad viewpoint of the subject and also to give you a deeper understanding of the subject.

When you have completed each assignment, send it, together with a TMA form, to your tutor. Make sure that each assignment reaches your tutor on or before the deadline given in the Presentation File. If for any reason, you cannot complete your work on time, contact your tutor before the assignment is due to discuss the possibility of an extension. Extensions will not be granted after the due date unless there are exceptional circumstances.

Final Examination and Grading

The final examination will be of three hours' duration and have a value of 70% of the total course grade. The examination will consist of questions which reflect the types of self-assessment practice exercises and tutor-marked problems you have previously encountered. All areas of the course will be assessed

Revise the entire course material using the time between finishing the last unit in the module and that of sitting for the final examination to. You might find it useful to review your self-assessment exercises, tutor-marked assignments and comments on them before the examination. The final examination covers information from all parts of the course.

Course Marking Scheme

The Table presented below indicates the total marks (100%) allocation.

Assignment	**Marks**
Assignments (Best three assignments out of four that is marked)	30%

Final Examination	70%
Total	**100%**

Course Overview

The Table presented below indicates the units, number of weeks and assignments to be taken by you to successfully complete the course, Environment and Sustainable Development (DES 211).

Units	**Title of Work**	**Week's Activities**	**Assessment (end of unit)**
	Course Guide		
Module 1: ENVIRONMENT, ENVIRONMENTAL CHALLENGES AND SUSTAINABLE DEVELOPMENT			
1	Overview of the environment as an Asset	Week 1	Assignment 1
2	Environmental Problem in a Global Context	Week 2	Assignment 2
3	Environmental Challenges and Risk to Food, Energy and Water Security	Week 3	Assignment 3
4	Renewable and Non-Renewable Resources	Week 4	Assignment 4
Module 2: HISTORICAL ROOT, CURRENT ISSUES ON SUSTAINABLE DEVELOPMENT AND THEORETICAL PERSPECTIVES OF ENVIRONMENT AND DEVELOPMENT			
1	Historical Background of Sustainable Development	Week 5	Assignment 1
2	Current Issues on Sustainable Development	Week 6	Assignment 2
3	Theoretical Perspective of Environment	Week 7	Assignment 3

4	Bio-economy and Sustainable Development	Week 8	Assignment 4
Module 3: EXTERNALITIES, THEORIES OF MANAGING COMMON POOL RESOURCES AND SUSTAINBLE DEVELOPMENT			
1	Externalities	Week 9	Assignment 1
2	Theories of Managing Common Pool Resources	Week 10	Assignment 2
3	Public Goods and the Free Rider Problem	Week 11	Assignment 3
4	Common Pool Resources and the Tragedy of the Commons	Week 12	Assignment 4
	Examination	Week 13, 14 & 15	

How To Get The Most From This Course

In distance learning the study units replace the university lecturer. This is one of the great advantages of distance learning; you can read and work through specially designed study materials at your own pace and at a time and place that suit you best.

Think of it as reading the lecture instead of listening to a lecturer. In the same way that a lecturer might set you some reading to do, the study units tell you when to read your books or other material, and when to embark on discussion with your colleagues. Just as a lecturer might give you an in-class exercise, your study units provides exercises for you to do at appropriate points.

Each of the study units follows a common format. The first item is an introduction to the subject matter of the unit and how a particular unit is integrated with the other units and the course as a whole. Next is a set of learning objectives. These objectives let you know what you should be able to do by the time you have completed the unit.

You should use these objectives to guide your study. When you have finished the unit you must go back and check whether you have achieved the objectives. If you make a habit of doing this you will significantly improve your chances of passing the course and getting the best grade.

The main body of the unit guides you through the required reading from other sources. This will usually be either from your set books or from a readings section. Some units require you to undertake practical overview of historical events. You will be directed when you need to embark on discussion and guided through the tasks you must do.

The purpose of the practical overview of some certain historical economic issues are in twofold. First, it will enhance your understanding of the material in the unit. Second, it will give you practical experience and skills to evaluate economic arguments, and understand the roles of history in guiding current economic policies and debates outside your studies. In any event, most of the critical thinking skills you will develop during studying are applicable in normal working practice, so it is important that you encounter them during your studies.

Self-assessments are interspersed throughout the units, and answers are given at the ends of the units. Working through these tests will help you to achieve the objectives of the unit and prepare you for the assignments and the examination. You should do each self-assessment exercises as you come to it in the study unit. Also, ensure to master some major historical dates and events during the course of studying the material.

The following is a practical strategy for working through the course. If you run into any trouble, consult your tutor. Remember that your tutor's job is to help you. When you need help, don't hesitate to call and ask your tutor to provide it.

1. Read this Course Guide thoroughly.
2. Organize a study schedule. Refer to the `Course overview' for more details. Note the time you are expected to spend on each unit and how the assignments relate to the units. Important information, e.g. details of your tutorials, and the date of the first day of the semester is available from study centre. You need to gather together all this information in one place, such as your dairy or a wall calendar. Whatever method you choose to use, you should decide on and write in your own dates for working breach unit.
3. Once you have created your own study schedule, do everything you can to stick to it. The major reason that students fail is that they get behind with their course work. If you get into difficulties with your schedule, please let your tutor know before it is too late for help.
4. Turn to Unit 1 and read the introduction and the objectives for the unit.
5. Assemble the study materials. Information about what you need for a unit is given in the `Overview' at the beginning of each unit. You will also need both the study unit you are working on and one of your set books on your desk at the same time.

6. Work through the unit. The content of the unit itself has been arranged to provide a sequence for you to follow. As you work through the unit you will be instructed to read sections from your set books or other articles. Use the unit to guide your reading.
7. Up-to-date course information will be continuously delivered to you at the study centre.
8. Work before the relevant due date (about 4 weeks before due dates), get the Assignment File for the next required assignment. Keep in mind that you will learn a lot by doing the assignments carefully. They have been designed to help you meet the objectives of the course and, therefore, will help you pass the exam. Submit all assignments no later than the due date.
9. Review the objectives for each study unit to confirm that you have achieved them. If you feel unsure about any of the objectives, review the study material or consult your tutor.
10. When you are confident that you have achieved a unit's objectives, you can then start on the next unit. Proceed unit by unit through the course and try to pace your study so that you keep yourself on schedule.
11. When you have submitted an assignment to your tutor for marking do not wait for it return `before starting on the next units. Keep to your schedule. When the assignment is returned, pay particular attention to your tutor's comments, both on the tutor-marked assignment form and also written on the assignment. Consult your tutor as soon as possible if you have any questions or problems.
12. After completing the last unit, review the course and prepare yourself for the final examination. Check that you have achieved the unit objectives (listed at the beginning of each unit) and the course objectives (listed in this Course Guide).

Tutors and Tutorials

There are some hours of tutorials (2-hours sessions) provided in support of this course. You will be notified of the dates, times and location of these tutorials. Together with the name and phone number of your tutor, as soon as you are allocated a tutorial group.

Your tutor will mark and comment on your assignments, keep a close watch on your progress and on any difficulties you might encounter, and provide assistance to you during the course. You must mail your tutor-marked assignments to your tutor well before the due date (at least two working days are required). They will be marked by your tutor and returned to you as soon as possible.

Do not hesitate to contact your tutor by telephone, e-mail, or discussion board if you need help. The following might be circumstances in which you would find help necessary. Contact your tutor if.

• You do not understand any part of the study units or the assigned readings

• You have difficulty with the self-assessment exercises
• You have a question or problem with an assignment, with your tutor's comments on an assignment or with the grading of an assignment.

You should try your best to attend the tutorials. This is the only chance to have face to face contact with your tutor and to ask questions which are answered instantly. You can raise any problem encountered in the course of your study. To gain the maximum benefit from course tutorials, prepare a question list before attending them. You will learn a lot from participating in discussions actively.

Summary

The course, Environment and Sustainable Development (DES 211), expose you to the analysis of environment and sustainable development and you will also be introduced to the historical root and current discourse on sustainable development. This course also gives you an insight into overview of theoretical perspectives of environment and development. Thereafter it shall enlighten you about introduction to the theories of managing common pool resources and their implications for sustainable development. Finally, the environmental challenges and types of resources was also examined to enable you understand more about environmental problems in a global context, environmental challenges and the risks to food, energy and water security, resources types (Renewable and non-renewable) and managing environmental challenges for sustainable development.

On successful completion of the course, you would have developed critical thinking skills with the material necessary for efficient and effective discussion on Environment and Sustainable Development: overview of theoretical perspectives of environment and development, introduction to the theories of managing common pool resources and their implications for sustainable development and the environmental challenges and types of resources.

However, to gain a lot from the course please try to apply anything you learn in the course to term papers writing in other economics courses. We wish you success with the course and hope that you will find it fascinating and handy.

MODULE ONE: ENVIRONMENT, ENVIRONMENTAL CHALLENGES

UNIT 1 **Overview of the Environment: Environment and Ecosystem**

UNIT 2 **Environmental Challenges in a Global Context**

UNIT 3 **Environmental Issues and Risk to Food, Energy and Water Security**

UNIT 4 **Renewable and Non-Renewable Resources**

UNIT ONE: OVERVIEW OF THE ENVIRONMENT: ENVIRONMENT AND ECOSYSTEM

CONTENTS

1.0 INTRODUCTION

When you observe your surroundings closely, you will notice various kinds of living organisms and elements all around you. All these things you can see, hear, smell, and feel are part of the environment you live in. Some might think that an environment is the same as an ecosystem and use the terms interchangeably. They are actually different, however.

2.0 OBJECTIVES

At the end of this unit, student should be able to:

- Describe what environment is all about

- Differentiate between environment and ecosystem
- Explain Human-Environment relationship

3.0 MAIN CONTENT

3.1 The Meaning of Environment

The term 'environment' is widely used and has a broad range of definitions, meanings and interpretations. What does the term 'environment' mean? In popular usage, for some people, the term 'environment' means, simply, 'nature': in other words, the natural landscape together with all of its non-human features, characteristics and processes. To those people, the environment is often closely related to notions of wilderness and of pristine landscapes that have not been influenced - or, at least, that have been imperceptibly influenced - by human activities. However, for other people, the term 'environment' includes human elements to some extent. Many people would regard agricultural and pastoral landscapes as being part of the environment, whilst others are yet more inclusive and regard all elements of the earth's surface - including urban areas - as constituting the environment. Thus, in popular usage, the notion of the 'environment' is associated with diverse images and is bound up with various assumptions and beliefs that are often unspoken - yet may be strongly held. All of these usages, however, have a central underlying assumption: that the 'environment' exists in some kind of relation to humans. Hence the environment is, variously, the 'backdrop' to the unfolding narrative of human history, the habitats and resources that humans exploit, the 'hinterland' that surrounds human settlements, or the 'wilderness' that humans have not yet domesticated or dominated.[1]

SELF ASSESSMENT EXERCISE

Describe in your own words what you understand as environment

[1] https://www.soas.ac.uk/cedep-demos/000_P500_ESM_K3736-Demo/unit1/page_08.htm

3.2 Ecosystem and the Environment

An ecosystem refers to a unit that functions as a whole. It involves the **environment** along with **the ecology**. The **environment** consists of biotic and abiotic factors. **Ecology** refers to the process in which living things interact with one another and their **environment**.

Table 1.1: Differences between Environment and Ecosystem

Environment	**Ecosystem**
Refers to the surroundings or the dwelling place of living things	Refers to a community that functions as a whole
The term does not include the relationship between living things and their surroundings	The term connotes the ecological relationship between all organisms and their environment

Figure 1.1: A Forest Environment

Source: [2]

[2] https://www.google.com/search?biw=1348&bih=635&tbm=isch&sa=1&ei=5fK2XbXvMKTsxgP1gJrADA&q=ecosysten+and+environment&oq=ecosysten+and+environment&gs_l=img.3...46612.52112..52946...0.0..1.569.5543.0j4j10j1j1j3.....0....1..gws-wiz-img.....0i8i30j0i67j0j0i7i30j0i7i5i30j0i8i7i30j0i24.m1quR37SUH4&ved=0ahUKEwj19cuejb_lAhUktnEKHXWABsgQ4dUDCAc&uact=5

An **environment** refers to the surroundings or setting in a particular area. The environment has 2 components: biotic and abiotic. The biotic component comprises the plants and animals, as well as the microorganisms in a particular habitat. Abiotic factors involve the topography, soil, atmosphere, sunlight, water, and nutrients, among others.

Figure 1.2: A Tundra Ecosystem

Source: [3]

3.2.1 Environment vs Ecosystem

What is the difference between an environment and an ecosystem? An environment refers to the surroundings or dwelling place of all living things while an ecosystem is likened to a community that functions as a single unit. When you talk about the environment, it does not include the relationship between organisms and their surroundings, but only the setting or habitat. An ecosystem, on the other hand, is about the ecological relationship between living things and their environment.

SELF ASSESSMENT EXERCISE

With the use of examples, differentiate between ecosystem and environment

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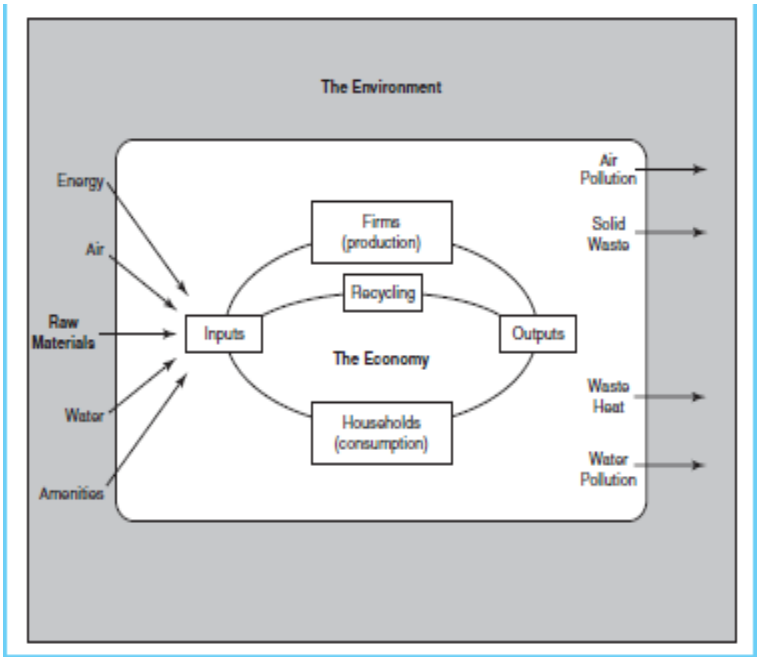
[3] https://www.google.com/search?biw=1348&bih=635&tbm=isch&sa=1&ei=5fK2XbXvMKTsxgP1gJrADA&q=ecosysten+and+environment&oq=ecosysten+and+environment&gs_l=img.3...46612.52112..52946...0.0..1.569.5543.0j4j10j1j1j3.....0....1..gws-wiz-img.....0i8i30j0i67j0j0i7i30j0i7i5i30j0i8i7i30j0i24.m1quR37SUH4&ved=0ahUKEwj19cuejb_lAhUktnEKHXWABsgQ4dUDCAc&uact=5

3.3 The Human – Environment Relation: The Environment as an Asset

In economics, the environment is viewed as a composite asset that provides a variety of services. It is a very special asset, to be sure, because it provides the life-support systems that sustain our very existence, but it is an asset nonetheless. As with other assets, we wish to enhance, or at least prevent undue depreciation of, the value of this asset so that it may continue to provide aesthetic and life-sustaining services.

The environment provides the economy with raw materials, which are transformed into consumer products by the production process, and energy, which fuels this transformation. Ultimately, these raw materials and energy return to the environment as waste products (see Figure 2.3) (Tietenberg and Lewis, 2012).



Source: Adopted from Tietenberg and Lewis, 2012

Figure 1.3: The Economic System and the Environment

The environment also provides services directly to consumers. The air we breathe, the nourishment we receive from food and drink, and the protection we derive from shelter and

clothing are all benefits we receive, either directly or indirectly, from the environment. In addition, anyone who has experienced the exhilaration of white-water canoeing, the total serenity of a wilderness trek, or the breathtaking beauty of a sunset will readily recognize that the environment provides us with a variety of amenities for which no substitute exists. If the environment is defined broadly enough, the relationship between the environment and the economic system can be considered a *closed system.* For our purposes, a closed system is one in which no inputs (energy or matter) are received from outside the system and no outputs are transferred outside the system. An *open system,* by contrast, is one in which the system imports or exports matter or energy.

If we restrict our conception of the relationship in Figure 2.4 to our planet and the atmosphere around it, then clearly we do not have a closed system. We derive most of our energy from the sun, either directly or indirectly. We have also sent spaceships well beyond the boundaries of our atmosphere. Nonetheless, historically speaking, for *material* inputs and outputs (not including energy), this system can be treated as a closed system because the amount of exports (such as abandoned space vehicles) and imports (e.g., moon rocks) are negligible. Whether the system remains closed depends on the degree to which space exploration opens up the rest of our solar system as a source of raw materials.

Excessive wastes produce by human activities (economy) can, of course, depreciate the asset; when they exceed the absorptive capacity of nature, wastes reduce the services that the asset provides. Examples are easy to find: air pollution can cause respiratory problems; polluted drinking water can cause cancer; smog obliterates scenic vistas; climate change can lead to flooding of coastal areas.

Once the stocks of stored energy (such as fossil fuels and nuclear energy) are gone, the amount of energy available for useful work will be determined solely by the solar flow and by the amount that can be stored (through dams, trees, and so on). Thus, in the very long run, the growth process will be limited by the availability of solar energy and our ability to put it to work (Bromley, 1991; Tietenberg and Lewis, 2012).

SELF ASSESSMENT EXERCISE

Describe the environment as an asset

4.0 CONCLUSION

So far this unit concludes that while an environment refers to the surroundings or setting in a particular area, an ecosystem refers to a unit that functions as a whole. It involves the environment along with the ecology. The environment consists of biotic and abiotic factors. The environment as an asset provides the economy with all the services it needs to function as a system. However, the economy pays the environment with the other side of the coin by producing wastes which are detrimental to the environment.

5.0 SUMMARY

In this unit, we have discussed environment as an asset and how environment relates with human activities. How the environment as a composite asset that provides a variety of services. It is a very special asset, to be sure, because it provides the life-support systems that sustain our very existence, but it is an asset nonetheless. Excessive wastes produce by the economy can, of course, depreciate the asset; when they exceed the absorptive capacity of nature, wastes reduce the services that the asset provides.

6.0 TUTORED MARKED ASSIGNMENTS

1. Briefly give an overview definition of an environment.
2. How is an environment different from an ecosystem?
3. Describe the environment as an asset in relation to an economic system.

7.0 REFERENCES/FURTHER READINGS

Bromley, D.W. (1991). Environment and Economy: Property Rights and Public Policy (Oxford: Basil Blackwell, Inc.). A detailed exploration of the property rights approach to environmental problems.

Tietenberg, T. and Lewis, L. (2012). Environmental and Natural Resource Economics (Ninth Edition), USA: Pearson Education Inc.

UNIT 2 ENVIRONMENTAL CHALLENGE IN A GLOBAL CONTEXT

CONTENTS

1.0 INTRODUCTION

Our environment is constantly changing. There is no denying that. However, as our environment changes, so does the need to become increasingly aware of the problems that surround it. With a massive influx of natural disasters, warming and cooling periods, different types of weather patterns and much more, people need to be aware of what types of environmental problems our planet is facing. In addition, future societies will be confronted by both resource scarcity and accumulating pollutants. Many specific examples of these broad categories of problems are discussed in detail in the following chapters. This unit provides a flavor of what is and what is to come by illustrating the challenges posed by one pollution problem (climate change).

2.0 OBJECTIVE

At the end of this unit, you should be able to:

- describe environmental challenges in a global context such as climate change
- identify the trends in greenhouse gas emissions
- explain global climate change
- discuss international actions on global climate change

3.0 MAIN CONTENT

3.1. Global Climate Change

Energy from the sun drives the earth's weather and climate. Incoming rays heat the earth's surface, radiating energy back into space. Atmospheric "greenhouse" gases (water vapor, carbon dioxide, and other gases) trap some of the outgoing energy. Without this natural "greenhouse effect," temperatures on the earth would be much lower than they are now, and life as we know it would be impossible. It is possible, however, to have too much of a good thing. Problems arise when the concentration of greenhouse gases increases beyond normal levels, thus retaining excessive heat somewhat like a car with its windows closed in the summer.

Since the Industrial Revolution, greenhouse gas emissions have increased considerably. These increases have enhanced the heat-trapping capability of the earth's atmosphere. According to the Intergovernmental Panel on Climate Change (2007), "Warming of the climate system is unequivocal. ". That study concludes that most of the warming over the last 50 years is attributable to human activities.

As the earth warms, extreme heat conditions are expected to affect both human health and ecosystems. Some damage to humans is caused directly by increased heat, as shown by the heat waves that resulted in thousands of deaths in Europe in the summer of 2003. Human health can also be affected by pollutants, such as smog, that are exacerbated by warmer temperatures. Rising sea levels (as warmer water expands and previously frozen sources such as glaciers melt), coupled with an increase in storm intensity, are expected to flood coastal communities. Ecosystems will be subjected to unaccustomed temperatures; some will adapt by migrating to new areas, but others may not be able to adapt in time. While these processes have already begun, they will intensify slowly throughout the century.

Climate change also has an important moral dimension. Due to their more limited adaptation capabilities many Developing countries that have produced relatively small amounts of greenhouse gases are expected to be the hardest hit as the climate changes. Dealing with climate change will require a coordinated international response. That is a significant challenge to a world system where the nation-state reigns supreme and international organizations are relatively weak.

3.1.1 Greenhouse Gas Emissions and Global Climate Change

- **Modeling Carbon Dioxide Emissions**

Human activity has increased concentrations of carbon dioxide in the atmosphere. There are several mathematical expressions that can be used to describe the primary factors driving anthropogenic greenhouse gas emissions, with emphasis on carbon dioxide. One of these is the *IPAT identity*:

Impact = Population × Affluence × Technology.

The IPAT identity relates a nation or other political unit's environmental impact (e.g., carbon dioxide emissions) in a given time period to the mathematical product of population, "affluence" (which can be measured as *gross domestic product* [GDP] per capita), and technology (which can be measured in emissions per unit of GDP). This relation can be expanded a bit more to yield the *Kaya identity* (Kaya 1990):

Carbon Dioxide Emissions = Population × (GDP/Population) × (Energy/ GDP) × (CO2 /Energy).

These equations are useful in understanding the complex factors influencing changes in carbon dioxide emissions, though it is important to note that the elements are not entirely independent of one another. The Kaya identity tells us that, all else equal, a country with a small population, or with low per capita income (GDP/population) of energy, or with low energy intensity (energy/GDP), or with low carbon intensity (CO2/energy), will have lower carbon dioxide emissions. A useful property of a multiplicative identity such as IPAT or Kaya is that the growth rate in energy-related emissions is equal to the sum of the growth rates of each component. Thus, for the case of the Kaya identity, we have:

$\%\Delta CO_2$ = %ΔPopulation + %Δ (GDP/Population) + %Δ(Energy/GDP) + %Δ (CO2/Energy).

Note that "%Δ" refers to growth rate in percentage terms. According to Watson, Zinyowera, and Moss (1996, hereinafter Watson et al.), worldwide energy-related carbon dioxide emissions have been growing at an average annual rate of approximately 1.7 percent since the middle of the nineteenth century. Using information from Nakicenovic et

al. (1993) and Watson et al., this 1.7 percent rate of growth in annual emissions equals the sum of a 1 percent annual rate of growth in population, a 2 percent annual rate of growth in per capita income, a 1 percent annual rate of decline in energy intensity, and a 0.3 percent annual rate of decline in carbon intensity (sometimes termed "de-carbonization"). The declines in both energy and carbon intensity are due to the fact that the intensities are mathematical quotients. So carbon intensity can improve (i.e., in the context of global climate change, decline) if, for example, a given quantity of electricity is generated from burning natural gas instead of coal (de-carbonization). Energy intensity will improve (i.e., decline) if, for example, a given level of GDP is generated from more energy- efficient capital equipment. Yet reducing the carbon intensity of energy is not sufficient to assure a reduction in total carbon dioxide emissions. This is because while carbon intensity may fall, population growth and per capita GDP growth can swamp any improvement in carbon intensity. Projections for future carbon dioxide emissions usually assume continued de-carbonization, though some experts believe that countries such as China, the United States, and India may "re-carbonize" by substituting abundant coal resources for declining and more costly oil and gas resources (Hackett, 2006).

SELF ASSESSMENT EXERISE

What is the relationship between greenhouse gas emission and climate change?

3.1. International Actions on Global Climate Change

The political economy of global climate change exemplifies a global environmental policy dilemma: The steps required to make a substantial reduction in greenhouse gas emissions imply significant near-term transition costs that are concentrated on fossil fuel–related industries and their consumers.

• The estimated benefits of substantially reducing greenhouse gas emissions are diffuse across the globe, uncertain or unknown in terms of probability and magnitude, and primarily fall far in the future.

• Moreover, global warming has the characteristic of irreversibility from the perspective of the next few human generations; Maier-Reimer and Hasselman (1987) estimate that it will

take approximately 1,000 years to remove 85 percent of the excess carbon dioxide from the atmosphere.

• With transition costs concentrated and in the present, and with benefits diffuse, uncertain, and cast in the future, the political economy of greenhouse gas control is "Olsonian". Thus, for example, current politicians may find it to be "political suicide" to deviate from a cheap energy policy and impose carbon taxes to limit emissions. Therefore coordinated international policies to slow or reverse global climate change will tend to be difficult to achieve and unstable.

• In order for global-warming policy to be effective, there must be international coordination and cooperation across countries that are highly diverse in income, extent of industrialization, culture, population growth rates and other demographic characteristics, educational attainment, and extent of democratic empowerment.

• The transnational characteristic of global climate change implies a concern about free-riding behavior by countries choosing to avoid costly greenhouse gas control efforts, which in turn creates a competitive advantage in terms of international trade.

The IPCC, which was formed in 1988, issued its First Assessment Report in 1990 in which the organization highlighted the importance of forming an international agreement on climate change. The Second World Climate Conference, also held in 1990, linked many who were advocating for international negotiations. As a result, the United Nations General Assembly opened negotiations on a framework convention on climate change in 1990, and created the Intergovernmental Negotiating Committee to conduct these negotiations. Thus, as early as 1990 it was recognized that the world's climate is a global common-pool resource (CPR), and that international action is necessary in order to avoid a potentially catastrophic tragedy of the commons.

As with managing the world's marine fishery CPR's, lack of international coordination and cooperation will likely result in many countries failing to take adequate measures, thus free riding on the control efforts undertaken by other countries. The question of what level of greenhouse gas control is in the best interests of a particular country is very difficult to answer for a variety of reasons. Regional effects are known with much less certainty than

global effects, yet in all likelihood, some regions and countries will be much more impacted than others. Moreover, northerly countries such as Canada, Norway, Sweden, Finland, and Russia may actually benefit from global warming.

In addition, given the high degree of asymmetry between high- and low income countries, diversity also exists in the extent to which countries can engineer around negative impacts of global warming. Countries also differ in terms of the educational attainment and political empowerment of their citizens. Thus, from an international relations perspective, countries are diverse and are unlikely to have national interests that are mutually consistent.

Nevertheless, most governments see a benefit in at least some control of greenhouse gas emissions as a type of insurance against the risk of negative future impacts.

While the world contends with the challenging political economy of climate change policy, human emissions continue. In the past, most public discussion about climate change was focused on how to prevent anthropogenic changes from occurring, and as we will see below, international action has focused on reducing future greenhouse gas emissions. But even if we were to sharply reduce our emissions of greenhouse gases today, the stock of atmospheric greenhouse gases that has accumulated from anthropogenic emissions will result in further warming and rising sea levels for decades, even centuries to come. Consequently what is required is a two-tracked climate change policy strategy of (i) preparation for the impacts of climate change that are likely to come about due to past greenhouse gas emissions, and (ii) stabilization of atmospheric concentrations of greenhouse gases. As the IPCC (2001) notes, populations that inhabit small islands and/or low-lying coastal areas are at particular risk of severe social and economic effects from sea level rise and storm surges. The impacts of climate change will fall disproportionately upon developing countries and upon the poor persons within all countries, and thereby exacerbate inequities in health status and access to adequate food, clean water, and other resources. Consequently, the first track will likely require an international fund to address the needs of "climate change refugees" displaced by the impacts of climate change. The IPCC (2001) estimates that the second track—stabilization of atmospheric carbon dioxide concentrations at 450 to 650 ppm—would require global anthropogenic carbon dioxide

emissions to drop below 1990 levels within a few decades to about a century, and continue to decrease steadily thereafter.

Eventually, carbon dioxide emissions would need to decline to a very small fraction of current emissions (Fisher, 1981; Hackett, 2006).

- **The Earth Summit**

The idea of sustainable economic development was made prominent following the publication in 1987 of the World Commission on Economic Development (Brundtland Commission) report *Our Common Future.* Concerns for integrating biodiversity and climate change with sustainable development strategies led to representatives of national governments meeting in May and June of 1992 at the United Nations Conference on Environment and Development (UNCED), frequently referred to as the Earth Summit. The United Nations Framework Convention on Climate Change (UNFCCC), which the Intergovernmental Negotiating Committee had adopted by consensus in May of 1992 in New York, was opened for signature during the Rio de Janeiro meetings of the Earth Summit. A total of 181governments and the European Community are parties to the Convention. To become a party, a country must ratify, accept, approve, or accede to the Convention. Parties meet regularly at the annual Conference of the Parties to review the implementation of the Convention and continue talks on how best to tackle climate change. The Convention set an "ultimate objective" of stabilizing atmospheric concentrations of greenhouse gases at safe levels. Such levels, which the Convention does not quantify, are to be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened, and to enable economic development to proceed in a sustainable manner.

The **Convention divides countries into Annex I Parties and unlisted "non– Annex I" countries**. ***Annex I Parties are industrialized countries, made up of wealthy Organization for Economic Cooperation and Development (OECD) countries and economies in transition (EITs) such as the Russian Federation and various central and eastern European countries that have historically contributed the most to climate***

change. The per capita emissions from these countries are higher than those of most developing countries, and they have greater financial and institutional capacity to address the problem. The principles of equity and "common but differentiated responsibilities" enshrined in the Convention therefore require these parties to take the lead in modifying longer-term trends in emissions. To this end, Annex I Parties committed themselves to adopting national policies and measures with the non–legally binding aim of returning their greenhouse gas emissions to 1990 levels by the year 2000. The OECD members of Annex I are also listed in Annex II of the UNFCCC. ***Annex II countries have a special obligation to provide "new and additional financial resources" to developing countries to help them tackle climate change, as well as to facilitate the transfer of climate-friendly technologies to both developing countries and EITs.*** A Global Environment Facility (GEF) was set up to coordinate the transfer of support from Annex II Parties to the non–Annex I developing countries and EITs in Annex I. The UNFCCC entered into force in 1994 after having been ratified by fifty countries. The UNFCCC also established a Conference of Parties, to which signatory countries agreed to report their current emissions levels and provide plans for reducing them. The Conference of Parties holds annual meetings.

- **The Kyoto Protocol**

The implementation arm of the UNFCCC is the Kyoto Protocol, which was developed in December 1997 at the Third Conference of the Parties (COP-3) in Kyoto, Japan. In order to enter into force, the **Kyoto Protocol had to be ratified by at least fifty-five parties to the Convention, including Annex I Parties accounting for 55 percent of anthropogenic carbon dioxide emissions from this group as a whole in 1990. Since the United States refused to ratify the Protocol, and since the United States accounts for a large percentage of total Annex I emissions (approximately 36 percent of emissions from Annex I Parties), the problem had been that the 55 percent rule could not be satisfied unless Russia ratified the Protocol. When Russia ratified the Kyoto Protocol at the end of 2004, that requirement was satisfied, and the Protocol entered into force on February 16, 2005.**

From a political economy standpoint, Russia's ratification is believed to have been a condition imposed by key European countries in return for their support for Russia being admitted to the World Trade Organization. As with the Montreal Protocol on Substances That Deplete the Ozone Layer, the Kyoto Protocol is a "two-world" approach whereby rich industrialized countries are required to cut emissions, while lower-income countries can continue business as usual. Proponents view this as politically essential to allowing large industrializing countries such as India and China to catch up economically to richer industrialized countries before having to stabilize or cut emissions. Opponents, particularly in the United States, see this as putting industry in the richer regulated countries at a competitive disadvantage, and leading to a shifting of industrial production—and emissions—to unregulated lower income countries.

The terms of the Kyoto Protocol call for Annex I countries (including most of the world's industrialized countries) to reduce their overall greenhouse gas emissions by at least 5 percent below 1990 levels over the 2008 to 2012 period. The Kyoto Protocol commits Annex I Parties to individual, legally binding quantified emissions targets to limit or reduce their greenhouse gas emissions. The individual targets for Annex I Parties are listed in the Kyoto Protocol's Annex B, and range from an 8 percent cut for the European Union (EU) and several other countries, to a 10 percent increase for Iceland. Under the terms of the Protocol, the EU may redistribute its target among its fifteen member states. It has already reached agreement on such a scheme, known as a "bubble," whereby the larger and richer EU countries must cut emissions, while Spain, Portugal, and Greece could actually increase emissions.

Starting from 2005, the parties to the Protocol began discussions about achieving greater reduction in a second five-year period after 2012 aimed at bringing emissions down to levels that will not affect the climate, considered to be at least a 60 percent global cut.

Early discussions have focused on creative ways of slowing the rate of emissions growth in China, India, and other rapidly developing large countries around the world.

Despite its significant diplomatic importance, the first phase of the Kyoto Protocol will have only a minimal impact on improving the climate. The reductions called for under the

Protocol by 2012 represent a modest first step for the nations of the world, but meeting these target reductions would not result in a reversal of anthropogenic climate change. Moreover, relatively few of the Annex I countries are likely to meet their emissions reduction obligations under the Kyoto Protocol. While industrialized countries cut their overall emissions by about 3 percent from 1990 to 2000, this was largely because of a significant decrease in the emissions of former Soviet-bloc countries caused by the transition of their economies. This decline in eastern European emissions masked an 8 percent increase in emissions among the other industrialized countries of the world. Overall, the industrialized world is not on target to meet the Kyoto emissions reduction goal, and is predicted to be about 10 percent above 1990 levels by 2010. As of 2004, only four European Union countries were on track to comply with the national targets that all pre-2004 member states had accepted in order to ensure that the EU as a whole fulfills its Kyoto commitment. The four are France, Germany, Sweden, and the United Kingdom.

The United States is prominent in its failure to meet the Earth Summit target. In 1990 the United States produced 1.346 gigatons of carbon-equivalent emissions due to the combustion of fossil fuel and by 2003 that figure had increased by 17.6 percent to 1.6 gigatons. Moreover, the United States also has the world's highest per capita emissions.

The Kyoto Protocol includes three incentive-based economic instruments that are designed to help Annex B countries reduce the cost of meeting their emissions targets. These instruments are joint implementation, emissions trading, and the Clean Development Mechanism (CDM). These instruments allow Annex I countries to meet their emissions target by either producing or acquiring emissions reductions in other countries, most commonly lower-income developing countries. Joint implementation projects allow an Annex I Party to receive emission credits for projects that reduce emissions or enhance emissions-absorbing sinks in other Annex I countries Hackett, 2006). It is specifically indicated in the Protocol that trading and joint implementation are supplemental to rather than a substitute for domestic actions. The world's first mandatory multinational carbon market—the EU Emissions Trading Scheme (ETS)—began in early 2005. As Michaelowa (2004) notes, the EU allocated generous quantities of carbon credits to various polluting

industries for the 2005–7 period to help ease the transition. Moreover, in April 2004 the EU parliament passed the "linking directive," which allows participants in the emissions trading system unlimited use of emission credits from the CDM. The linking directive is the world's first large-scale incentive for companies to participate in the CDM. Michaelowa goes on to report that the EU, especially Germany and the Netherlands, is making significant funds available for CDM projects, in order to generate credits that can be used to help the EU meet its Kyoto obligations.

The CDM was envisioned to perform a three-fold function:

• to assist non–Annex I countries in achieving sustainable development;

• to contribute to the ultimate goal of the convention, that is, stabilization of greenhouse gas concentrations in the atmosphere;

• to help Annex I countries comply with their emission reduction commitments.

The CDM assists developing countries in achieving sustainable development by directing "environmentally friendly" investment into their economies from Annex I Parties and corporations. Two biomass examples included a sugarcane waste–fueled power plant constructed in Brazil, and a swine waste/methane–fueled power plant in Chile, both of which generated Certified Emissions Reductions (CERs) to the Annex I country funding the power plants. Environmental groups have been concerned that some CDM projects, such as large-scale hydroelectric facilities, fail to satisfy an "environmentally friendly" criterion.

SELF ASSESSMENT EXERCISE

What are the steps taken by international actions against the scourge of climate change?

3.1. **Other Global Environmental Challenges**

Global warming has become an undisputed fact about our current livelihoods; our planet is warming up and we are definitely part of the problem. However, this isn't the only environmental problem that we should be concerned about. All across the world, people are facing a wealth of new and challenging environmental problems every day. Some of

them are small and only affect a few ecosystems, but others are drastically changing the landscape of what we already know.

Our planet is poised at the brink of a severe environmental crisis. Current environmental problems make us vulnerable to disasters and tragedies, now and in the future. We are in a state of planetary emergency, with environmental problems piling up high around us. Unless we address the various issues prudently and seriously we are surely doomed for disaster. Current environmental problems require urgent attention.[4]

Figure 1.4: Environmental Pollution

Source: https://www.conserve-energy-future.com/15-current-environmental-problems.php

1. Pollution: Pollution of air, water and soil require millions of years to recoup. Industry and motor vehicle exhaust are the number one pollutants. Heavy metals, nitrates and plastic are toxins responsible for pollution. While water pollution is caused by oil spill, acid rain, urban runoff; air pollution is caused by various gases and toxins released by industries and

[4] https://www.conserve-energy-future.com/15-current-environmental-problems.php

factories and combustion of fossil fuels; soil pollution is majorly caused by industrial waste that deprives soil from essential nutrients.

2. Global Warming: Climate changes like global warming is the result of human practices like emission of Greenhouse gases. Global warming leads to rising temperatures of the oceans and the earth' surface causing melting of polar ice caps, rise in sea levels and also unnatural patterns of precipitation such as flash floods, excessive snow or desertification.

3. Overpopulation: The population of the planet is reaching unsustainable levels as it faces shortage of resources like water, fuel and food. Population explosion in less developed and developing countries is straining the already scarce resources. Intensive agriculture practiced to produce food damages the environment through use of chemical fertilizer, pesticides and insecticides. Overpopulation is one of the crucial current environmental problems**.**

4. Natural Resource Depletion: Natural resource depletion is another crucial current environmental problem. Fossil fuel consumption results in emission of Greenhouse gases, which is responsible for global warming and climate change. Globally, people are taking efforts to shift to renewable sources of energy like solar, wind, biogas and geothermal energy. The cost of installing the infrastructure and maintaining these sources has plummeted in the recent years.

5. Waste Disposal: The over consumption of resources and creation of plastics are creating a global crisis of waste disposal. Developed countries are notorious for producing an excessive amount of waste or garbage and dumping their waste in the oceans and, less developed countries. Nuclear waste disposal has tremendous health hazards associated with it. Plastic, fast food, packaging and cheap electronic wastes threaten the well-being of humans. Waste disposal is one of urgent current environmental problem**.**

6. Climate Change: Climate change is yet another environmental problem that has surfaced in last couple of decades. It occurs due to rise in global warming which occurs due to increase in temperature of atmosphere by burning of fossil fuels and release of harmful gases by industries. Climate change has various harmful effects but not limited to melting of polar ice, change in seasons, occurrence of new diseases, frequent occurrence of floods and change in overall weather scenario.

7. Loss of Biodiversity: Human activity is leading to the extinction of species and habitats and loss of bio-diversity. Eco systems, which took millions of years to perfect, are in danger when any species population is decimating. Balance of natural processes like pollination is crucial to the survival of the eco-system and human activity threatens the same. Another example is the destruction of coral reefs in the various oceans, which support the rich marine life.

Figure 1.5: Loss of Biodiversity

Source:https://www.conserve-energy-future.com/wp-content/uploads/2014/11/Deforestation_environmental_concern.jpg

8. Deforestation: Our forests are natural sinks of carbon dioxide and produce fresh oxygen as well as helps in regulating temperature and rainfall. At present forests cover 30% of the land but every year tree cover is lost amounting to the country of Panama due to growing population demand for more food, shelter and cloth. Deforestation simply means clearing of green cover and makes that land available for residential, industrial or commercial purpose.

9. Ocean Acidification: It is a direct impact of excessive production of CO2. 25% of CO_2 are produced by humans. The ocean acidity has increased by the last 250 years but by 2100, it may shoot up by 150%. The main impact is on shellfish and plankton in the same way as human osteoporosis.

10. Ozone Layer Depletion: The ozone layer is an invisible layer of protection around the planet that protects us from the sun's harmful rays. Depletion of the crucial Ozone layer of the atmosphere is attributed to pollution caused by Chlorine and Bromide found in Chloro-floro carbons (CFC's). Once these toxic gases reach the upper atmosphere, they cause a hole in the ozone layer, the biggest of which is above the Antarctic. The CFC's are banned in many industries and consumer products. Ozone layer is valuable because it prevents harmful UV radiation from reaching the earth. This is one of the most important current environmental problems.

11. Acid Rain: Acid rain occurs due to the presence of certain pollutants in the atmosphere. Acid rain can be caused due to combustion of fossil fuels or erupting volcanoes or rotting vegetation which release sulfur dioxide and nitrogen oxides into the atmosphere. Acid rain is a known environmental problem that can have serious effect on human health, wildlife and aquatic species.

12. Water Pollution: Clean drinking water is becoming a rare commodity. Water is becoming an economic and political issue as the human population fights for this resource. One of the options suggested is using the process of desalinization. Industrial development is filling our rivers seas and oceans with toxic pollutants which are a major threat to human health.

13. Urban Sprawl: Urban sprawl refers to migration of population from high density urban areas to low density rural areas which results in spreading of city over more and more rural land. Urban sprawl results in land degradation, increased traffic, environmental issues and health issues. The ever growing demand of land displaces natural environment consisting of flora and fauna instead of being replaced.

14: Public Health Issues: The current environmental problems pose a lot of risk to health of humans, and animals. Dirty water is the biggest health risk of the world and poses threat to the quality of life and public health. Run-off to rivers carries along toxins, chemicals and disease carrying organisms. Pollutants cause respiratory disease like Asthma and cardiac-vascular problems. High temperatures encourage the spread of infectious diseases like Dengue.

15. Genetic Engineering: Genetic modification of food using biotechnology is called genetic engineering. Genetic modification of food results in increased toxins and diseases as genes from an allergic plant can transfer to target plant. Genetically modified crops can cause serious environmental problems as an engineered gene may prove toxic to wildlife. Another drawback is that increased use of toxins to make insect resistant plant can cause resultant organisms to become resistant to antibiotics.

16. Mining: Mining results in extraction of minerals from earth's core. These minerals also bring out harmful chemicals from deep inside the earth to the earth's surface. The toxic emissions from mining can cause air, water and soil pollution.

17: Natural Resource Depletion: Non-renewable resources are limited and will get expired one day. Consumption of fossil fuels at an alarming rate can lead to global warming which can further result in melting of polar ice caps and increase in sea levels.

18: Natural Disasters: Natural disasters like earthquakes, floods, tsunamis, cyclones, volcanic eruption can be unpredictable, devastating and can cause irreparable damage. They can cause huge loss of life and property …….

19: Nuclear Issues: Radioactive waste is a nuclear fuel that contains radioactive substance and is a by-product of nuclear power generation. The radioactive waste is an environmental concern that is extremely toxic and can have devastating effect on the lives of the people living nearby, if not disposed properly. Radioactive waste is considered to be harmful for humans, plants, animals and surrounding environment.

20. Loss of Endangered Species: Human overpopulation is prompting the elimination of species and environmental surroundings and the loss of various biomes. Environmental frameworks, which took a huge number of years to come into being, are in risk when any species populace is huge.

21. Agricultural Pollution: Modern day agriculture practices make use of chemical products like pesticides and fertilizers to deal with local pests. Some of the chemicals when sprayed do not disappear and infact seeps into the ground and thereby harms plants and crops. Also, contaminated water is used for irrigation by farmers due to disposal of industrial and agricultural waste in local water bodies.

22. Light and Noise Pollution: Noise pollution is another common form of pollution that causes temporary disruption when there is excessive amount of unpleasant noise. Construction activities, industrialization, increase in vehicular traffic, lack of urban planning are few of the causes of noise pollution.

23. Medical Waste: Medical waste is any kind of waste that is produced in large quantity by healthcare centers like hospitals, nursing homes, dental clinics and is considered to be of a bio-hazardous nature. The waste can include needles, syringes, gloves, tubes, blades, blood, body parts and many more.

24. Littering and Landfills: Littering simply means disposal of piece of garbage or debris improperly or at wrong location usually on the ground instead of disposing them at trash container or recycling bin. Littering can cause huge environmental and economic impact in the form of spending millions of dollars to clean the garbage of road that pollute the clean air. Landfills on the other hand are nothing but huge garbage dumps that make the city look ugly and produce toxic gases that could prove fatal for humans and animals. Landfills are generated due to large amount of waste that is generated by households, industries and healthcare centers every day.

Figure 1.6: Landfills and Littering

Source:-https://www.conserve-energy-future.com/wp content/uploads/2014/11/Landfill_environmental_concern.jpg

25. Soil and Land Pollution: Land pollution simply means degradation of earth's surface as a result of human activities like mining, littering, deforestation, industrial, construction and agricultural activities. Land pollution can have huge environmental impact in the form of air pollution and soil pollution which in turn can have adverse effect on human health.

26. Household and Industrial Waste: The over utilization of assets and formation of plastics are making a worldwide emergency of waste transfer. Developed nations are infamous for creating an unreasonable measure of waste or junk and dumping their waste in the seas and, less created nations.

27. Energy Crisis: Today, there are many options of energy sources such as petroleum, biofuel, coal etc. But all these sources are non-renewable sources and will get depleted in the coming years if their consumption is not checked. Apart from the energy crisis, resources such as coal and petroleum are contributing to the emission of greenhouse gases. Due to the excess usage of these energy sources, not only are the sources getting depleted, but they are also adding to the greenhouse gases which in turn are adding to the global warming conditions. So, many countries are searching for alternative energy sources such as wind energy, solar energy, nuclear energy, etc., which may help in the future. But to get totally dependent on these resources and ensure their proper functioning may take some time.

The need for change in our daily lives and the movements of our government is growing. Because so many different factors come into play; voting, governmental issues, the desire to stick to routine, many people don't consider that what they do will affect future generations. If humans continue moving forward in such a harmful way towards the future, then there will be no future to consider. Although it is true that we cannot physically stop our ozone layer from thinning (and scientists are still having trouble figuring out what is causing it exactly,) there are still so many things we can do to try and put a dent in what we already know. By raising awareness in your local community and within your families

about these issues, you can help contribute to a more environmentally conscious and friendly place for you to live.[5]

SELF-ASSESSMENT EXERCISE

1. Write a brief essay on what is known as global climate change.

4.0 CONDITION

In this unit, we examined climate change as an environmental challenge and we conclude that it has surfaced in last couple of decades. This phenomenon occurs due to rise in global warming which occurs due to increase in temperature of atmosphere by burning of fossil fuels and release of harmful gases by industries. In addition, it has various harmful effects but not limited to melting of polar ice, change in seasons, occurrence of new diseases, frequent occurrence of floods and change in overall weather scenario. We also examined other global environmental challenges such as pollution, overpopulation, natural resources depletion etc.

5.0 SUMMARY

In this unit, we have discussed environmental challenges in the global context. We looked at climate change as a global environmental challenge which arises as a result of rise in global temperature which has both natural cause and the artificial cause (human activities of burning of fossil fuels, and other anthropogenic gases) into the atmosphere. Other global environmental issues raised in this unit include pollution, global warming, over population, natural resources depletion loss of biodiversity etc.

6.0 TUTOR-MARKED ASSIGNMENT

1. Mention and explain 10 environmental challenges on a global scale.

[5] https://www.conserve-energy-future.com/wp-content/uploads/2014/06/Deforestation_Environmental_problem-e1426569839560.jpg

2. What is the theoretical connection between greenhouse gas emissions and climate change.
3. Discuss the phrase “climate change”.
4. Briefly discuss international actions taken to combat the scourge of climate change.

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UNIT 3 ENVIRONMENTAL ISSUES AND RISK TO FOOD, ENERGY WATER SECURITY

CONTENTS

1.0. INTRODUCTION

Water, food and energy form a complex web of inter-linkages. Agriculture is both energy user and energy generator. Energy generation from biofuel and hydropower are land & water intensive and sometime compete with food production over limited land and water resources. Other energy sources, e.g. fossil fuels such as oil, coal, gas, nuclear, also have various impacts on water quantity and water quality. Nevertheless, food production is water & energy-intensive, accounting for 70% of global water use and 6% of global energy use. Energy policies and subsidies influence water use for food or energy. In other cases, food policies, subsidies and consumption patterns drive water use.

2.0. OBJECTIVES

At the end of this unit, you should be able to:

- explain environmental challenges and how they affect food security
- discuss the relationship between the environment and energy security
- substantiate environmental issues and how they affect water security
- describe how to reduce the knowledge gap to management of land, food, energy and water resources for food and energy security in a sustainable and equitable way, in

synergy with natural ecosystems and compatible with the respective socio-economic context.

3.0 MAIN CONTENT

3.1 Environmental Challenges and the Risk to Food Security

The Intergovernmental Panel on Climate Change (IPCC)'s Fifth Assessment Report reaffirmed that warming in the climate system is unequivocal and that it is "extremely likely" that human influence has been the dominant cause. The climate is changing already – and, as the World Bank's *Turn Down the Heat* report explains, failure to limit warming to 2°C will create a high risk of that change becoming catastrophic. There is growing realization that failure to act, quickly and effectively, could reverse many of the advances of the 20th century.

- **Risks to Food Security: Analysis**

The risk to food security is especially great because agriculture is already straining to meet a rapidly growing demand from a finite resource base. The combined impact of a rising population and growth of the middle class – wealthier people eat more cereal-intensive meat – is set to drive a demand increase of 60% by 2050. Yet the global average yield growth for cereals has slowed in recent years; it already lags behind demand growth. This gap cannot be covered by an expansion of cropland because of the need to protect forests and other areas of high value for conservation and carbon sequestration. Agriculture is increasingly competing with other uses for land – such as urbanization, transport, bioenergy, forestry and mining – and so crop production is pushed towards ever more marginal soils (Campell, Vermeulen, Aggarwal, Corner-Dollof, Caitlin, Girvetz, Rosenstock, Sebastian, Thornton and Wollenberg, 2016).

Yet more worrying is the fierce competition for water, the lifeblood of agriculture. Water withdrawals have increased threefold over the last 50 years, and demand is anticipated to rise by a further 40% by 2030. With a shift in global production towards intensive systems that rely on groundwater resources for irrigation, along with the current growth in demand for water-intensive animal products, agriculture becomes even thirstier. At the same time, urbanization and industrialization in emerging and developing economies are also driving

up demand for fresh water in energy production, mineral extraction, and domestic use, further stretching the already tight supply.

Against this backdrop of tightening constraints, climate change seriously threatens food security in two ways. First, it will harm agricultural production: rising temperatures and changing rainfall patterns will slow yield gains, contributing to higher food prices and an increasingly precarious supply-demand balance that will make markets more prone to volatility. Second, it will increasingly disrupt food systems: more extreme weather will destabilize tighter markets and exacerbate volatility, imperil transport infrastructure and trigger local food crises. As a result, the risks of humanitarian emergencies, national or regional instability and mass migration will increase. In the words of a former Executive Director of the World Food Programme, "without food, people have only three options. They riot, they emigrate, or they die. The security implications will be felt by developing and developed countries alike.

- **Climate Impacts on Agricultural Production**

Climate change will slow global yield growth because higher average temperatures result in shorter growing seasons and lower yields. Shifting rainfall patterns can also reduce yields because lower rainfall reduces soil moisture or increased rainfall waterlogs soils. Climate trends are already believed to be diminishing global yields of maize and wheat.

As climate change gathers pace, the negative impacts on yields will become more pronounced. This is unlikely to be a steady deterioration. Yield responses to biophysical stresses are highly non-linear – once critical thresholds for temperature or water are breached, plants suffer severe damage and yields can fall precipitously. If climate change is allowed to reach a point where these biophysical thresholds are exceeded routinely, crop failure will become the norm.

- **Extreme Weather and Disruption of Food Systems**

Some of climate change's most serious risks to food security arise from more frequent and extreme weather events such as droughts, heat waves and floods. These can trigger local

food crises, disrupt trade infrastructure and have cascading systemic consequences – for example, crop failure in a major breadbasket region can precipitate international food price spikes.

3.1.1 Spheres of Action to Mitigate the Climate Risk on Food Security

This sub-unit addresses three spheres in which action can be taken. These include the use of big data to boost the efficiency and specificity of climate-risk information; the provision of insurance innovations that can reduce risk to small farmers, who are an essential and fundamental aspect of agricultural success; and the incentivization of climate-resilient, low-carbon investments.

1. Big Data and Improved Climate-Risk Information Services

Timely, accessible and actionable climate and weather information enables farmers, communities and local authorities to identify their specific vulnerabilities to climate variability and to develop response strategies. This information is also key to any design of the kind of efficient and effective insurance schemes further explored below, which could help reduce exposure to economic losses.

Tailored information is critical, given the complexity and geographic specificity of climate change impacts. One example is high-resolution topographic data, which will be made available by the US Geological Survey following a White House announcement last September. The data, generated from NASA's Shuttle Radar Topography Mission (SRTM) in 2000, previously covered only the United States; it is now also available for Africa, and next year will expand to include Latin America and the Caribbean. This kind of topographic data could greatly enhance agricultural planning for drought, glacial retreat, inland flooding, landslides and coastal storm surges.

However, enhanced information alone is not enough. Equally essential is the capability to model potential impacts on interconnected environmental, social and economic systems if vulnerable communities are to develop the better capacities and integrated policies needed for long-term resilience. It is challenging, however, to develop actionable information from a large range of data gathered from different sources. Data are mostly insufficient to meet the information needs for evidence-based climate adaptation, especially in vulnerable developing regions that have large agricultural sectors exposed to increased climate risk.

Consequently, attention is increasingly turning towards broad-based partnerships that bring together information services, policy resources, technological and modelling skills and capacity building and training. Many of these partnerships cut across public and private sectors to leverage increased data analysis and modelling capabilities. Such programmes illustrate how large-scale collaborative efforts that leverage large data sets, scientific modelling, computational power and capacity-building programmes can improve local decision-making to increase resilience and reduce exposure to important food security-related risks.

2. Reducing Economic Exposure through Insurance Innovations

Crop insurance schemes do not always deliver sufficient protection for small farmers against potential losses – either because they are too expensive for low-income smallholder farmers or because they provide perverse incentives that discourage policy-holders from investing in crop productivity. International aid for disaster relief financing has often proved to be slow, ad hoc and expensive. Innovative climate-informed insurance schemes can help to address the shortcomings in these two models, efficiently reducing exposure to economic losses and thereby food insecurity.

Robust and affordable weather insurance depends on the availability of accurate data, together with improved capabilities to forecast weather variability and extreme events such

as droughts. Today a combination of data provided by weather stations with remote sensing and satellite imagery are helping scale innovative insurance schemes across developing countries.

Weather index insurance schemes, also known as "index-based financial risk-transfer mechanisms", pay out based on weather rather than crop losses. They use an index of productivity-relevant weather variables such as precipitation onset and intensity, streamflow and temperature: the insurance pays out, for example, if measured rainfall falls below a specified level.

One advantage of weather index insurance is that it removes the need for expensive field visits to assess crop damage, reducing costs and improving accessibility of insurance for low-income smallholder farmers. Having such insurance coverage can create a virtuous circle: it often is a necessary condition for accessing bank loans or other credit, which in turn can be used to invest in improved agricultural inputs for increased productivity and reduced risk exposure. Weather index insurance schemes also remove the possibility of poorly designed crop failure insurance schemes that effectively incentivize farmers to allow crops to fail.

3. Financial System Shift to Unleash Climate-Resilient, Low-Carbon Investments

Effectively tackling climate-induced risks will require new ways to incentivize climate-smart investment. Despite increasing recognition of the economic risks, global financial systems are yet to incorporate them into financial decision-making. Finding ways to adapt established risk assessment analytics, models and reporting frameworks could unleash larger flows of capital towards climate-friendlier investments.

3.1.2 Reducing Food Insecurity

After decades of relative neglect, agriculture and the need to produce sufficient food are high on the global development agenda. Reasons include the recent increases in food prices, the large number of food insecure people in the world and concerns over the sustainable use of land and water resources. These problems are exacerbated by the threat of climate change and other global changes, including demographic changes, urbanisation, change forest cover, change diets, foreign land investments, accelerated production of other agricultural goods (fuel, fiber and fodder) on scarce land resources etc.

Agricultural water management plays a central role in food production and food security. On the one hand, poor water management practices contribute to depletion and degradation of land & water resources. On the other hand, improved water management plays a vital role in increasing food production and reducing food insecurity as well as supporting sustainable land and water resources development.

SELF ASSESSMENT EXERCISE

Explain the relationship between environmental issues and food security

3.2 Environmental Challenges and Risk to Water Security

Another class of threats is posed by the interaction of a rising demand for resources in the face of a finite supply. Water provides a particularly interesting example because it is vital to life. One of the most important areas of environmental concern is the earth's water supply. We need to be concerned about water pollution as well as the increasing scarcity of drinkable water in certain areas of the world.

According to the United Nations, about 40 percent of the world's population lives in areas with moderate-to-high water stress. ("Moderate stress" is defined in the U.N. Assessment of Freshwater Resources as "human consumption of more than 20 percent of all accessible renewable freshwater resources," whereas "severe stress" denotes consumption greater

than 40 percent.) By 2025, it is estimated that about two-thirds of the world's population—about 5.5 billion people—will live in areas facing either moderate or severe water stress.

This stress is not uniformly distributed around the globe. For example, in the United States, Mexico, China, and India, groundwater is being consumed faster than it is being replenished and aquifer levels are steadily falling. Some rivers, such as the Colorado in the western United States and the Yellow in China, often run dry before they reach the sea. Formerly enormous lakes, such as the Aral Sea and Lake Chad, are now a fraction of their once-historic sizes. Glaciers that feed many Asian rivers are shrinking. According to U.N. data, Africa and Asia suffer the most from the lack of access to sufficient clean water. Up to 50 percent of Africa's urban residents and 75 percent of Asians lack adequate access to a safe water supply.

The availability of potable water is further limited by human activities that contaminate the finite supplies. According to the United Nations, 90 percent of sewage and 70 percent of industrial wastes in developing countries are discharged without treatment.

Some arid areas have compensated for their lack of water by importing it via aqueducts from more richly endowed regions or by building large reservoirs. Regional and international political conflicts can result when the water transfer or the relocation of people living in the area to be flooded by the reservoir is resisted. Additionally, aqueducts and dams may be geologically vulnerable. For example, in California, many of the aqueducts cross or lie on known earthquake-prone fault lines (Reisner, 2003). The reservoir behind the Three Gorges Dam in China is so vast that the pressure and weight are causing tremors and landslides.

Water scarcity is one of the key challenges facing the world in the 21st century. The continuing availability of water underpins action on food security, energy security, poverty reduction, economic growth, conflict reduction, climate change adaptation and biodiversity loss. But increasing global exploitation of water resources across the world has led to significant degradation of ecosystems and the goods and services they provide. In many places, the result has been rivers that no longer reach the sea, lakes that are a fraction of their natural size and aquifers whose levels have fallen drastically. As well as being an

issue of concern to environmentalists and communities, over-exploitation of water has economic impacts on businesses and can adversely affect the ability of governments to meet a broad set of policy goals. The concept of risk can be used to describe the impacts and highlight potential responses.

SELF ASSESSMENT EXERCISE

Explain the relationship between environmental issues and water security

3.3 Environmental Challenges and Risk to Energy Security

Energy and environmental security has emerged as the primary issue on the global agenda for 2007. Consensus has recently been forged on the potential for long-term economic, national security and societal damage from insecure energy supplies and environmental catastrophe, as well as the intense need for technological advances that can provide low-polluting and secure energy sources. Yet despite growing global momentum, there is still little agreement on the best set of actions required to reduce global dependency on fossil fuels and greenhouse gas emissions. Confounding the international policy challenge is the disproportionate impact of high oil prices and global warming across nations, insulating some countries from immediate concern while forcing others to press for more rapid change (McKibbin, and Wilcoxen, 2016).

Today, there are many options of energy sources such as petroleum, biofuel, coal etc. But all these sources are non-renewable sources and will get depleted in the coming years if their consumption is not checked. Apart from the energy crisis, resources such as coal and petroleum are contributing to the emission of greenhouse gases. Due to the excess usage of these energy sources, not only are the sources getting depleted, but they are also adding to the greenhouse gases which in turn are adding to the global warming conditions. So, many countries are searching for alternative energy sources such as wind energy, solar

energy, nuclear energy, etc., which may help in the future. But to get totally dependent on these resources and ensure their proper functioning may take some time.

These challenges will only grow greater in the year ahead as the rising economies, specifically China and India, expand and consume at remarkable rates. According to the United States Energy Information Administration (EIA), China's oil consumption increases by almost half a million barrels per day in 2006, or 38 percent of total growth in world oil demand. India's electricity consumption is estimated to grow from 519 billion kilowatt-hours in 2003 to 845 billion kilowatt-hours in 2010. Overall, the EIA forecasts that worldwide oil consumption will rise from 80 million barrels per day in 2003 to 98 in 2015 and 118 million in 2030.

Although energy and environmental security are frequently argued about as separate and distinct issues, policymakers in the United States and abroad would be well advised to focus on mitigating climate change as the most effective means to the energy security end. Establishing a credible, practical and effective framework for cooperation on climate change should be the primary means of making an immediate impact by addressing energy and environmental security in a coherent policy (McKibbin, 2005; Mckibbin and Wilcoxen, 2016) .

SELF ASSESMENT EXERCISE

Explain the relationship between environmental issues and energy security

4.0. CONCLUSION

In this unit, we examined environmental challenges and the risk to food, water and energy insecurity. We concluded that climate change seriously threatens food security in two ways. First, it will harm agricultural production: rising temperatures and changing rainfall patterns will slow yield gains, contributing to higher food prices and an increasingly

precarious supply-demand balance that will make markets more prone to volatility. Second, it will increasingly disrupt food systems: more extreme weather will destabilize tighter markets and exacerbate volatility, imperil transport infrastructure and trigger local food crises.

5.0 SUMMARY

In this unit, we have discussed environmental challenges and the risk to food, water and energy insecurity. Water, food and energy form a complex web of inter-linkages. Agriculture is both energy user and energy generator. Energy generation from biofuel and hydropower are land & water-intensive and sometime compete with food production over limited land and water resources. Other energy sources, e.g. fossil fuels such as oil, coal, gas, nuclear, also have various impacts on water quantity and water quality. Nevertheless, food production is water & energy-intensive, accounting for 70% of global water use and 6% of global energy use. Energy policies and subsidies influence water use for food or energy. In other cases, food policies, subsidies and consumption patterns drive water use.

6.0 TUTOR MARKED ASSIGNMENT

1. Briefly discuss extensively the inter-linkages of food, energy and water insecurity due to environmental challenges.
2. Describe the link between environmental challenges and water security.
3. Environmental problems pose threat to energy security. Discuss.
4. What the relationship between environmental issues and food security.

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UNIT 4 RENEWABLE AND NON-RENEWABLE RESOURCES

CONTENTS

1.0. INTRODUCTION

A resource is any source or supply, man-made or natural, from which humans can benefit. There are many different resource classification systems. Resources can be classified based on their availability, development, basis of origin, or location. Resources are a relevant concept in a variety of fields, including economics, computing, biology, and ecology. In most fields, resources are discussed in terms of their rate of consumption, availability, and utility.

Natural resources are derived from our environment. They can be classified either by their source of origin, stage of development, or renewability. Natural resources are vital to both humans and the economy, because they contain all the materials humans need to live, and because all physical man-made resources are made from natural resources.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- explain natural resources in context
- discuss the types and sources of natural resources (renewable and non-renewable)
- Describe how to manage natural resources for sustainable development

3.0 MAIN CONTENT

3.1 Natural Resources in Context
3.2 Types of Natural Resources (Renewable and Non-Renewable)
3.3 Managing and Conservation of Natural Resources

3.1 Natural Resources in Context

Natural resources are what occur in nature in their original, untouched form - unless of course man disturbs this. They consist of all things that do not come under man-made creations, where what we see around us that take its course without the intervention of humans, is what would account as a natural resource. From rivers to mountains, to precious stones and minerals, the earth is abundant with resources that develop on the planet using its surrounding environment to help it thrive or take form.

3.1.1 List of Natural Resources

1 Forest resources (pertaining to plant and tree life)
2 Aquatic / Marine resources
3 Hydro geological resources (water bodies of all kinds)
4 Animal resources (domesticated animals, or those that can be easily approached by humans)
5 Microbial resources (organisms that aren't visible to the naked eye)

6 Human resources (the population at large)
7 Atmospheric resources (anything that humans cannot control - rainfall, sunlight, temperature, and the like)
8 Crop resources (agricultural growth)
9 Geological resources (naturally occurring formations - rocks, valleys, minerals, precious metals, and the like)
10 Edaphic resources (anything related to the soil and its properties)
11 Wildlife resources

Natural resources can further be defined as renewable and non-renewable resources. Renewable resources are those that can be produced again, for example, plants and animals, whereas, nonrenewable resources are those which cannot be produced again, for example, fossil fuels. The latter is exhaustible and needs to be carefully utilized to leave enough for future generations.

We need to make serious attempts to use natural resources in an efficient manner because in recent years, these resources have depleted as a result of their careless use. The seriousness of the problem can be understood from the words of former American president Theodore Roosevelt, "The conservation of natural resources is the fundamental problem. Unless we solve that problem, it will avail us little to solve all others."

3.1.2. Classification of Natural Resources

- Classified by source of origin, natural resources are either biotic or abiotic. Biotic resources are derived from organic material, like plants and animals. This classification includes materials such as fossil fuels, which come from decayed organic matter. Resources that are non-living and non-organic are abiotic resources. This includes water, air, soil, metals, and all the minerals found in the Earth.

- **Natural resources are also classified by their stage of development. Actual resources are natural resources that humans have identified, measured, and are ready to utilize**. Potential resources are resources that, while not yet ready to be utilized, have been identified and can be measured and used in the future. An example of a potential resource is the presence of minerals in a rock that haven't yet been excavated.
- **A third classification for natural resources is based off of their renewability. Minerals and fossil fuels are classified as nonrenewable** because the rate at which they form is slower than the rate at which humans utilize them. Renewable resources are able to be replenished, and are frequently available. Examples of renewable resources are sunlight and wind.

Most discussions surrounding natural resources center around the concepts of sustainability and conservation. This is because natural resources are both central to many world economies, and limited in quantity. Many governments have put policies and laws into place in an effort to manage the rate at which natural resources are used.

SELF ASSESSMENT EXERCISE

List the types of natural resources you know and their classifications

3.2. Types of Natural Resources (Non-Renewable and Renewable)

Our demand for natural resources steadily rises every year. Until 1970s, our consumption remained within the natural capacity of our ecosystems to replenish these resources. But since then, we have crossed the threshold of the sustainable resource management, and began using more resources than one planet Earth can possibly provide.

Currently, we live as if we had 1.7 planet Earths available to sustain our needs. This means that **we all are living with the growing ecological debt to our planet**.

We are depleting our planet so much that we have started tracking when this "overshoot" takes place. For example, in 2017, the demand for natural resources exceeded what our ecosystems can regenerate on August 2nd [1]. All resources and ecosystem services we had used in the remaining four months of the last year collectively add to the debt.

- **The Difference between Renewable and Non-renewable Resources?**

Our planet's finite resources and the rate at which we are depleting them has led to a lot of debate about the efficient use of our planet's natural wealth, as well as the type of resources that we should prefer in order to minimize the impact we are having on our planet.

A key distinction in terms of the resources that are at our disposal is whether they are renewable or non-renewable. So, what exactly are renewable and nonrenewable resources?

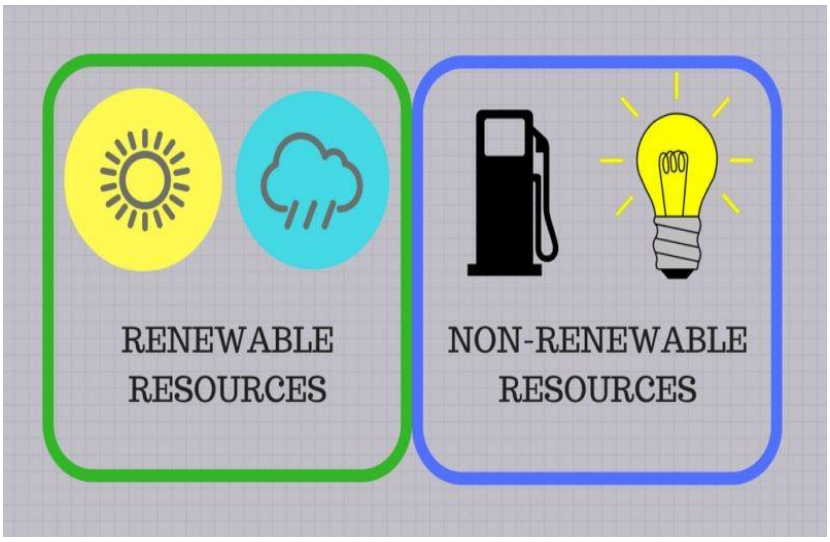
Renewable resources are resources that are replenished naturally in the course of time. The use of these resources corresponds with the principles of sustainability, because the rate at which we are consuming them does not affect their availability in the long term. Sources of energy that cannot be depleted, but can be replaced, recycled, or renewed by natural processes or the environmental cycle are known as renewable sources of energy.

In contrast, **non-renewable resources** are those that are available to us in limited quantities, or those that are renewed so slowly that the rate at which they are consumed is too fast. This means that their stocks are getting depleted before they can replenish naturally. *Non-renewable sources of energy, on the other hand, are those that cannot be reproduced, and once used, cannot be replaced.* These are formed naturally over a period of millions of years and therefore, they cannot be replaced easily. Moreover, there is always

a danger of these resources getting extinguished. Hence, they are also known as exhaustible resources. Due to this fact, conservative use of these resources is the need of the day. Researchers are in the process of finding substitute sources of energy that will replace these resources, but until that time it is our responsibility to use these non-renewable resources carefully and wisely. About 85% of the world's energy comes from non-renewable sources of energy, if we use resources at this rate; it will only intensify the problem further. A list of non-renewable resources is given below, which as a result of continual use may no longer exist and humanity will have to find alternate sources of energy.

Table 1.1 Examples of Renewable and Non-renewable Resources

Examples of Renewable Resources	**Examples of Non-renewable Resources**
1.Solar energy	1. Coal
2. Wind energy	2. Oil and Natural Gas
3. Geothermal energy	3. Peat
4. Water	4. Uranium
5. Air	5. Gold
6. Soil	6. Aluminum
7. Cultivated Plants	7. Sand
8. Biomass	8. Iron
9. Biofuels	9. Phosphate Rock
10. Animals	10. Rare Earth Element



Source:https//www.topdifferences.com/difference-between-renewable-resources-and-non-renewable-resources/

3.2.1 Non-renewable Resources and the Environment

Ever wonder exactly what the major problems are with some of the non-renewable energy sources? In addition to the greenhouse gas emissions released when things like natural gas, oil, and coal are burned, each of the fossil fuel energies below come with a world of other eco-woes. Below is a list of the most common non-renewable energy sources and their related impacts on human health and the environment.

- **Oil (Crude and Petroleum) and the environment**

In addition to carbon dioxide (CO2), byproducts (air pollutants) of burning petroleum products include:

- Carbon monoxide(CO)
- Sulfur dioxide (SO2) which causes acid rain and harms plants and animals
- Nitrogen oxides (NOx) and volatile organic compounds (VOC) which contribute to smog (ground level ozone)
- Particulate matter (PM) which contributes to asthma and chronic bronchitis in humans

- Lead and various air toxins such as benzene, formaldehyde, acetaldehyde, and 1,3-butadiene which may be emitted when some types of petroleum are burned, all of which come with significant human health hazards
- Not only that, but exploring and drilling for these products disturbs natural habitats on land and in the sea, and as we know from the Deepwater Horizon Oil Spill of 2010, catastrophic failures can be extremely damaging (Smith, 2018).

➢ **Tar sands, a special concern for the oil industry**

The tar sands are oil deposits (many of which are concentrated in Canada) that are essentially vast swaths of land with oil-soaked soil and sand. To get at this difficult resource, oil companies' strip away all vegetation (destroying huge areas of ecosystems), scrape away the oil-soaked soil, then use unbelievable amounts of water and chemicals to separate the oil from the land. Often referred to as the world's largest slow-motion oil spill, tar sands leave amazing environmental destruction in their wake:

- It takes two units of energy (usually natural gas) to extract one unit of energy from the tar sands, which means the energy return on energy invested (EROEI) is not positive
- Puts a large drain on surface water resources
- Contamination of groundwater
- Giant tailings ponds full of toxins (and massive bird deaths if not properly managed)
- Seepage of toxins into human drinking water

➢ **Natural gas and the environment**

This fossil fuel releases fewer air pollutants, including CO_2, CO, SO_2, and NOx, however since it is mainly composed of methane, a greenhouse gas that is significantly more potent in terms of trapping heat in our atmosphere compared to carbon dioxide, it still has a big impact on global warming (contributes 3% to total US greenhouse gas emissions).

Like exploring and drilling for oil, the job of extracting natural gas results in massive disturbances on vegetation and soil (which harms wildlife) from vehicles, pipelines, storage facilities, and so on.

- **Fracking, a special concern for the natural gas industry**

Fracking (short form for fracturing) is a process of using enormous amounts of water and sand or ceramic beads combined with toxic chemicals like benzene, ethylbenzene, toluene, xylene, naphthalene and other chemicals to remove the gas from hard to access sources. This results in groundwater contamination that causes measurable health problems for wildlife and humans.

- **Coal and the environment**

Coal is a very old form of fossil fuel energy (a major component of the industrial revolution), but comes with some big environmental problems, too – from mining to transporting to burning it.

- Air pollutants, including SO2, NOx, and CO2
- Mercury is released when coal is burned – linked to neurological and developmental problems in humans
- Mountaintop removal coal mining involves blowing the tops off of entire mountains to get at the coal deposits
- Acidic water can drain from mines, polluting natural ecosystems
- Fly ash and bottom ash are two byproducts produced when burning coal, adding to air pollution
- Many humans die in the process of mining every year around the world

- **Nuclear and the environment**

Though nuclear power plants do not produce air pollution or greenhouse gas emissions while operating, there are some significant concerns regarding the mining of uranium ore (the fuel used in nuclear reactors) and what to do with spent uranium when it is retired.

- Mining uranium and building nuclear power plants require large amounts of energy, leading some to question whether the energy inputs are worth the energy outputs.
- The radioactive nuclear waste created in nuclear power plants remains dangerous to human and environmental health for thousands of years – storing it is therefore an enormous problem (financial and environmental) for which there is no viable solution as of yet.
- These power plants can experience major failures resulting in catastrophic meltdowns like Chernobyl.

3.2.2 Renewable Resources and the Environment

All energy sources have some impact on our environment. Fossil fuels—coal, oil, and natural gas—do substantially more harm than renewable energy sources by most measures, including air and water pollution, damage to public health, wildlife and habitat loss, water use, land use, and global warming emissions.

However, renewable sources such as wind, solar, geothermal, biomass, and hydropower *also* have environmental impacts, some of which are significant.

The exact type and intensity of environmental impacts varies depending on the specific technology used, the geographic location, and a number of other factors. By understanding the current and potential environmental issues associated with each renewable energy source, we can takes steps to effectively avoid or minimize these impacts as they become a larger portion of our electric supply.

- **Wind Power**

Harnessing power from the wind is one of the cleanest and most sustainable ways to generate electricity as it produces no toxic pollution or global warming emissions. Wind is also abundant, inexhaustible, and affordable, which makes it a viable and large-scale alternative to fossil fuels.

Despite its vast potential, there are a variety of environmental impacts associated with wind power generation that should be recognized and mitigated.

- **Solar Power**

Like wind power, the sun provides a tremendous resource for generating clean and sustainable electricity.

The environmental impacts associated with solar power can include land use and habitat loss, water use, and the use of hazardous materials in manufacturing, though the types of impacts vary greatly depending on the scale of the system and the technology used—photovoltaic (PV) solar cells or concentrating solar thermal plants (CSP).

- **Geothermal Energy**

The most widely developed type of geothermal power plant (known as hydrothermal plants) are located near geologic "hot spots" where hot molten rock is close to the earth's crust and produces hot water.

In other regions enhanced geothermal systems (or hot dry rock geothermal), which involve drilling into the earth's surface to reach deeper geothermal resources, can allow broader access to geothermal energy.

Geothermal plants also differ in terms of the technology they use to convert the resource to electricity (direct steam, flash, or binary) and the type of cooling technology they use (water-cooled and air-cooled). Environmental impacts differ depending on the conversion and cooling technology used.

- **Biomass Power for Electricity**

Biomass power plants share some similarities with fossil fuel power plants: both involve the combustion of a feedstock to generate electricity. Thus, biomass plants raise similar, but not identical, concerns about air emissions and water use as fossil fuel plants. However,

the feedstock of biomass plants can be sustainable produced, while fossil fuels are non-renewable.

Sources of biomass resources for producing electricity are diverse; including energy crops (like switchgrass), agricultural waste, manure, forest products and waste, and urban waste. Both the type of feedstock and the manner in which it is developed and harvested significantly affect land use and life-cycle global warming emissions impacts of producing power from biomass.

- **Hydroelectricity Power**

Hydroelectric power includes both massive hydroelectric dams and small run-of-the-river plants. Large-scale hydroelectric dams continue to be built in many parts of the world (including China and Brazil), but it is unlikely that new facilities will be added to the existing US fleet in the future.

Instead, the future of hydroelectric power in the United States will likely involve increased capacity at current dams and new run-of-the-river projects. There are environmental impacts at both types of plants (Smith, 2018).

SELF ASSESSMENT EXERCISE

With concrete examples differentiate between renewable and non-renewable resources

3.3. Managing and Conserving Natural Resources for Sustainable Development

Resources are features of environment that are important and value of to human in one form or the other. However, the advancement of modern civilization has had a great impact on our planet's natural resources. So, conserving natural resources is very essential today. There are many ways that one can conserve natural resources. All you need to do is to look around and see what natural resources you are using and find out ways to limit your usage. Most of the people use natural gas to heat their water and their home. You can monitor how much you are using this resource to minimize its usage.

For conservation of natural resources like natural gas, one can get tank less water heater as it reduces the usage of natural gas. The other way to save natural gas is the use of another energy source for instance hydro, solar or wind power are all healthy and great alternatives to conserving natural resources. In fact these energy sources are clean and healthy for environment. Moreover, these energy sources do not emit or produced harmful gases or toxin into our environment like that of the burning fossil fuels at the same time they are renewable as well as are not easy to deplete.

Today, most of the people are finding many ways for conserving natural resources. One of the great option before is Hydro-power and solar power. Power can be generated from these sources and these are the best ways for natural resources conservation like fossil fuels. There is also way to conserve natural resource like trees. It can be conserve through recycling process. Many products come from the trees like papers, cups, cardboards and envelopes. By recycling these products you can reduce the number of trees cut down a year. One should make the most use of these paper products without being wasteful and then recycle them. This is one great way for conserving natural resources.

Fossil fuels on Earth will not last forever; we need to conserve these fossil fuels. To conserve fossil fuels one can choose to buy a hybrid car. Some of these cars will run on electricity combined with using small amounts of gas. Some hybrid cars just run on electricity. Either way it is a great way for conserving natural resources when it is concern with fossil fuels.[6]

SELF ASSESSMENT EXERCISE

Briefly discuss ways of managing and conserving resources

4.0. CONCLUSION

[6] http://www.eia.doe.gov/energyexplained/index.cfm?page=natural_gas_environment

In this unit, we explained resource in the general context. The meaning and differences of natural resources such as renewable and non-renewable have been hilighted with examples of each. The unit concludes that Sources of energy that cannot be depleted, but can be replaced, recycled, or renewed by natural processes or the environmental cycle are known as renewable sources of energy. Whereas Non-renewable sources of energy, on the other hand, are those that cannot be reproduced, and once used, cannot be replaced.

5.0. SUMMARY

This unit explained renewable and non-renewable types of resources. The different types of resources enumerated with examples. How each of the resources types affect the environment have been discussed. And the various ways of conserving both renewable and non-renewable resources have been explained.

6.0. TUTUR-MARKED ASSIGNMENT

1. How does each type of renewable and non-renewable resources affect the environment? Explain both positive and negative effects of each.
2. What are the various ways of managing renewable and non-renewable resources for sustainable development?
3. With concrete examples, differentiate between renewable and non-renewable resources.

7.0 REFERENCES/FURTHER READINGS

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MODULE 2: HISTORICAL ROOTS AND CURRENT DISCUSS ON SUSTAINABLE DEVELOPOMENT

Unit 1: Historical Background of Sustainable Development

Unit 2: Current Issues on Sustainable Development

Unit 3: Overview of Theoretical Perspective of the Environment and its Sustainability

Unit 4: Bio-economy and Sustainable Development

UNIT 1: HISTORICAL BACKGROUND OF SUSTAINABLE DEVELOPMENT

CONTENT

1.0 INTRODUCTION

The concept of sustainable development formed the basis of the United Nations Conference on Environment and Development held in Rio de Janeiro in 1992. The summit marked the first international attempt to draw up action plans and strategies for moving towards a more sustainable pattern of development. It was attended by over 100 Heads of State and representatives from 178 national governments. The Summit was also attended

by representatives from a range of other organisations representing civil society. Sustainable development was the solution to the problems of environmental degradation discussed by the Brundtland Commission in the 1987 report on Our Common Future. **Brundtland Report**, also called *Our Common Future*, publication released in 1987 by the World Commission on Environment and Development (WCED) that introduced the concept of sustainable development and described how it could be achieved. Sponsored by the United Nations (UN) and chaired by Norwegian Prime Minister Gro Harlem Brundtland, the WCED explored the causes of environmental degradation, attempted to understand the interconnections between social equity, economic growth, and environmental problems, and developed policy solutions that integrated all three areas[7].

The remit of the Brundtland Report was to investigate the numerous concerns that had been raised in previous decades, namely, that human activity was having severe and negative impacts on the planet, and that patterns of growth and development would be unsustainable if they continued unchecked. Key works that highlighted this thinking included Rachel Carson's Silent Spring (1962), Garret Hardin's Tragedy of the Commons (1968), the Blueprint for Survival by the Ecologist magazine (1972) and the Club of Rome's Limits to Growth report (1972).

The concept of sustainable development received its first major international recognition in 1972 at the UN Conference on the Human Environment held in Stockholm. The term was not referred to explicitly, but nevertheless the international community agreed to the notion - now fundamental to sustainable development - that both development and the environment, hitherto addressed as separate issues, could be managed in a mutually beneficial way.

The term was popularised 15 years later in Our Common Future, the report of the World Commission on Environment and Development, which included what is deemed the 'classic' definition of sustainable development: "development which meets the needs of the present without compromising the ability of future generations to meet their own needs".

[7] For further reding visit:
https://sustainabledevelopment.un.org/content/documents/5987our-common-future.pdf

It was not until the Rio Summit, however, that major world leaders recognised sustainable development as the major challenge it remains today (WCED, 1987).

In 2002, the World Summit on Sustainable Development was held in Johannesburg, attended by 191 national governments, UN agencies, multilateral financial institutions and other major groups to assess progress since Rio. The Johannesburg Summit delivered three key outcomes: a political declaration, the Johannesburg Plan of Implementation, and a range of partnership initiatives. Key commitments included those on sustainable consumption and production, water and sanitation, and energy.

2.0 OBJECTIVES

At the end of this unit, students are expected to:

- understand the term sustainable development
- Explain the history of sustainable development
- Understanding the Development Goals: Transiting from MDGs to SDGs

3.0 MAIN CONTENT

3.1 Meaning of Sustainable Development

Sustainable development is defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts: The concept of 'needs', in particular the essential needs of the world's poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs. Sustainable development simply means that the needs of the present generation should be met without compromising the ability of future generations to meet their own needs. It is about safeguarding the earth's capacity to support life in all its diversity and is based on the principles of democracy, gender equality, solidarity, the rule of law and respect for fundamental rights, including freedom and equal opportunities for all. It aims at the continuous improvement of the quality of life and well-being on earth for present and future generations. To that end it promotes a dynamic economy with full employment

and a high level of education, health protection, social and territorial cohesion and environmental protection in a peaceful and secure world, respecting cultural diversity.

Sustainable development means enhancing the economic, social and environmental wellbeing of people and communities, achieving a better quality of life for our own and future generations: In ways which promote social justice and equality of opportunity; and in ways which enhance the natural and cultural environment and respect its limits - using only our fair share of the earth's resources and sustaining our cultural legacy. Sustainable development is the process by which we reach the goal of sustainability. The goal of sustainable development is to enable all people throughout the world to satisfy their basic needs and enjoy a better quality of life, without compromising the quality of life of future generations. Therefore if the world must meet both the needs of the present and future generations, it is now more important than ever to put into practice the concept of sustainable development, which integrates economic growth, social development, and protection of the environment. To achieve this, global strategies for economic development that can lift low-income countries having per capita income of less than USD 767 out of abject poverty, illiteracy, economic stagnation, environmental degradation and technological exclusion *inter alia* Adesina-Uthman (2019)[8].

Source: http://macaulay.cuny.edu/eportfolios/akurry/files/2011/12/SDspheres.jpg

[8] For further readings visit https://www.researchgate.net/publication/334432132_Higher_Education_and_Sustainable_Development_for_Knowledge-based_Nigerian_Economy_Journal_of_Economics_Studies, 15(1), Department of Economics, UNN, pp_21-38

Source: http://macaulay.cuny.edu/eportfolios/akurry/files/2011/12/SDspheres.jpg

SELF ASSESSMENT EXCERCISE 3.1

In your own words, define the term sustainable development and explain its goal.

3.2 Historical Roots of Sustainable Development

A short history of the concept of sustainable development could begin with the US government's National Environmental Policy Act (NEPA) of 1969. This act came largely in response to the 1969 Santa Barbara oil spill, which had a devastating impact on wildlife and the natural environment in the area. But it was also the product of greater societal attention to the consequences of industrial pollution, awareness of which was promoted by the 1962 publication *Silent Spring* by Rachael Carson. Around the same time, and as a result of the same push towards great concern for the environment, arrived the Clean Water Act, the Water Quality Act, the push to ban Dichlorodiphenyltrichloroethane (DDT), and the institution of the National Wilderness Preservation System. Shortly after the passage of NEPA, the Environmental Protection Agency (EPA) opened its doors in 1970, promoting protection of the environment through research, standard-setting, and monitoring. The goals of the EPA concerned both human health as well as natural resource protection.

The next step in the growth of sustainable development as a mainstream concept and practice was the 1972 United Nations Conference on the Human Environment, in Stockholm, Sweden. This conference brought the industrialised and developing nations together to delineate the 'rights' of the human family to a healthy and productive environment. A series of such meetings followed, e.g. on the rights of people to adequate food, to sound housing, to safe water, to access to means of family planning. The recognition to revitalize humanity's connection with nature, led to the creation of global institutions within the UN system. Here, we have a transition from a national focus to an international one.

At this point, the term 'sustainable' had yet to really take off. The United Nations Conference on Sustainable Development (Brundtland, 1987) provides an excellent, condensed history of the term, which I will quote at length:

> *The concept of sustainable development was originally synonymous with that of sustainability and is often still used in that way. Both terms derive from the older forestry term "sustained yield", which in turn a translation of the German term "nachhaltiger Ertrag" is dating from 1713. According to different sources, the concept of sustainability in the sense of a balance between resource consumption and reproduction was however applied to forestry already in the 12th to 16th century. The history of the concept of sustainability is however much older. Already in 400 BCE, Aristotle referred to a Greek concept in talking about household economics. This Greek household concept differed from modern ones in that the household had to be self-sustaining at least to a certain extent and could not just be consumption oriented.*[9]

The first time the term 'sustainable' was used "in the modern sense" was as part of the Club of Rome, in 1972. This came to the fore as a part of the publication of *Limits to Growth*, a report that described a particular state in which the global population would achieve balance or equilibrium. "Describing the desirable "state of global equilibrium", the

[9] https://sustainabledevelopment.un.org/content/documents/5987our-common-future.pdf

authors used the word “sustainable”: “We are searching for a model output that represents a world system that is: 1. sustainable without sudden and uncontrolled collapse; and 2. capable of satisfying the basic material requirements of its entire people.

About fifteen years after the Club of Rome’s publication came another large step forward in this movement, at least according to most mainstream sources. The World Commission on Environment and Development (WCED) was tasked by the Secretary General of the UN, in 1983, to “re-examine critical environmental and development problems around the world and formulate realistic proposals to address them. This culminated in the 1987 Bruntland Report’s publication of “Our Common Future”, which established a suggested path for sustainable development on a global level and served to bring the concept of sustainability into the foreground on an international level.

A ground-breaking step came in 1992 with the first UN Conference on Environment and Development (UNCED) in Rio de Janeiro. At this conference, an agenda called Agenda 21 was adopted, which recognized each nation’s right to pursue social and economic progress and assigned to States the responsibility of adopting a model of sustainable development. The Secretary General of UNCED regarded Agenda 21 as a program of action for a tolerable future for the human family and an initial step toward making sure the world will change into a more just, secure and wealthy habitat for all humanity. The focus, then, had become broader than when the EPA was first established. The emphasis was much more clearly on working towards a world where all peoples had access to the natural resources they needed to thrive.

Another notable international protocol designed to guide the international community towards sustainable development, in this case particularly environmental, was the Kyoto Climate Agreement in 1997. Its goal was to reduce the emissions of its signatories, with more emphasis placed on those developed countries which were responsible for most of the air pollution and its subsequent consequences. You should note noted that the US is the

only developed country and one of the only two in general (the other being South Sudan) that has not ratified this protocol.

SELF ASSESSMENT EXCERCISE

Trace the historical roots of sustainable development in the world economy

3.3 Criticisms of Sustainable Development

Dear student, though the notion of sustainable development typically enjoys positive attention on a global level, there have been various points of criticism and some complications that have developed over time. This could be described below:

(a) Environmental Critique

One point of contention has arisen as a result of the differences in power and responsibility between some developing and developed countries. For instance, developed countries are most often the ones pushing for particular types of sustainable development, whether that means a cap in emissions from power plants or a transition towards more sustainable forms of energy such as wind and solar. However, developed countries are often the ones who have already benefitted from the exploitation of environmental resources employing these less-sustainable methods for many decades, whereas many developing countries are just now beginning to have access to these technologies. At the same time, these new sustainable technologies entail more costs, which may be possible for developed countries, but not for many developing countries. You should know, in other words that one criticism is that developed countries have long benefitted from unsustainable practices and are now imposing their new-found sustainable values upon developing countries, for whom, this transition is much more difficult and costly.

(b) Economic Critique

The previous point was mostly focused on natural, environmental concerns (e.g., how we might reduce emissions). Another large focus in the sustainable development movement has been on freeing peoples in parts of the developing world from the bonds of poverty and starvation. In essence, this is a focus on the economics of sustainable development.

Perhaps the biggest conflict seen regarding sustainable development is economic in nature. Broadly speaking, the global economy has a neoliberal bent to it. With regard to sustainable development, the tenets of neoliberal economic agenda such as commodification, deregulation, privatisation and cuts in government expenditure may in some context undermine the attainment of sustainable development by increasing poverty and inequality. This in turn increases the exploitation of environmental resources, such as forests, as a result of poverty-induced constraints. Additionally, the regulatory capacity of environmental management provided by the state has been reduced mainly due to budgetary constraints imposed by the adoption of neoliberalism. In other words, the properties of the neoliberal economic system run counter to what many consider to be the goals of sustainable development. Neoliberal economics can be harmful to the environment and to the standard of living for various groups of people – particularly the poor.

Indian economist Amartya Sen is famous for his work on the relationship between economics and social justice, particularly in relation to famine and starvation as a result of faulty economic policies. One of his most profound arguments, that of 'capability', argues that the rights provided by governments (such as the right to vote, freedom of speech, etc.) are empty benefits, not of much use unless the society provides its citizens "functionings," such as education, transportation to voting locations, access to food, etc. Therefore, in order to promote sustainable development with the lives of people in mind, we must focus on economic policies that may hinder or promote well-being. However, the world system of capitalism might be viewed to be incompatible with sustainable development progress.

SELF ASSESSMENT EXCERCISE

Write a critique of sustainable development thesis

3.4 Understanding the Development Goals: Transiting from MDGs to SDGs

The 17 SDGs carry on the work begun by the Millennium Development Goals (MDGs), which galvanized a global campaign from 2000-2015 to end poverty in its various dimensions. Yet while the MDGs only applied to developing countries, it will interest you

to know that the SDGs will apply universally to all UN member states, and are considerably more comprehensive and ambitious than the MDGs. In order for the SDGs to be fully successful, urban areas and their local governments – where the majority of implementation and monitoring will occur – need to be empowered. Decentralized cooperation and vertically integrated action, which leverage and enable the capacities of local government actors, can make a positive impact on the success of the SDGs. The most significant challenges to the universal implementation of the SDGs, and thereby their success, include capacities for progress monitoring and contentions around how they will be financed.

What came out of the UN Sustainable Development Summit 2015? On September 25-27, 2015 during the 70th session of the United Nations General Assembly, UN member states convened a special summit for the adoption of the post-2015 development agenda. This special summit concluded with the adoption of the declaration "Transforming Our World - the 2030 Agenda for Sustainable Development", a universal call to action for the betterment of people, planet, prosperity, peace, and partnership which is unprecedented in both scope and ambition. To catalyze cooperative, transformative action at the international scale, the 2030 Agenda includes a set of 17 universally applicable, integrated objectives for sustainable development, which are accompanied by a total of 169 concrete targets and indicators. These objectives are officially referred to as the Sustainable Development Goals (SDGs). The SDGs build upon the expiring Millennium Development Goals (MDGs): eight targets which guided global action on the reduction of extreme poverty in its multiple dimensions from 2000-2015. While the SDGs maintain the thematic work on poverty eradication targeted by the MDGs, they reflect a comprehensive perspective on international development and sustaining human life on this planet. By providing a set of integrated targets and progress indicators the SDGs are the key to the success of the 2030 Agenda, and will guide the development agendas and national policies of UN member states and their international cooperation over the next 15 years.

SELF ASSESSMENT EXCERCISE

Explain the transition from MDGs to SDGs

3.5 What were the MDGs and How Successful?

In September 2000, at the UN Millennium Summit, the UN General Assembly adopted the United Nations Millennium Declaration. The Declaration, which called for a global partnership to reduce extreme poverty, was the first ever global strategy with quantifiable targets to be agreed upon by all UN member states and the world's leading development institutions. To support the Declaration, former UN Secretary General Kofi Annan established eight accompanying objectives. These objectives were set with a deadline of 2015 and became known as the Millennium Development Goals (MDGs) as listed hereunder:

1. Eradicate extreme poverty and hunger
2. Achieve universal primary education
3. Promote gender equality and empower women
4. Reduce child mortality
5. Improve maternal health
6. Combat HIV/AIDS, malaria and other diseases
7. Ensure environmental sustainability
8. Develop a global partnership for development

The effectiveness of the MDGs has been the subject of considerable debate. Supporters argue that the development agenda promoted by the MDGs has spearheaded an unprecedented international movement against extreme poverty, reducing it by more than 50 percent globally. Prior to their enactment, individual campaigns aimed at the thematic areas within the MDGs – such as eliminating income poverty and promoting literacy – were already underway, but prior to the MDGs they had not been conceived as a coherent catalog of goals at the global level. Critics, on the other hand, note that progress on the specific targets set out by the MDGs has been both regionally and thematically unbalanced. This is because many countries adopted a "piecemeal approach", choosing to engage with some but not all of the MDGs. This has been attributed to the fact that the MDGs only applied to countries of the global South, and that they had collectively played a minimal

role in their design. Consequently, the MDGs were perceived by several critics as a platform that was imposed.

SELF ASSESSMENT EXCERCISE

How Successful was the MDGs that rounded up in 2015?

3.6 What makes the SDGs different?

In sharp contrast to the MDGs, the Sustainable Development Goals (SDGs) are uniformly applicable to all countries of the world, removing the "developing" versus "developed" dichotomy that left the MDGs open to criticism. And while there are similarities in regard to the format of the MDGs and the SDGs – e.g. each framed the international development agenda for a 15-year period - the SDGs have significantly expanded on the scale and content of the MDGs. The SDGs are focused on a global development with and for sustainability, and demonstrate an understanding that the environment is not an add-on or in opposition to sustainable development, but rather the basis that underpins all other goals. As a result, where the MDGs maintained a retrospectively narrow focus on poverty reduction, the SDGs include new themes which reflect an approach that sees the environment, economy and society as embedded systems rather than separate competing "pillars" e.g.: urban areas, water and sanitation, energy, and climate change are all prominently featured. Another significant difference between the MDGs and SDGs is how they have been created. The crafting of the SDGs has been regarded as an unparalleled participatory policy process, and this is reflected in their scale and ambition. A UN Open Working Group (OWG) made up of 70 countries sharing 30 seats was established in 2013 to draft the SDGs and was tasked with incorporating a range of stakeholders into their negotiation process. As a result, developing countries have been able to provide significant input into the content, as have local and sub national governments, and prominent actors from civil society and the private sector.

The 17 Sustainable Development Goals are:

1. End poverty in all its forms everywhere

2. End hunger, achieve food security and improved nutrition, and promote sustainable agriculture

3. Ensure healthy lives and promote wellbeing for all at all ages

4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

5. Achieve gender equality and empower all women and girls

6. Ensure availability and sustainable management of water and sanitation for all

7. Ensure access to affordable, reliable, sustainable and modern energy for all

8. Promote sustained, inclusive and sustainable economic growth, full and productive employment, and decent work for all

9. Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation

10. Reduce inequality within and among countries

11. Make cities and human settlements inclusive, safe, resilient and sustainable

12. Ensure sustainable consumption and production patterns

13. Take urgent action to combat climate change and its impacts (noting agreements made by the UNFCCC forum)

14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development

15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification and halt and reverse land degradation, and halt biodiversity loss

16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels

17. Strengthen the means of implementation and revitalize the global partnership for sustainable development.

The 17 Sustainable Development Goals

Source: http://www.un.org/sustainabledevelopment/news/communications-material/

SELF ASSESSMENT EXCERCISE

1. How successful was the MDGs
2. List the Sustainable Development Goals as declared by the UN
3. Briefly discuss the dichotomy between MDGs and SDGs.

3.7 What will make the SDGs successful?

The experience of the MDGs demonstrates that when presented with ambitious targets for development, nations will often opt to use their own goals as a benchmark for progress. Because of this, empowering a variety of non-state actors for implementation will be a key driver of their success. For although it seems that monitoring progress on the SDGs will be focused at the national level, cities and urban areas where a great amount of the implementation and monitoring will occur. Local government authorities and communities need to be empowered accordingly. This means establishing a collaborative

balance between local governments, states, and national governments, as well as involving and maximizing the contributions from stakeholders and all levels of administration within cities and regions - as well as the communities they serve. Another key to making the SDGs a success will be making sure the cross-cutting issues of sustainable production and consumption are a priority. This can be accomplished by moving towards economic models that are at once sustainable and inclusive. Cities, which are the central hubs of both innovation and the global economy, are where the transition to such sustainable economic models will continue to occur.

However, this transition does not only refer to the world's iconic megacities; small and medium sized cities comprise the statistical majority of urban areas and are experiencing rapid growth rates, yet they are currently facing the most significant resource/capacity gaps. Targeted sustainable economic and institutional development within these urban areas will have a positive impact on the success of the SDGs. Lastly, with global urbanization forecasted to continue throughout the course of the 2030 Agenda for Sustainable Development, we will likely see the persistence of challenges to the SDGs – such as planning, employment, resource management, demographics, and service provision. These challenges require a strategic long-term planning perspective with focus on the inter-linkages within regions, because progress on the SDGs will not be made if a country is only considered as a separate unit or if a district or city is considered in isolation. Success within the SDGs that are particularly cross-cutting can best be achieved through effective vertical integration; this means all levels of government working together to align and accelerate strategic actions, mobilize appropriate resources, and engage key stakeholders.

SELF ASSESSMENT EXCERCISE

Explain how best to achieve the SDGs.

3.8 Challenges Facing the SDGs

The immediate concern is that the targets established within the SDGs will be considered as the "ceiling" for achievement rather than the "floor" which is necessary for

international sustainability. This concern has not been lessened by the challenges to how the SDGs will be implemented, monitored, and financed.

1. Missing out on integration potential - A major challenge facing the successful implementation of the SDGs is the possibility that national governments will choose to focus only on the goals that align with their existing development agenda. The challenge posed by this approach is that the SDGs were designed as an integrated vehicle for sustainable development; wherever possible, cross-cutting indicators have been put in place, particularly in regard to housing, health, gender equality, production and consumption, and employment. Lack of action on one goal can compromise their collective success.

2. Data and monitoring challenges – Do you know that as was the case for the MDGs, monitoring of the SDGs will be performed by national statistical offices with the support of various UN agencies. However, many countries were unable to access the capacity necessary to collect, analyze, and disseminate the data required for reporting their progress on the MDGs. There is concern that the SDGs will suffer similar shortfalls in regard to capacity for monitoring, as there are now even more goals and targets which must be monitored.

3. Financing & the North-South divide - The most contentious challenge facing the SDGs is in regard to how they will be financed, as current projections estimate the needs for financing their implementation and monitoring to be around $17 trillion. It is within this debate that the "developed" versus "developing" country dichotomy re-emerges. "Developed" countries are pushing for the mobilization of domestic resources, wherein each UN member state will be responsible for securing its own funding, whereas "developing" countries are calling for financing to be provided by the "developed" countries through aid agreements. A solution may lie within a development finance model that can leverage and catalyze a combination of private investment, international and domestic public resources; however, without an answer to the finance question, the ambitious scope of the SDGs may be curtailed.

SELF ASSESSMENT EXCERCISE

Identify and discuss the obstacles that may likely hinder the achievement of Sustainable Development Goals.

4.0 CONCLUSION

The promotion of economically, socially and ecologically sustainable development is the central goal of this unit. It is also an integral element of the comprehensive approach to environmental sustainability. Therefore, it has become important to incorporate this into the curriculum of development studies.

5.0 SUMMARY

This unit has thrown more light on Millennium Development Goals (MDGs) and Sustainable Development Goals (SDGs). It has also x-rayed the differences between MDGs and SDGs, including the challenges that place limitations on the achievement of these goals and the way forward.

6.0 TUTOR-MARKED ASSIGNMENT

1. Distinguish between the MDGs and SDGs.
2. Suggesting ways to achieve the current SDGs in line with the decision of United Nations.
3. List the Sustainable Development Goals as declared by the UN
4. Briefly discuss the dichotomy between MDGs and SDGs.
5. What makes the SDGs different from the MDGs?

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UNIT 2: CURRENT ISSUES ON SUSTAINABLE DEVELOPMENT

CONTENT

1.0 Introduction

Sustainable development is a phrase we hear ecoing around from time to time in order to underline our ideal vision of the future – free of all the problems that the inhabitants of the earth tackle today. Depletion of natural resources, population growth, Gender inequality, energy, ecosystem, food security, industry, and unequal distribution of wealth etc are issues that temper with environmental quality and its sustainability.

2.0 OBJECTIVES

At the end of this unit, students are expected to:

- Understand current issues on sustainable development
- Explain the linkage between economic growth and sustainability
- Comprehend the challenges of sustainable development

3.0 MAIN CONTENT

3.1 Contemporary Issues

- ✓ **Issues on population and human Resources:**

- World population reached 6 billion in 1999 and could pass the 8 billion mark by 2025.
- The most rapid population growth is in the South, e.g. Africa, Asia and Latin America.
- The degree of consumption of resources per capita differs markedly between the South and the North.
- Health status, education levels and social conditions also differ greatly between the South and the North.

- ✓ **Issues on Food Security:**

- There is widespread hunger today despite the dramatic increase in the world production of cereal, meat and milk which have more than tripled since 1950.
- The increase in food production has been due to new methods of farming, including the use of new seed varieties, chemical fertilisers and pesticides, and increased irrigation but the cost of these inputs is beyond the reach of most small farmers.
- New methods of farming have had detrimental effects on the environment.
    - New seed varieties are not generally resistant to pests and require large amounts of water and chemicals.
    - Overuse of chemical pesticides and fertilisers has led to widespread pollution of water and biological magnification of these chemicals in food chains.
    - Irrigation has also caused salinisation and alkalisation of soils.
- Farm subsidies in the North result in over-production. Not only does this overuse land, it also affects opportunities for other countries to produce and sell food.

- The international debts of many countries in the South have led to the use of land to produce cash crops for export. This pushes subsistence farmers onto marginal lands which in turn contribute to widespread soil degradation.

The Urban Challenge:

- Over 50% of the world's population lives in urban communities.
- Most cities in the South have more than quadrupled in population in the last 30 years.
- Population pressure has resulted in inadequate urban infrastructure and services.
- The most serious problems are unemployment, poor housing conditions and environmentally and socially related health concerns.

✓ **Issues on Energy:**

- By the year 2025 global energy consumption will have increased by 40% over 1980 figures.
- The most used energy sources for commercial energy production and consumption are:
    - fossil fuels, such as oil and gas;
    - hydropower;
    - nuclear power; and
    - biomass fuels (wood, crop residues and dung) on which the majority of people in the South rely for their energy supplies.
- Renewable energy amounts to only 21% of the total energy consumed worldwide. Solar, wind, geothermal and alternative energy sources, such as ethanol, have found only limited, small-scale use.
- The dependence on fossil fuels, which are finite, has resulted in four major problems:
    - large-scale climatic change resulting from the emission of carbon dioxide (Greenhouse Effect);

    - urban air pollution and acidification as a result of the release of sulphur dioxide and nitrogen dioxide during combustion;
    - depletion of resources; and
    - international conflict.
- Nuclear power also causes problems:
    - health risks to workers involved in its production and disposal of the wastes;
    - health risks to the community;
    - risk of catastrophic accident; and
    - need for very strict security.

✓ **Issues on Industry:**

- Industrialisation brings economic growth but also leads to a shift in population from rural to urban areas and escalating pollution of air, sea, the land and rivers.
- The pattern of industrialisation in the South now mirrors that of the industrialised nations and presents similar social and environmental problems.
- The ability of developing countries to deal with such problems as the disposal of hazardous wastes and industrial pollution has not been as great as in the industrialised nations due to cost, trade and technological inequalities between countries.

✓ **Issues on Species and Ecosystems:**

- The estimated total number of species on Earth ranges from 5 to 30 million.
- The most biod
- Diverse ecosystems are the wet tropical forests. For example the forests of Latin America could contain over one million species of plants, animals, birds and insects.
- The depletion of the gene pool has serious implications for the global economy since a substantial proportion of the production of medicines and drugs depends on species found in the tropical forests.

✓ **Managing the Commons:**

- The world's oceans, Antarctica and space are part of the 'global commons' for which all nations have joint responsibility.
- Marine environmental problems such as over-fishing and marine pollution are increasing rapidly.
- The sustainable catch from world fisheries is being exceeded by as much as 30 million tonnes per year (FAO figures).
- Sources of marine pollution include municipal sewage, industrial and agricultural run-off, oil spills and the dumping of toxic and other hazardous wastes.
- Management of Antarctica is governed by the Antarctic Treaty System. The dominant issues facing nations that are signatories to the System include the growing stockpiles of waste, the extent to which there should be mining of the continent's minerals, and the exclusion of most nations from much of the decision making about Antarctica.
- The increasing amount of space 'junk' is a pollution problem that has been largely overlooked. It indicates the need for international agreements on the issue. Management of outer space by the 1967 Outer Space Treaty has not been endorsed by all nations.

✓ **Conflict and Environmental Degradation:**

- Environmental degradation caused by factors such as over-exploitation of the land, drought and global climatic changes leads to deepening poverty and famine, which in turn contribute to social unrest and conflict.
- The threat of nuclear war presents us with the possibility of unprecedented global ecosystem destruction.
- Excessive military expenditure diverts funds from the urgent environmental problems facing developing nations.

(Source: Adapted from Macleod, H. (1992) *Teaching for Ecologically Sustainable Development*, Queensland Department of Education, Brisbane).

SELF ASSESSMENT EXCERCISE

Discuss the challenges of development and environmental sustainability

3.2 Economic Growth and Sustainability

Economic growth is conventionally measured in terms of increases in income. Development studies is a course interested in the dynamics of sustainable economic growth with the requirement that desirable environmental features are sustainable in terms of social utility function which is a combination of the utility of consumption and environmental quality. This formation incorporates the inevitable link between economy and environment. Economic growth is largely endogenous relative to stock of resources, resource use and flow of environment to technical progress and knowledge.

SELF ASSESSMENT EXCERCISE

How is economic growth linked to the quest for environmental sustainability?

3.3 Challenges of Sustainable Development

The world is faced with challenges in all three dimensions of sustainable development—economic, social and environmental. More than 1 billion people are still living in extreme poverty and income inequality within and among many countries have been rising; at the same time, unsustainable consumption and production patterns have resulted in huge economic and social costs and may endanger life on the planet. Achieving sustainable development will require global actions to deliver on the legitimate aspiration towards further economic and social progress, requiring growth and employment, and at the same time strengthening environ-mental protection. Sustainable development will need to be inclusive and take special care of the needs of the poorest and most vulnerable. Strategies

need to be ambitious, action-oriented and collaborative, and to adapt to different levels of development. They will need to systemically change consumption and production patterns, and might entail, inter alia, significant price corrections; encourage the preservation of natural endowments; reduce inequality; and strengthen economic governance.

(a) The impact of climate change threatens to escalate in the absence of adequate safeguards and there is a need to promote the integrated and sustainable management of natural resources and ecosystems and take mitigation and adaptation action in keeping with the principle of common but differentiated responsibilities;

(b) Hunger and malnourishment, while decreasing in many developing countries, remain persistent in other countries, and food and nutrition security continues to be an elusive goal for too many;

(c) Income inequality within and among many countries has been rising and has reached an extremely high level, invoking the spectre of heightened tension and social conflict;

(d) Rapid urbanization, especially in developing countries, calls for major changes in the way in which urban development is designed and managed, as well as substantial increases of public and private investments in urban infrastructure and services;

(e) Energy needs are likely to remain unmet for hundreds of millions of households, unless significant progress in ensuring access to modern energy services is achieved;

(f) Recurrence of financial crises needs to be prevented and the financial system has to be redirected towards promoting access to long-term financing for investments required to achieve sustainable development.

Over the past years, the global challenges to sustainable development have been driven by a broad set of "megatrends", such as changing demographic profiles, changing

economic and social dynamics, advancements in technology and trends towards environmental deterioration. A better understanding of the linkages among these trends and the associated changes in economic, social and environmental conditions is needed. The United Nations Conference on Sustainable Development, held in Rio de Janeiro, Brazil, from 20 to 22 June 2012, highlighted a range of interlinked challenges which call for priority attention, including decent jobs, energy, sustainable cities, food security and sustainable agriculture, water, oceans and disaster readiness. This sub-unit focuses on three of these cross-sectoral issues with immediate implications for realizing sustainable development, namely: (a) sustainable cities, (b) food and nutrition security and (c) energy transformation (World Economic and Social Survey, 2013). The other challenges are important, but a comprehensive discussion of them is beyond the scope of this study.

SELF ASSESSMENT EXCERCISE

Identify the challenges of sustainable development.

4.0 CONCLUSION

It is hoped that the coverage provided in this unit, including sustainability definitions and contexts, its economic, environmental and social dimensions, sustainable development, sustainability assessment measures and relevant applications, will assist efforts to address sustainability challenges today and, as an even more important priority, in the future.

5.0 SUMMARY

Sustainable development will need to be inclusive and take special care of the needs of the poorest and most vulnerable. Strategies need to be ambitious, action-oriented and collaborative, and to adapt to different levels of development. They will need to systemically change consumption and production patterns, and might entail, *inter alia*, significant price corrections; encourage the preservation of natural endowments and the environment, reduce inequality; and strengthen economic governance.

6.0 TUTOR MARKED ASSIGNMENTS

1. Examine the relationship between environment and development.
2. Identify measures to conserve the environment in the light of increasing global natural resource depletion.
3. Explain the link between economic growth and the quest for environmental sustainability.

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UNIT 3: OVERVIEW OF THEORETICAL PERSPECTIVE OF THE ENVIRONMENT AND ITS SUSTAINABILITY

CONTENT

1.0 INTRODUCTION

It has become necessary to think about the relationship between the earth and the economy. The issue now is not which celestial sphere atmosphere revolves around the other but whether the environment is part of the economy or the economy is part of the environment. Economists see the environment as a subset of the economy. Ecologists, on the other hand see the economy as a subset of the environment. This is an attempt to understand the modern world.

Evidence that the economy is in conflict with the earth's natural systems can be seen in the daily news reports of collapsing fisheries, shrinking forests, eroding soils, deteriorating rangelands, expanding deserts, rising carbon dioxide (CO_2) levels, falling water tables, rising temperatures, more destructive storms, melting glaciers, rising sea level, dying coral reefs, and disappearing species,. These trends which mark an increasing stressed relationship between the economy and the earth's eco system, are taking a growing economic toll. At some point, this could overwhelm the worldwide forces of progress, leading to economic decline.

The challenge for our generation is to reverse these trends before environmental deterioration leads to long-term economic decline, as it did for so many earlier civilisations. Therefore, economists and ecologists need to work together to design and build an ecological economy (eco-economy) that can sustain progress. It implies that the only formulation of economic policy that will succeed is one that respects the principles of ecology (the environment).

The Conservation of our environment is something we must all be a part of. There are many environmental projects promoting sustainable living – large and small, local, national and global – that we can participate in. Looking after environmental health is crucial to ensuring we, and future generations, can all go green and can live healthy lives on a healthy planet. Our individual or household environmental projects can include carrying out our own environmental impact assessment to ensure we use energy and water efficiently and make sure our food, furniture and clothing is from sustainable sources.

In this and other units, the study is concerned with sustainable development and environmental quality. This would be more apparent in unit four and subsequent modules. You will find this piece a useful reference material on sustainability issues such as green economy, bio-economy, the environment and development, amongst others.

2.0 OBJECTIVES

At the end of this unit, students should be able to:

- Understand the theoretical perspective of environmental sustainability
- Explain the concept of economic sustainability
- Examine the linkage between sustainable development and the environment

3.0 MAIN CONTENT

3.1 Economic Sustainability in Development Theory

Economic sustainability implies a system of production that satisfies present consumption levels without compromising future needs. The ‘sustainability’ that ‘economic sustainability’ seeks is the ‘sustainability’ of the economic system itself. The

notion of ‘economic sustainability’ was originated by Hicks (1939). In his classic work *Value and Capital, 1*939; second edition 1946, Hicks defined ‘income’ as ‘the amount one can consume during a period and still be as well off at the end of the period’. Traditionally, economists, assuming that the supply of natural resources was unlimited, placed undue emphasis on the capacity of the market to allocate resources efficiently. They also believed that economic growth would bring the technological capacity to replenish natural resources destroyed in the production process. Today, however, a realization has emerged that natural resources are not infinite. The growing scale of the economic system has strained the natural resource base. This has caused many commentators, such as Goodland, to question the feasibility of uncontrolled growth and exponential consumption. Goodland (1995) writes that to speak accurately in terms of ‘economic sustainability’, it is necessary to ‘extrapolate the definition of Hicksian income from its sole focus on human-made capital and its surrogate money to embrace the other three forms of capital, natural, social and human.

SELF ASSESSMENT EXCERCISE

Briefly explain the term economic sustainability?

3.2 Economic, Social, and Environmental Perspective of Sustainability

An economic system designed in light of the theory of ‘economic sustainability’ is one constrained by the requirements of ‘environmental sustainability’. It restrains resource use to ensure the ‘sustainability’ of natural capital. It does not seek to achieve ‘economic sustainability’ at the cost of ‘environmental sustainability’. In the literature of sustainable development, it has become commonplace to call for supplanting the prevailing doctrine of economic *growth* with a new doctrine of economic *development* for pursuing a form of qualitative growth rather than quantitative growth.

SELF ASSESSMENT EXCERCISE

Explain sustainability in terms of economic, social and environmental factors.

3.3 Theoretical Perspectives on Urban sustainability

The advent of 'sustainability' in development science has led planners to apply evolving notions of 'sustainability' to the contemporary debate over how cities and regions should be revitalized, redeveloped, and reformed. Sustainability is regarded alternatively as either the proper means or the proper end of urban development. Today, it is common in planning circles for urban planners to describe efforts to reverse problems of urban sprawl, congestion, and decline as a search for 'urban sustainability' (see Basiago, 1996). This is the case even though in urban theory no consensus exists as to which human settlements embody 'sustainability'. 'Urban sustainability' might imply the vitality of a city as a complex system, the quality of life of its citizens, or the capacity of nature to support its activities. Some commentators define this concept narrowly in terms of the *economic* 'sustainability' of a city, its potential 'to reach qualitatively a new level of socio-economic, demographic and technological output which in the long run reinforces the foundations of the urban system' (see Ewers and Nij-kamp, 1990).

Others, notably environmental activists, link 'urban sustainability' to broader *social* principles of futurity, equity, and participation, especially involvement of public citizens in the land development process (FoE, 1994). When *environmental* planners speak of urban 'sustainability', they mean the pursuit of urban form that synthesizes land development and nature preservation. Hence, for environmental planners, the pursuit of 'urban sustainability' becomes a matter of placing the development of land into cities and the protection of natural systems into a state of vital equipoise (Lyle, 1994). It is as if city and regional planners have seized upon the ideal of 'sustainability' as a tangible goal, a particular societal end-state, rather than properly viewing it as an organizing principle governing activity at all levels of an urban system, a process for selecting urban alternatives that will yield vitality (Basi-ago, 1995). Perhaps this confusion in planning circles about what 'urban sustainability' will require stems from the fact that *Agenda 21*, the 'Earth

Summit' pact that addresses the 'sustainable development' of Economic, Social, and Environmental Sustainability cities, both mandates concrete planning measures and implies abstract concepts that should guide planning generally. This is not inconsistent; nonetheless, the tumult over 'sustainability' in planning circles has tended to conflate planning *guidelines*, which are specific in nature and applicable on a case-by-case basis (Calthorpe *et al*, 1991), and planning *principles*, which, by definition, must be general and of universal applicability (McDonough, 1992).

In terms of practical planning guidance, *Agenda 21* proposes a number of concrete measures to achieve 'sustainability' in the socioeconomic realm. These include equity, entrepreneurship and technology transfer. *Agenda 21* ties access to land, security of land tenure, tenants' rights, liberalized credit policies, and low-cost building material programs to 'sustainable' urban living for the homeless and for the urban poor. It calls upon developing countries to foster small businesses in the informal economic sector and developed countries to provide developing countries monetary and technical aid to educate environmental managers. Within nations, wealthy districts are asked to provide clean water, sanitation, and waste collection services to poorer ones (Keating, 1993). *Agenda 21* also proposes a number of tangible strategies to bring about 'sustainability' in the environmental realm. *Agenda 21* calls for appropriate technology, transport reform, and urban renewal. Governments are asked to improve rural areas and urban slums, to build moderately sized cities that promote job creation and housing, and to build cities invulnerable to natural disasters. National construction programs based on technologies that utilize local materials and are energy-efficient, non-polluting and labour-intensive, as well as action programs in energy conservation and renewable energy, such as wind, solar, hydro-electric and biomass, are urged. Transport policies that favour public, bicycle, and foot transport over automobiles, municipal development designed to reduce commuting, and land use that contains urban sprawl and prevents it from encroaching upon agricultural land and environmentally sensitive areas are enunciated (Keating, 1993).

SELF ASSESSMENT EXCERCISE

Give a theoretical discuss on urban sustainability

3.4 Economic, Environmental and Social Trends

Driven by technological advances and global integration, the strong economic growth experienced over the last century has been accompanied by gains in material welfare in all parts of the world. World GDP is projected to expand by 75% from 1995-2020, bringing with it increased pressures on environmental and social resources. Governments pursuing sustainable development face the challenge of discerning how best to balance the challenges and opportunities of growth and to decouple economic growth from environmental pressures. Given the global nature of many of the most pressing development challenges such as climate change it is imperative that countries build strong coalitions to address issues of common concern, and that they adapt institutions and decision making processes to ever-increasing globalization. This section provides an overview of some key economic, environmental and social trends important to sustainable development and discusses the challenges they pose for the wellbeing of current and future generations.

3.5 Key Features and Principles in Sustainable Development

Seeking to link and priorities among aspirations pertaining to human welfare, the sustainable development perspective stresses the long-term compatibility between the economic, environmental and social dimensions of development, while acknowledging possible competition across these areas in the shorter term. Addressing the objectives of sustainable development necessitates the institutional and technical capacity to assess the economic, environmental, and social implications of development strategies and to formulate and implement appropriate policy responses. This unit describes the key features and principles of sustainable development, examining the concepts of need, capital, and productivity. It also looks at the role of technological progress, resource substitution,

alternate capital valuation, and better provision and pricing mechanisms of public goods in enhancing the productivity of existing assets. With corrected market signals and incentives to modify behaviour in line with sustainability, policy makers can secure more efficient resource use, meaning higher overall welfare and equity today and in the future.

4.0 CONCLUSION

You will see that this course would equip you with understanding of the need to strike a balance between productivity and the environment. It requires resilience, and interconnectedness that allows human society to satisfy its needs while neither exceeding the capacity of its supporting ecosystems to continue to regenerate the services necessary to meet those needs nor by our actions diminishing biological diversity.

5.0 SUMMARY

This unit has taking you through discussions on the theoretical disposition of sustainable development in relation to environmental sustainability, showing you the need to systemically change consumption and production patterns, which might entails significant price corrections; encourage the preservation of natural endowments; reduce inequality; and strengthen economic governance.

6.0 TUTOR-MARKED ASSIGNMENT

1. Discuss the term economic sustainability.

2. Explain the theoretical concept of urban sustainability

3. Economic, social and environmental factors are synonymous to sustainability. Discuss.

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UNIT 4: BIO-ECONOMY AND SUSTAINABLE DEVELOPMENT

CONTENT

1.0 INTRODUCTION

This unit aims at disseminating knowledge on the role of bio-economy on sustainable development. Every nation of the world faces major environmental, economic and social challenges as it aspires to develop sustainably. These challenges cannot be surmounted without the application of a knowledge-based bio-economic pursuit. Bio-economy is a greener alternative that have impacts on natural and environmental resources, food, soil, land and livelihoods. Bio-economy has a relevant impact in important bio products such as textiles, cosmetics, bio-energy, bio-fuels, building products, and other by-products and bio-power. Bio-economy serves a market of environmentally sustainable products and services, and therefore requires more investment in research and development in order to keep pace with long term global consumption needs without damaging the environment. This has been the reason why bio-economy is today influencing biotechnological research and development, business models and market structure globally.

The bio-economy is the idea of an economy based on the sustainable exploitation of biological resources. Within this concept, there is increasing emphasis on issues such as climate change, depletion of natural resources and growing world food needs. The bio-economy builds on the recognition of advances in technology, particularly in the life sciences, but at the same time covers issues such as innovation management, ecosystem services, development, and good governance. This unit explores the development of the bio-economy across the world from an economic and policy perspective, as well as identifying potential future pathways and issues. It uses a broad definition, covering all sectors using biological resources except health, and rather than focusing on individual sectors, it explores the breadth of interconnections that make the bio-economy a new and challenging subject. The bio-economy is gaining increasing prominence in the policy debate, with several countries developing bio-economy strategies to decouple economic growth from dependence on fossil fuel, as well a pathway to supporting some of the UN Sustainable Development Goals (SDGs) and commitments under the Paris Climate Agreement (Diakosovvas and Frezal (2019).

Therefore, bio-economy connects and expands economics and biology to anchor in its empirical prediction to give it the power of regeneration and sustainability to the activities of the socio-economic and biological systems (Vargas-Hernández, Pallagst and Hammer, 2018). This unit discusses the recent developments on bio-economy, green economy, ecology and renewable resources in the promotion of sustainable development.

2.0 OBJECTIVES

At the end of this unit, students are expected to:

- Explain the concept of bio-economy
- Discuss the principles of bio-economy
- Describe the strategy for attaining a sustainable bio-economy

3.0 MAIN CONTENT

3.1 Concept of Bio-economy

The concept of bio-economy is relatively new. It deals with bioscience advances and rush in the scientific knowledge in biotechnology, genetics, genomics, etc, to achieve practical applications from biological processes. Bio-economy is the sustainable production and conversion of biomass into a range of goods and services such as food, health, fibre and industrial products and energy. It is a concept related to the economic activities derived from utilising natural and biological resources or bioprocesses to produce bio-products. Bio-economy is an aggregated set of economic operations and activities related with biological products to capture economic value, growth and welfare benefits for human development. The concept of a bio-economy refers to that economy where the basic components of materials, chemicals and energy come from renewable biological resources such as plant and animal sources. This type of economy can meet many of the requirements for sustainability from environmental and social aspects as it is designed and implemented intelligently (Vargas-Hernandez, Pallagst & Hammer, 2018).

Source: https://www.google.com/search?q=pictures+of+green+economy&sxsrf=ACYBGNQo8q2-vccrB_Q4pHEkeTzkgkIm5A:1571868782546&tbm=isch&source=iu&ictx=1&fir=Ir9zAGDbq0

ebIM%253A%252C4g1TlTJUJiek6M%252C_&vet=1&usg=AI4_-kRY8AaL1UHMXyIgKe6zNkRv80nGig&sa=X&ved=2ahUKEwjq4KrDs7PlAhUGi1wKHZOaAYoQ9QEwAXoECAcQCQ#imgrc=uxB4-4WA7oyp5M:&vet=1

The concept of biotechnology is under debate. Bio-technology can be defined as an economy in which the basic building blocks for materials, chemicals and energy are derived from renewable biological resources (McCormick & Kautto, 2013). It could also be described as the global industrial transition of sustainably utilising renewable aquatic and terrestrial biomass resources in energy, intermediate and final products for economic, environmental, social and national security benefits (USDA, 2015). Bio-economy simply means the science of using living things to produce goods and services. Thus, it involves manipulating and modifying organisms to create new and practical applications for primary production, health and industry (Vargas-Hernandez, Pallagst & Hammer, 2018).

SELF ASSESSMENT EXCERCISE

1. Describe the concept of bio-economy.
2. What is biotechnology?

3.2. Bio-economy as Green Economy

The bio-economy called green economy refers to an economy with low carbon emissions, uses resources efficiently and is socially inclusive (PNUMA, 2016). The bio-economy sector is a warrantor for a green economy. The bio-economy agenda has developed the concept 'green economy' that emerged at the 2012 Rio+20 summit and is promoted by the United Nations Environmental Programme to pursue natural renewable resources, bio-energy and sustainable biological products (Socaciu, 2014). This agenda has been pushed by large corporations and developed countries linked to green economy and the knowledge-based bio-economy (Hall & Zacune, 2012). The Rio+20 agenda 'Towards a Green Economy gave rise to the bio-economic strategy for sustainable development and economic growth (European Commission, 2012). For instance, the European Union

promotes among its member states the commitment to the agenda of green economy and bio-energy, and agro-fuels as an alternative to fossil fuels (Hall & Zacune, 2012; OECD, 2009).

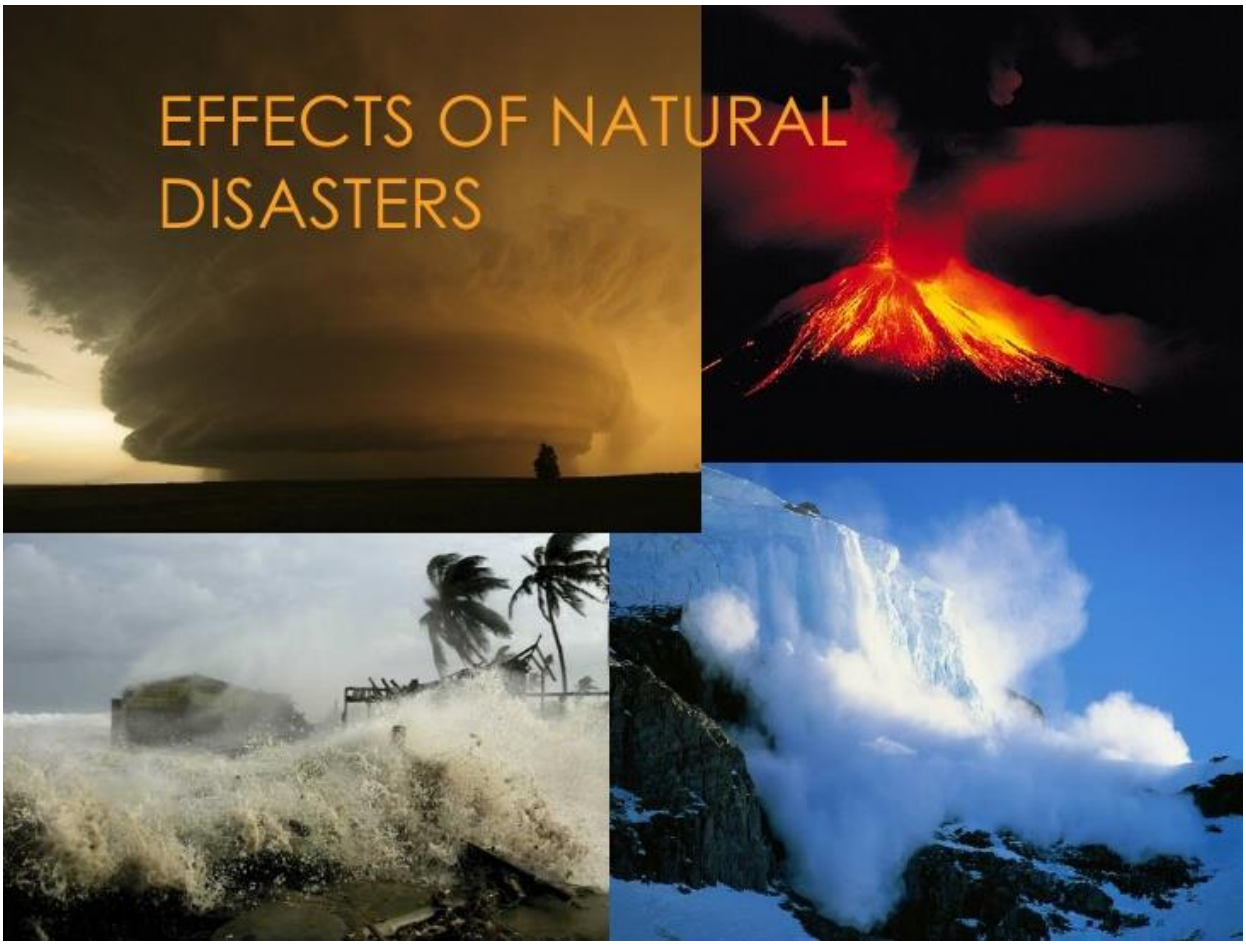
SELF ASSESSMENT QUESTION

Discuss bio-economy as a green economy.

3.3 Bio-economy as Ecological Economics

Bio-economy is the ecological economy that reconciles the economy and the ecology that at the same time looks for the economic efficiency, and takes care of the natural resources that are essential for humanity. The bio-economic approach calls for a change in values on the use of available resources and energy to be conserved for the use of future generations. The bio-economy is the basis of the business of ecological projects, agriculture, etc. Bio-economics studies the biological origin of economic process and the human activities associated with a limited stock of available and accessible resources that are unevenly located and unequally appropriated (Mayumi, 2001).

Ecological disasters in recent years as a result of the subordination of the laws of nature to the laws of the market economy and that has demonstrated the destructive capacity of the forces of nature, to the point that has created an awareness by the environmental care. Some analysts consider that the bio-economy approach is destructive and should be restructured from an agro ecological perspective.



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The economy as a science oriented by the competition has serious methodological deficiencies that the bio-economy tries to overcome through bio centric processes and of bio-economic balance centred in the cooperation for the sustainable development and the conservation of nature and the environment in their interactions with the humanity. From

a holistic perspective, the interactions between biological and socio-economic systems result in the field of bio-economics. The interactions of the natural biological and economic processes that give rise to the bio-economy have an impact on the complex and uncertain phenomena of the biosphere.

The Physiocrats subordinated reproduction and economic transformation to nature, classical economics to capital, later to the goal of market equilibrium and the financial system with economic neoliberalism. The heterodox economy is more oriented to the human aspects with approaches such as humanist socialism that resists the clashes of the liberal economy and analyzes the contradictions of economic liberalism with the argument that the labour force is not a commodity that separates from the human being. The market economy reduces natural, social and moral values but cannot regulate the behaviour of nature. The first report of the Club of Rome (Club de Roma, 1972) which warns about the limits of economic growth and the Brundtland Report (Brundtland, 1987) that reports threats to the mechanisms that regulate nature, emerges the issues for sustainable development to maintain the balance between the interdependence of the economy, nature and the biosphere.

SELF ASSESSMENT EXCERCISE

How does bio-economy relate with ecological economics?

3.4 Principles of Bio-economy

The principles of bio-economy revolve around the circular economy, sustainable development, holistic approach, transdisciplinary approach, innovation culture and capacity building, knowledge-based economy, global ethics, social capital and culture of peace.

a. *Circular economy*: Bio-economy links economic growth with environmental sustainability under the guiding principles of a circular economy. Bio based circular economy is bio-economy for sustainable policy agenda which can solve the

challenges of climate change, eco-technologies, agriculture and food security, blue growth, etc. For example, the wood-based bio-economy is a bio-based circular economy that originates from processing and recycling timber, pulpwood and other forests utilised for material and energy sources. Bio-economy innovation is shaping the new social economy combining elements of circular economy and social inclusion.

b. *Sustainable development*: bio-economy is a transitional step towards sustainable development. Bio-economy promotes sustainable development by protecting biodiversity and reducing dependence on fossil natural resources. The White Paper on the European bio-economy in 2030 sustains that bio-economy has to face challenges such as the sustainable management of natural resources, sustainable production, public health, mitigating climate change, integrating and balancing social development and global sustainable development.

The neoclassical model of the economy supports neoliberal capitalism while the bio-economically centred sustainable development model encourages people to engage in cooperative socio-economic activities that benefit in the long run. The bio-economy reduces dependence on fossil natural resources, prevent biodiversity loss and creates economic growth and employment in line with the principles of sustainable development. The bio-economy provides benefits for the increasing sustainable development by improving economic growth and outputs, replacing fossil fuels with renewable natural resources, biodiversity conservation, and increase in energy self-sufficiency.

Some contributions of bio-economy to sustainable development are in the areas of global food security, renewable raw materials, fisheries, climate change mitigation, etc. One of the main challenges of the bio-economy is to change the current production, distribution and consumption systems to those that are more

environmentally friendly, and provide sustainable development for the conservation of natural resources, while meeting human current needs.

c. *Holistic Approach*: According to Mohammadian (2005), bio-economics is a holistic interdisciplinary science, also called biological economics known as epistemology for the investigation of the interrelationships between biological and socio-economic systems beyond the different approaches of environmental economics, economics of natural resources, and the ecological economy. These relationships balance the network of economic, biological, natural, technological, social, human and environmental conditions for a sustainable future. This is a holistic perspective that focuses on interdisciplinary process that results from the scientific experimentation of new cognitive processes and synthesis of the interactions and interrelations of biological, economic, social and environmental processes. To achieve this new mentality, the educational course of action must undergo a scientific-academic revolution through the synthesis of theories of Biology, Economics, and Cognition, to promote an integrated education in the form of a bio-economics educational process. Such an educational process is holistic and interdisciplinary, and helps to dismantle reductionist education to promote the synthesis culture in addition to facilitating the art of learning to learn.
d. *Transdisciplinary approach*: Modern scientific research in the past centuries has suffered from sustaining development and impacting the environment negatively. They have defects in their reductionist methodology that divided socio-economic systems into separate components, to be investigated by various discipline, forgetting the unity of human life with its biological basis. It is indeed evaluating current interactive problems with an outdated mindset of a world it has left behind decades ago. Bio-economics is born as a response to the incremental advances of economics-environment disciplines through which the pathologies of capitalism and its industrial system have been investigated individually and separately.

Bio-economy is a transdisciplinary approach that encompasses Biology, Economics, Physics, Genetics, Forestry, Marine Sciences, etc. Bio-economics as a transdisciplinary science proposes the integration of biophysical subsystems of nature and environmental, biological, bio-spherical with economic, social and human subsystems with long term orientation to ensure the happiness of future generations. Bio-economics is a transdisciplinary science that seeks to study and analyse biological and socio-economic systems from a perspective of cooperation and solidarity for the conservation of physical, natural, biological and social capital.

Bio-economics proposes among its transdisciplinary principles for the creation of bio-economic capital through biology and economics as the integrated solution to sustainable bio-economic development. Sustainable bio-economy needs transdisciplinary capabilities and expertise. The bio-economy is not only a transdisciplinary branch, but also contributes to change the mentality of people, passing from a greedy, guided by the power that grants the money to a person who uses resources in a rational way, thinking about the future and the conservation of the planet.

e. *Innovation culture and capacity development*: The bio-economic theory is based on the value of complex innovations based on an ethical-economic-humanist balance. Business culture to foster innovation is essential in bio-economy aligned with the needs of sustainable development and with the collaboration of all the stakeholders involved on strategic alliances or other forms of cooperation between different sectors. Education, research and innovation skills are a critical factor for the development of a bio-economy. It means that knowledge and the role of biotechnology in innovation and growth is important in stimulating the knowledge-based economy and ensuring competitiveness and economic growth of a nation state. This implies that discoveries, ideas and innovations play a crucial role in

economic growth and development, and research in bio-economics is a major driver of innovation (Vargas-Hernandez, Pallagst & Hammer, 2018).

It should be noted that small and medium-sized enterprises (SMEs) are drivers of innovation in bio-economy. In developed countries, groundbreaking innovations in bio-economy are led by not only large corporations, but also SMEs in all sectors for the development and implementation of bio-economy by being able to develop the capability to absorb the knowledge, produce in accordance with research outcome and the marketing innovations of the new bio-products (Vargas-Hernandez, Pallagst & Hammer, 2018). It implies that the transition towards bio-economy requires the innovation and development in biotechnology through research and development (R&D). It is clear that bio-economy offers opportunities to promote innovations, competitiveness and production of market demanding sustainable products and services, market access and solutions to human needs. Biotechnology innovation can influence technology transfer from scientific institutions to industry through cooperation and networks with private firms, academic, social and governmental institutions. Research and innovation on diverse sustainable technologies, facilities, processes and skilled workforce maximise environmental sustainable bio-economy. Innovation along the value chain is necessary to reduce costs, and a deficient innovation system may lead to weak innovative firms. Therefore, the bio-economy transition requires changes at the level of system involving social, political, government and industry actors in the strategy formulation and implementation on research and innovation, land use, biomass, social change governance.

f. *Knowledge-based economy*: Knowledge, novel ideas and technical expertise to use biological processes for practical applications in production of bio-products has become the basis for current thinking for global sustainable development. This agrees with bio-economic sustainable theory which emphasises knowledge and ideas as the most relevant factor of production, is an alternative theory to the

neoclassical growth model. The use of advanced knowledge of genes and cellular processes to design and develop new processes and products; the use of renewable biomass and efficient bioprocesses to stimulate sustainable production is a good example of a knowledge driven economy. The integration of knowledge and applications of biotechnology in a range of sectors has, as a policy point of view, become crucial for the implementation of bio-economy which requires a coherent and integrated policy for a sectoral and multidisciplinary investment on bio-economy research and knowledge development. It implies that this can only be achieved with innovation, entrepreneurship and the development of skilled workforce in knowledge based bio-economy.

The bio-economy agenda is sustained by the knowledge-based bio-economy (KBBE) as an approach that emerged from the life sciences research focusing on bio agriculture. The knowledge-based bio-economy develops biological processes technologically to provide a wide range of bio products from renewable raw materials. The knowledge-based bio-economy promotes strategic research and innovation to support the transition from an oil-based to a bio-based economy that enables economic prosperity with ecological and social compatibility. Efficient and sustainable biological resources rests on bio-economy knowledge-based innovation aimed to business and large corporations to concentrate control over natural resources, production processes and distribution chains. The bio-economy is expanding knowledge on biosciences and biotechnologies.

The main competitive bio-economy sectors include sustainable agricultural production, the global food security, healthy and safe foods, the development of biomass-based energy carriers and the industrial application of renewable resources. Bio-economy involves the use of knowledge of genes and cell processes to develop new products and services while maintaining the environment thereby increasing economic growth. This transformation process is driven by technological

knowledge and supported by structures of innovation networks that create a competitive edge and commercial advantages in global markets. This is to contribute to global responsibility in the present and to appropriate foresight for future generations.

Bio-economy knowledge can be transferred from research centres to different sectors. Knowledge-based bio-economy competences and expertise is developed by research infrastructure extended in bio-economy research centres, information and communication technologies. This requires the implementation of complex interrelationships of training research agents committed to the creation of sustainable bio-based economy in accordance with demographic and socio-economic changes.

g. *Global Ethics*: Bio-economics represents a fundamental change in ideology in everything that is related to socio-economic, biological, and ethical activities. It considers the ethical implications with an eye for the future. Homo bio-economics is based on biological principles of conservation, recycling, regeneration and respect, as well as on the socio-economic principles of equity, equality, and under the ethical principle of exploiting natural and biological resources. The bio-economy supports economic activities based on the principle of an ethical practice to benefit all participants, thereby reducing transaction costs.

The science of bio-economics is considered a postmodern science that considers the participation of all interest groups around the concepts of sustainability, quality, value, ethics, equality, social justice, fraternity and compassion. Ideas and knowledge as intangible resources of the bio-economy emanate from heuristics as a tool for sustainable economic growth that is based on biological, environmental, economic, social and ethical resources. The framework of bio-economy interdisciplinary research projects contributes to discussions on social, legal and ethical issues. Sustainable bio-economy global demand of bio products and bio

services requires to be framed by ethical consumer behaviour and legislation (Vargas-Hernandez, Pallagst & Hammer, 2018).

h. *Social Capital and Culture of Peace*: the business bio-economic activities have as components in bio-economic capital and social capital. Social capital facilitates the relations of solidarity and compassionate cooperation that contribute to the formation of a more generous and altruistic society. For organisations and companies with a bio-economic orientation, social capital, biological capital and financial and monetary capital have the same importance in their scale of values. In other words, a bio-economic enterprise attaches as much importance to social capital and biological capital as to money capital (Mohammadian (2005). At the centre of social capital is trust and cooperation, the main ingredients of a culture of peace (Vargas-Hernandez, Pallagst & Hammer, 2018).

The bio-economy is based on solid principles of trust and cooperation, fraternity, justice and compassion to achieve the creation of bio-economic value and economic growth through internationalisation of costs that produce the externality attached to the care of the biological foundation. This encourages transformation of economic activities with capitalist profit purposes, cooperation and competition, quality and level of employment, and on building societal trust. The 'Homo economicus' is a being that seeks efficiency, focuses on competition and is predatory, greedy and without any human feeling while 'Homo Bio-economicus' is a being that is sensitive to human needs and nature, centres on relations of cooperation and trust, in harmony with himself, with those around him and with nature and with a culture of sufficiency and conservation with a sense of the values of solidarity and fraternity for sustainability (Mohammadian, 2000; 2003).

The sustainable bio-economy encourages relationships of cooperation between different economic sectors and improves the well-being of society. Homo bio-economicus, unlike homo economicus, is a being satisfied with the resources that

he has access to and self-fulfillment in his life, sensitive to human needs and realities, in harmony and with an attitude of cooperation and care with environmental, economic, social and political situations. Bio-economy is sustained as the third path of economy because it is considered to be between the classical equilibrium economy and use value, and the new global economy of complexity and exchange value and therefore benefits both (Mohammadian, 2003) as models of competition and cooperation (Mohammadian, 2000).

Development cooperation between business units, regions and nations demand sustainable bio-economy development activities in sustainable use and expertise of natural resources. Advancement requires active participation in relationships of international cooperation programmes to strengthen support of bio-economy activities. A good example of sustainable bio-economy implementation is the cooperation with financial providers across sectoral boundaries. Bio-economy technologies, products and services can be standardised and certified to follow the rules of global markets by means of international cooperation and allocation.

SELF ASSESSMENT EXERCISE

Discuss the principles of bio-economy

3.5 Bio-economy as a Strategy

Bio-economy strategy aims at self-sufficiency in energy, raw materials and securing availability of biomass, low-carbon and resource efficient society. It identifies energy, environment, water, food, health, social, etc, challenges and act upon critical bio-economy research from using waste materials to gain market value and growth. Thus, a bio-economy strategy links bio-economy-based renewable resources with sustainability by ensuring sustainable production and use of biomass (Plau, Hagens, Dankbaar, Smits, 2014). Bio-economics is a win-win strategy with strong innovation potential that applies science and industrial technologies along with local and tacit knowledge to produce bio-products and

address the challenges of the environment, the use of energy and food security. This is a greening strategy that promotes bio-production for the attainment of a green economy towards a sustainable growth and development.

A strategic plan on bio-economy is therefore required to provide a roadmap for future potential and directions, matching economic and social needs, and formulating policy agendas on bio-economic science and technology. Sustainable bio-economy development can be accelerated by systemic strategic choices and policy actions by all stakeholders such researchers, businesses, entrepreneurs, educational institutions, community and social organisations, and governments at all levels. The target of bio-economy is to offer alternative well-being services and products to consumer choices. Active dialogue, participation and relationships of cooperation among citizens, firms, new social movements and governments are required to support bio-economic initiatives embraced by public policies.

SELF ASSESSMENT EXERCISE

What are the strategies of bio-economy?

4.0 CONCLUSION

The high dependence of today's economic development supported on fossil-based resources increases environmental sustainability concerns of production systems and food security. This situation justifies the urgent need for a transition from neoclassical economy type of development based on fossil resources towards a more sustainable development supported by the bio-economy based on biological resources and bio biological products. Sustainable development based on bio-economy optimises the allocation of natural and biological renewable resources whilst increasing the environmental, food security, energy and health concerns.

5.0 SUMMARY

The bio-economy sustainable development model focuses more on quality than on quantity as opposed to neoclassical economic development model. Some critical points addressed here regarding the sustainable development model are to consider natural resource as infinity goods which lead to an over exploitation, require massive inputs, and the production methods impact on agricultural land and the environment. This interpretation which deals with similarities between economic and biological systems had been examined. This study has identified some principles of bio-economy which are critical issues affecting the prospects for the bio-economy based sustainable development. Therefore, the study concludes that bio-economy is at the crossroads of the sustainable development.

6.0 TUTOR-MARKED ASSIGNMENT

1. What is bio-economy?

2. Identify and discuss any five (5) principles of a bio-economy

3. What are the strategies for achieving sustainable bio-economy?

4. Explain the relationship between bio-economy and ecological economics.

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MODULE THREE: EXTERNALITIES, THEORIES OF MANAGING COMMON POOL RESOURCES AND THEIR IMPLICATIONS FOR SUSTAINABLE DEVELOPMENT

UNIT 1 EXTERNALITIES

CONTENTS

UNIT 1 EXTERNALITIES

1.0 INTRODUCTION

The market failures examined in this unit fall under a general category called externalities. Exclusivity is one of the chief characteristics of an efficient property rights structure. This characteristic is frequently violated in practice. **Market failure** is the economic situation defined by an inefficient distribution of goods and services in the free **market**. In **market failure**, the individual incentives for rational behavior do not lead to rational outcomes for the group. One broad class of violations occurs when an agent making a decision does not bear all of the consequences of his or her action. An **externality** arises when a person

engages in an activity that influences the well-being of a bystander but neither pays nor receives any compensation for that effect. In the presence of externalities, society's interest in a market outcome extends beyond the well-being of buyers and sellers who participate in the market to include the well-being of bystanders who are affected indirectly. Because buyers and sellers neglect the external effects of their actions when deciding how much to demand or supply, the market equilibrium is not efficient when there are externalities. That is, the equilibrium fails to maximize the total benefit to society as a whole.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- Describe externalities and market inefficiency
- Identify Types of externalities
- Discuss public policies toward externalities

3.0 MAIN CONTENT

3.1. Externalities and Market Inefficiency

In this unit, we use the tools of welfare economics to examine how externalities affect economic well-being. The analysis shows precisely why externalities cause markets to allocate resources inefficiently. Later in the unit, we examine various ways in which public policymakers may remedy this type of market failure.

We begin by recalling the key lessons of welfare economics. To make our analysis concrete, we consider a specific market—the market for steel. Figure 2.1 shows the supply and demand curves in the market for steel. The supply and demand curves contain important information about costs and benefits. The demand curve for steel reflects the value of steel to consumers, as measured by the prices they are willing to pay. At any given quantity, the height of the demand curve shows the willingness to pay of the marginal buyer. In other words, it shows the value to the consumer of the last unit of steel bought. Similarly, the supply curve reflects the costs of producing steel. At any given quantity, the

height of the supply curve shows the cost to the marginal seller. In other words, it shows the cost to the producer of the last unit of steel sold.

In the absence of government intervention, the price adjusts to balance the supply and demand for steel. The quantity produced and consumed in the market equilibrium, shown as Q_M in Figure 2.1, is efficient in the sense that it maximizes the sum of producer and consumer surplus. That is, the market allocates resources in a way that maximizes the total value to the consumers who buy and use steel minus the total costs to the producers who make and sell steel.

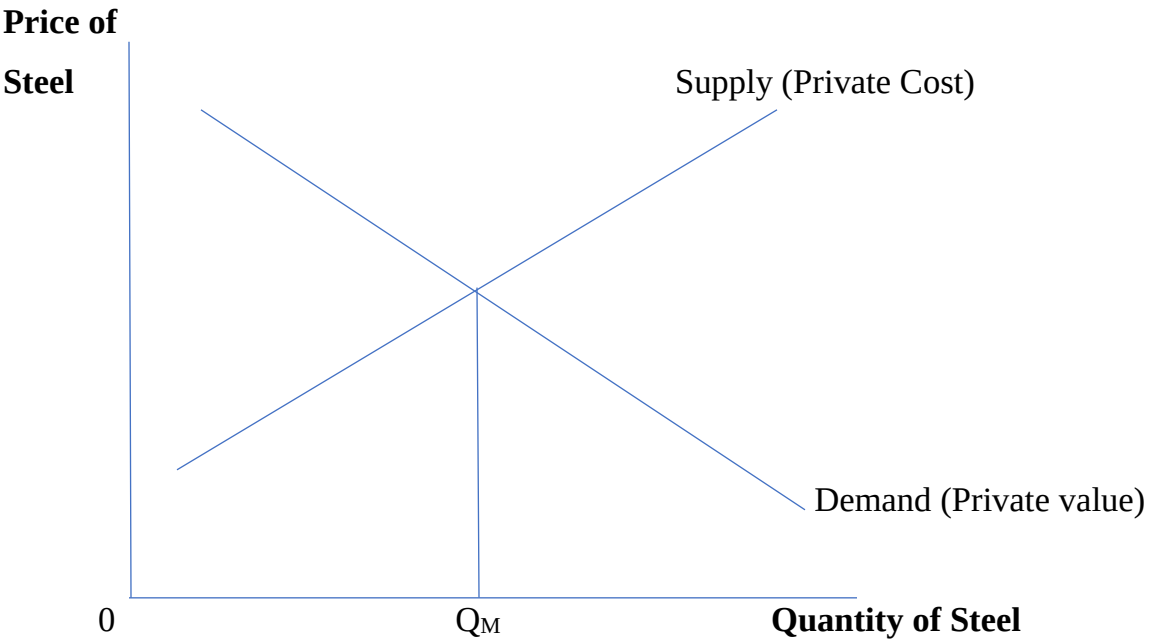

Figure 3.1 Markets for Steel

SELF ASSESSMENT EXERCISE

Briefly describe externality constitute a market failure.

3.2 Types of Externalities

3.2.1 Negative Externalities

Now let's suppose that steel factories emit pollution: For each unit of steel produced, a certain amount of smoke enters the atmosphere. Because this smoke creates a health risk

for those who breathe the air, it is a negative externality. How does this externality affect the efficiency of the market outcome? Because of the externality, the cost to *society* of producing steel is larger than the cost to the steel producers. For each unit of steel produced, the *social cost* includes the private costs of the steel producers plus the costs to those bystanders affected adversely by the pollution. Figure 2.2 shows the social cost of producing steel. The social-cost curve is above the supply curve because it takes into account the external costs imposed on society by steel production. The difference between these two curves reflects the cost of the pollution emitted.

What quantity of steel should be produced? To answer this question, we once again consider what a benevolent social planner would do. The planner wants to maximize the total surplus derived from the market—the value to consumers of steel minus the cost of producing steel. The planner understands, however, that the cost of producing steel includes the external costs of the pollution.

The planner would choose the level of steel production at which the **demand curve crosses the social-cost curve.** This **intersection determines the optimal amount of steel from the standpoint of society as a whole**. Below this level of production, the value of the steel to consumers (as measured by the height of the demand curve) exceeds the social cost of producing it (as measured by the height of the social-cost curve). The planner does not produce more than this level because the social cost of producing additional steel exceeds the value to consumers. Note that the equilibrium quantity of steel, Q_M, is larger than the socially optimal quantity, Q_O. This inefficiency occurs because the **market equilibrium reflects only the private costs of production**. In the market equilibrium, the marginal consumer values steel at less than the social cost of producing it. That is, at Q_M, the demand curve lies below the social-cost curve. Thus, reducing steel production and consumption below the market equilibrium level raises total economic well-being.

How can the social planner achieve the optimal outcome? One way would be to **tax steel producers for each ton of steel sold**. The tax would shift the supply curve for steel upward by the size of the tax. If the tax accurately reflected the external cost of pollutants released into the atmosphere, the new supply curve would coincide with the social-cost curve. In

the new market equilibrium, steel producers would produce the socially optimal quantity of steel.

The use of such a tax is called **internalizing the externality** because it gives buyers and sellers in the market an incentive to take into account the external effects of their actions. Steel producers would, in essence, take the costs of pollution into account when deciding how much steel to supply because the tax would make them pay for these external costs. And, because the market price would reflect the tax on producers, consumers of steel would have an incentive to use a smaller quantity. The policy is based on how people respond to incentives.

Later in this unit, we consider in more detail how policymakers can deal with externalities.

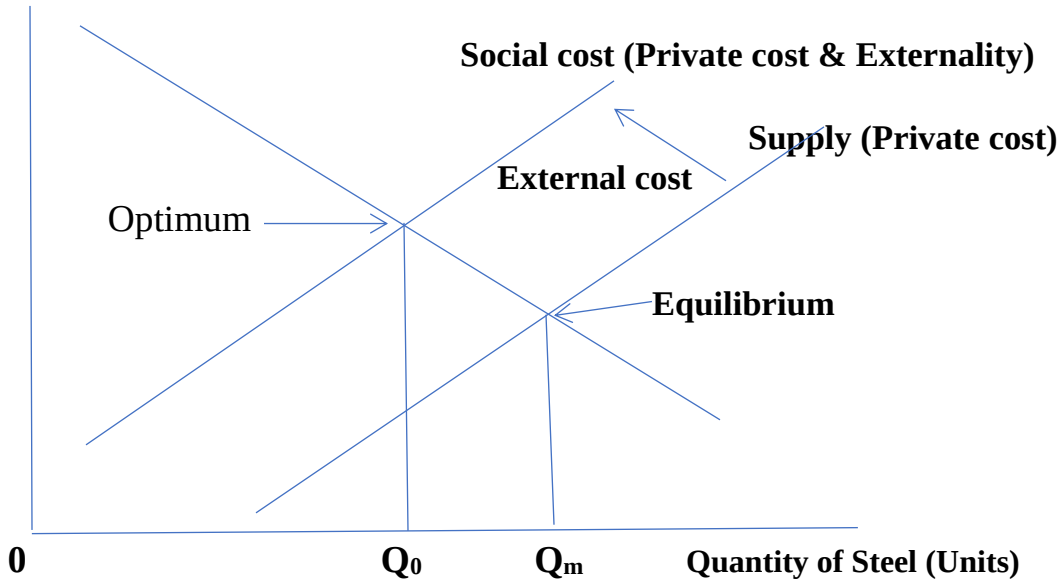

Figure 3.2: Pollution and Social Optimum

3.1.2 Positive Externalities

Although some activities impose costs on third parties, others yield benefits. For example, consider education. To a large extent, the benefit of education is private: The consumer of education becomes a more productive worker and thus reaps much of the benefit in the form of higher wages. Beyond these private benefits, however, education also yields

positive externalities. One externality is that a **more educated population leads to more informed voters**, which means **better government for everyone**. Another externality is that a **more educated population tends to mean lower crime rates**. A third externality is that a **more educated population may encourage the development and dissemination of technological advances, leading to higher productivity and wages for everyone**. Because of these three positive externalities, a person may prefer to have neighbors who are well educated.

The analysis of positive externalities is similar to the analysis of negative externalities. Figure 2.3 show that the demand curve does not reflect the value to society of the good. Because the social value is greater than the private value, the social value curve lies above the demand curve. The optimal quantity is found where the social-value curve and the supply curve (which represents costs) intersect.

Hence, the socially optimal quantity is greater than the quantity determined by the private market.

Once again, the government can correct the market failure by inducing market participants to internalize the externality. The appropriate response in the case of positive externalities is exactly the opposite to the case of negative externalities.

To move the market equilibrium closer to the social optimum, a positive externality requires a subsidy. In fact, that is exactly the policy the government follows: Education is heavily subsidized through public schools and government scholarships.

Price of Education (N per unit)

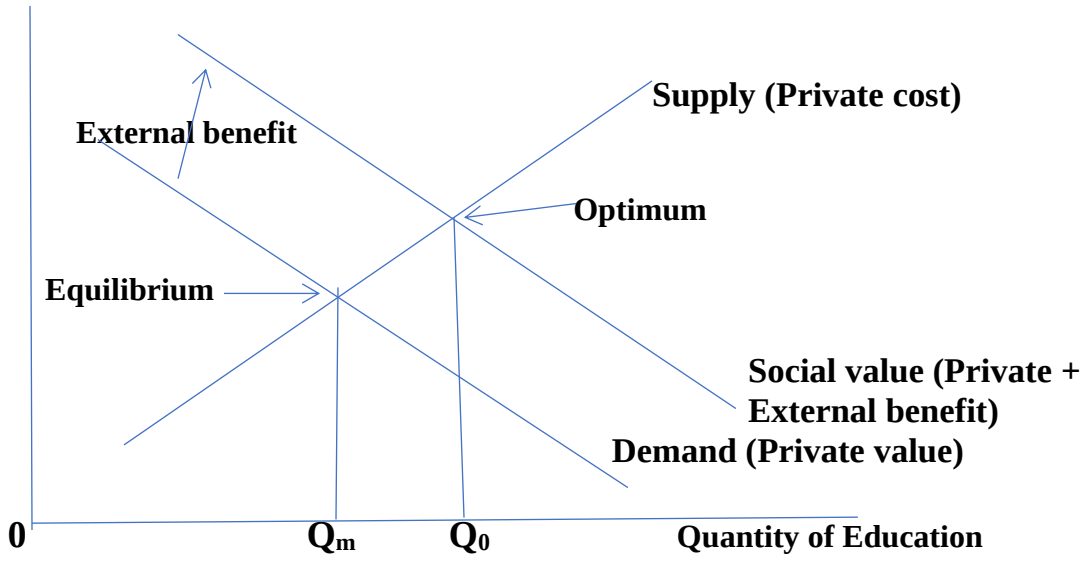

Figure 3.3: Education and Social Optimum

SELF ASSESSSMENT EXERCISE

How does externality makes market inefficient?

What are the benefits of positive externality especially education?

3.3. Public Policies toward Externalities

We have discussed why externalities lead markets to allocate resources inefficiently but have mentioned only briefly how this inefficiency can be remedied. In practice, both public policymakers and private individuals respond to externalities in various ways. All of the remedies share the goal of moving the allocation of resources closer to the social optimum. This unit considers governmental solutions. As a general matter, the government can respond to externalities in one of two ways. 1. *Command-and-control policies* regulate behavior directly. 2. *Market-based policies* provide incentives so that private decision makers will choose to solve the problem on their own.

1. Command-and-Control Policies: Regulation

The government can remedy an externality by making certain behaviors either required or forbidden. For example, it is a crime to dump poisonous chemicals into the water supply. In this case, the external costs to society far exceed the benefits to the polluter. The government therefore institutes a command-and control policy that prohibits this act altogether.

In most cases of pollution, however, the situation is not this simple. Despite the stated goals of some environmentalists, it would be impossible to prohibit all polluting activity. For example, virtually all forms of transportation—even the horse—produce some undesirable polluting by-products. But it would not be sensible for the government to ban all transportation. Thus, instead of trying to eradicate pollution entirely, society has to weigh the costs and benefits to decide the kinds and quantities of pollution it will allow. In Nigeria, the Environmental Protection Agency (EPA) is the government agency with the task of developing and enforcing regulations aimed at protecting the environment.

Environmental regulations can take many forms. Sometimes the EPA dictates a maximum level of pollution that a factory may emit. Other times the EPA requires that firms adopt a particular technology to reduce emissions. In all cases, to design good rules, the government regulators need to know the details about specific industries and about the alternative technologies that those industries could adopt. This information is often difficult for government regulators to obtain.

2. Market-Based Policy 1: Corrective Taxes and Subsidies

Instead of regulating behavior in response to an externality, the government can use market-based policies to align private incentives with social efficiency. For instance, as we saw earlier, the government can internalize the externality by taxing activities that have negative externalities and subsidizing activities that have positive externalities. Taxes enacted to deal with the effects of negative externalities are called **corrective taxes.** They are **also called *Pigovian taxes*** after economist Arthur Pigou (1877–1959), an early advocate of their use. An ideal corrective tax would equal the external cost from an activity

with negative externalities, and an ideal corrective subsidy would equal the external benefit from an activity with positive externalities.

Economists usually prefer corrective taxes to regulations as a way to deal with pollution because they can reduce pollution at a lower cost to society. To see why, let us consider an example.

Suppose that two factories—a paper mill and a steel mill—are each dumping 500 tons of glop into a river every year. The Environmental Protection Agency (EPA) decides that it wants to reduce the amount of pollution. It considers two solutions:

• Regulation: The EPA could tell each factory to reduce its pollution to 300 tons of glop per year.

• Corrective tax: The EPA could levy a tax on each factory of N50,000 for each ton of glop it emits.

The regulation would dictate a level of pollution, whereas the tax would give factory owners an economic incentive to reduce pollution. Which solution do you think is better? Most economists prefer the tax. To explain this preference, they would first point out that a tax is just as effective as a regulation in reducing the overall level of pollution. The EPA can achieve whatever level of pollution it wants by setting the tax at the appropriate level. The higher the tax leveled the larger the reduction in pollution. If the tax is high enough, the factories will close down altogether, reducing pollution to zero.

Although regulation and corrective taxes are both capable of reducing pollution, the tax accomplishes this goal more efficiently. The regulation requires each factory to reduce pollution by the same amount. An equal reduction, however, is not necessarily the least expensive way to clean up the water. It is possible that the paper mill can reduce pollution at lower cost than the steel mill. If so, the paper mill would respond to the tax by reducing pollution substantially to avoid the tax, whereas the steel mill would respond by reducing pollution less and paying the tax.

In essence, the corrective tax places a price on the right to pollute. Just as markets allocate goods to those buyers who value them most highly, a corrective tax allocates pollution to those factories that face the highest cost of reducing it. Whatever the level of pollution the

EPA chooses; it can achieve this goal at the lowest total cost using tax. Economists also argue that corrective taxes are better for the environment.

Under the command-and-control policy of regulation, the factories have no reason to reduce emission further once they have reached the target of 300 tons of glop. By contrast, the tax gives the factories an incentive to develop cleaner technologies because a cleaner technology would reduce the amount of tax the factory has to pay. Corrective taxes are unlike most other taxes. Most taxes distort incentives and move the allocation of resources away from the social optimum. The reduction in economic well-being—that is, in consumer and producer surplus—exceeds the amount of revenue the government raises, resulting in a deadweight loss. By contrast, when externalities are present, society also cares about the well-being of the bystanders who are affected. Corrective taxes alter incentives to account for the presence of externalities and thereby move the allocation of resources closer to the social optimum. Thus, while ***corrective taxes raise revenue for the government, they also enhance economic efficiency***.

1. Market-Based Policy 2: Tradable Pollution Permits

Returning to our example of the paper mill and the steel mill, let us suppose that, despite the advice of its economists, the EPA adopts the regulation and requires each factory to reduce its pollution to 300 tons of glop per year. Then one day, after the regulation is in place and both mills have complied, the two firms go to the EPA with a proposal. The steel mill wants to increase its emission of glop by 100 tons. The paper mill has agreed to reduce its emission by the same amount if the steel mill pays it N5 million. Should the EPA allow the two factories to make this deal?

From the standpoint of economic efficiency, allowing the deal is good policy. The deal must make the owners of the two factories better off because they are voluntarily agreeing to it. Moreover, the deal does not have any external effects because the total amount of pollution remains the same. Thus, **social welfare is enhanced by allowing the paper mill to sell its pollution rights to the steel mill**.

The same logic applies to any voluntary transfer of the right to pollute from one firm to another. If the EPA allows firms to make these deals, it will, in essence, have created a new

scarce resource: pollution permits. A market to trade these permits will eventually develop, and that market will be governed by the forces of supply and demand. The invisible hand will ensure that this new market allocates the right to pollute efficiently. That is, the permits will end up in the hands of those firms that value them most highly, as judged by their willingness to pay.

A firm's willingness to pay for the right to pollute, in turn, will depend on its cost of reducing pollution: The more costly it is for a firm to cut back on pollution, the more it will be willing to pay for a permit.

An advantage of allowing a market for pollution permits is that the initial allocation of pollution permits among firms does not matter from the standpoint of economic efficiency. Those firms that can reduce pollution at a low cost will sell whatever permits they get, and firms that can reduce pollution only at a high cost will buy whatever permits they need. As long as there is a free market for the pollution rights, the final allocation will be efficient regardless of the initial allocation.

Reducing pollution using pollution permits may seem very different from using corrective taxes, but the two policies have much in common. In both cases, firms pay for their pollution. With corrective taxes, polluting firms must pay a tax to the government. With pollution permits, **polluting firms must pay to buy the permit**. (Even firms that already own permits must pay to pollute: The opportunity cost of polluting is what they could have received by selling their permits on the open market.) Both corrective taxes and pollution permits internalize the externality of pollution by making it costly for firms to pollute.

The similarity of the two policies can be seen by considering the market for pollution. Both panels in Figure 2.4 show the demand curve for the right to pollute.

This curve shows that the **lower the price of polluting, the more firms will choose to pollute**. In panel (a), the EPA uses a corrective tax to set a price for pollution.

In this case, the supply curve for pollution rights is perfectly elastic (because firms can pollute as much as they want by paying the tax), and the position of the demand curve determines the quantity of pollution. In panel (b), the EPA sets a quantity of pollution by issuing pollution permits. In this case, the supply curve for pollution rights is perfectly

inelastic (because the quantity of pollution is fixed by the number of permits), and the position of the demand curve determines the price of pollution. Hence, the EPA can achieve any point on a given demand curve either by setting a price with a corrective tax or by setting a quantity with pollution permits.

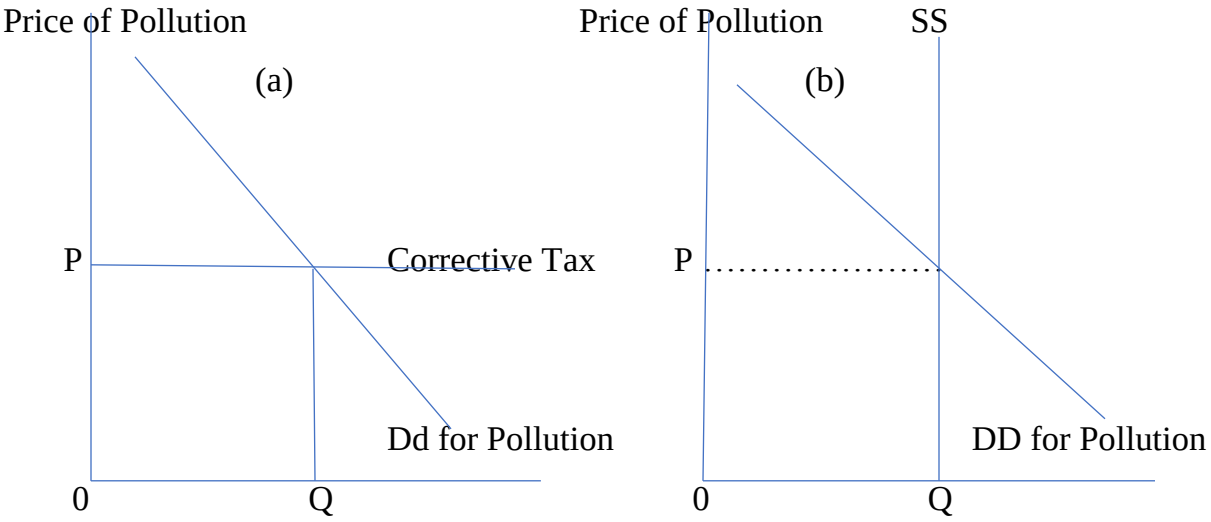

Figure 3.4: The Equivalence of corrective Taxes and Pollution Permits

In some circumstances, however, selling pollution permits may be better than levying a corrective tax. Suppose the EPA wants no more than 600 tons of glop dumped into the river. But because the EPA does not know the demand curve for pollution, it is not sure what size of tax would achieve that goal. In this case, it can simply auction off 600 pollution permits. The auction price would yield the appropriate size of the corrective tax.

The idea of the government auctioning off the right to pollute may at first sound like a creature of some economist's imagination. And in fact, that is how the idea began. But increasingly, the EPA has used the system as a way to control pollution. A notable success story has been the case of sulfur dioxide (SO_2), a leading cause of acid rain. In 1990 in the US, amendments to the Clean Air Act required power plants to reduce SO2 emissions substantially. At the same time, the amendments set up a system that allowed plants to trade their SO_2 allowances. Initially, both industry representatives and environmentalists were skeptical of the proposal, but over time the system has reduced pollution with minimal

disruption. **Pollution permits, like corrective taxes, are now widely viewed as a cost-effective way to keep the environment clean.**

SELF ASSESSMENT EXERCISE

1. What are the public policies towards externalities?
2. In some circumstances, however, selling pollution permits may be better than levying a corrective tax. Discuss.

4.0. CONLUSION

In this unit, we can conclude that an *externality* exists whenever the welfare of some agent, either a firm or household, depends not only on his or her activities, but also on activities under the control of some other agent. We also learned that externality can be negative or positive and the use of such a tax is called **internalizing the externality** because it gives buyers and sellers in the market an incentive to take into account them external effects of their actions.

5.0 SUMMARY

In this unit, we have discussed externalities and the market inefficiency, the types of externalities (negative and positive). If the impact on the bystander is adverse, it is called a negative externality. If it is beneficial, it is called a positive externality. In the presence of externalities, society's interest in a market outcome extends beyond the well-being of buyers and sellers who participate in the market to include the well-being of bystanders who are affected indirectly. Negative externalities lead markets to produce a larger quantity than is socially desirable. Positive externalities lead markets to produce a smaller quantity than is socially desirable. To remedy the problem, the government can internalize the externality by taxing goods that have negative externalities and subsidizing goods that have positive externalities. An extensive discussion on public policies towards externalities was also covered in this unit. Such public policies include command and control, market-based

policy 1 which includes corrective taxes/subsidy and market-based policy 2 which includes tradeable pollution permits.

6.0. TUTOR-MARKED ASSIGNMENT

1. Give an example of a negative externality and a positive externality. Explain why market outcomes are inefficient in the presence of these externalities.
2. What are corrective taxes? Why do economists prefer them to regulations as a way to protect the environment from pollution?
3. In some circumstances, however, selling pollution permits may be better than levying a corrective tax. Discuss.
4. Enumerate the benefits of positive externality.

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UNIT 2 THEORIES OF MANAGING COMMON POOL RESOURCES

CONTENTS

1.0 INTRODUCTION

Common Pool Resources (CPRs) are rival in consumption but not excludable. Also referred to as common goods, common pool resources are goods that typically possess a natural or constructed system of resources. They are non-excludable, meaning that individuals or populations typically cannot be prevented from using them, even if they are not paying for them. They are however, rivalrous, meaning that some part of their usage makes it more difficult for others to utilize them. For example, fish in the ocean are rivalry in consumption: When one person catches fish, there are fewer fish for the next person to catch. Yet these fish are not an excludable good because, given the vast size of an ocean, it is difficult to stop fishermen from taking fish out of it.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- Explain the history of common pool resources
- Describe the theories of common pool resources
- Discuss the packaging of common pool resources design principles into common projects

3.0 MAIN CONTENT

3.1 History of Common Pool Resources

In 1833, William Forster Lloyd wrote a short pamphlet detailing the concepts behind the economic theory known as The Tragedy of the Commons. The contents of this pamphlet were mostly unknown until 1968, when Garrett Hardin wrote an article in *Science* magazine that brought Lloyd's work into the spotlight (Hardin, 1968). Understanding this economic theory requires a working definition of what is meant by "the commons." "The commons" includes any natural resources that are not owned by an individual or corporation. Rather, these resources are available for public use. This might include public pasture land, lumber, oil, the oceans, the atmosphere, wildlife and fish, and many other common resources. The Tragedy of the Commons describes how people often take advantage of resources that are freely available to them. Often, they don't consider the fact that if everyone over-uses the resource, this will lead to negative effects for everyone, including themselves.

The **study of common pool resources**, a historical concept, has become an object of interest for the modern social sciences and the general public like few before it. It is well known that **it became famous due to Garrette Hardin and his influential article, "The Tragedy of the Commons"** Hardin (1968). Hardin had extrapolated from the historical phenomenon of the commons to identify principles for managing parking lots, oceans, national parks, air and water (Blicker, 1998). The question arises here whether this might be historical analogy that contributes little to clarify the problem as it presents itself today. The criticism of Hardin's essay made it clear that the historical commons were by no means "open to all" and therefore subject to tragically unavoidable destruction. Instead, there was a clearly defined group of people with rights to the commons who agreed with one another on rules in order to avoid degrading the resources (Ciriacy-Wantrup and Richard, 1975). Hardin used a less sharply defined concept than Gordon, who spoke of the oceans as a "common-property resource" (Gordon, 1954). However, Gordon's critics argued that it is

wrong to speak of common property if nobody has claimed the resources accessible to all as property.

Elinor Ostrom dropped the category of property rights as a starting point for analysis and instead founded her studies on the term "common-pool resource," a term used to describe oil or groundwater deposits. She also differentiated between open-access and limited-access natural resources. She agreed with Hardin that open-access resources belonging to no one are vulnerable (Ostrom 1990), but disagreed when it came to limited-access resources. Ostrom and others gave a number of examples of common usage, some of which had existed for centuries and had sustained the resources in question. And this is where the concept of property rights comes into play again.

Ostrom and Schlager differentiated between various bundles of property rights and their holders, namely 1) authorized users, whose rights are limited to access and withdrawal of resources; 2) claimants, who can also exclude others; 3) proprietors, who have additional management rights; and 4) owners, who also have the right of alienation, i.e. to sell the resource. The stronger the bundle of rights, the less danger to the existence of the common pool resources, they postulated (Schlager/Ostrom 1992).

The concept of property as a bundle of rights permits us to create a hierarchy of the rights of authorized users, claimants, proprietors and owners. We can derive a typology by means of a comparative analysis of cases of common property management around the world, or by looking at the historical commons, as to which forms of management and which constitutions relating to property rights enabled them to survive for centuries.

SELF ASSESSMENT EXERCISE

Give a brief synopsis of common pool resources.

3.2 Theories of Common Pool Resources

Commons projects, such as community-based natural resource management, have widespread appeal, which has enabled them to shrug off a mixed performance in practice. Over the past 20–25 years small-scale, localized commons projects have been a prominent rural development strategy in developing countries. These projects commonly combine conservation

and development ambitions and are promoted as strategies that give local people more control over resources that are important for their livelihoods. Important underpinning assumptions that drive the continued dissemination of this natural resource model are that rural communities are motivated by beneficial opportunities to cooperate and are best placed to make decisions about resource management and use.

Despite the continuing popularity of these projects, they have generated disappointing outcomes in practice **(Blaikie 2006; Shackleton et al. 2010).** The 'problem' of commons projects has recently been debated, with key contributions by **Roe and Nelson (2009), Murphree (2001, 2009)**, **Nelson and Agrawal (2008)** and **Blaikie (2006),** as well as, several articles in two special issues on commons projects in *Environmental Conservation* (most notably by **Dressler et al. 2010; Shackleton et al. 2010**). Almost exclusively these publications have interrogated the empirical rather than abstract or theoretical dimensions of commons projects, which have been left largely unexamined in this debate. Dealing critically with such an influential body of work like Common Pool Resource (CPR) theory is not a task taken lightly.

Much of the criticism of commons projects, such as community-based natural resource management is of the oversimplified adaptations by some non-governmental organizations and development agencies about the widespread acceptability and promise of giving control of resources to those groups and individuals depending on them. These communities may, in many cases, also have customary rights or claims over the resources or territory in question. In many of examples of commons projects, resources have been managed for decades, if not centuries, before coming under government control or in some instances private ownership. The key argument made is that if, at some later time, the areas/resources are handed back (usually through a conditional agreement), this presents an entirely different setting than when they were organized by a community in the first place. In addition to the specific institutional design principles identified in Ostrom's work, the complex contextual concepts inherent within CPR theory such as participation, social capital, social learning and empowerment have proved difficult to craft into commons projects. So despite the recognition that communities can manage CPR effectively, transposing this knowledge into projects has encountered difficulties. Thus this unit dwells on the

challenges presented by this problem by examining how CPR theory relates to the messy world of commons projects and their implementation.

3.2.1 CPR Theory - Pertinent Methodological and Theoretical Issues

CPR theory sees the individual as the unit of analysis and her rational choices under a set of constraints that must be explained or controlled **(Bardhan and Ray 2006).** Calculation of individual preferences provides the logic supporting commons projects with the assumption that rational actors influenced by constraints of resource institutions (enforced rules) will make calculated decisions based on their own best interest **(Ostrom 1990;** Baldwin 2003). Following this logic, the task of commons projects is to craft the CPR design principles into locally suited rules to build or link into norms (what is permitted and what is not) of compliance and cooperation in order to meet desired resource conservation objectives. Whether the project objectives themselves are open to discussion varies from case to case. However, key from an institutional theory view, is to alter the structure of informal and formal constraints and incentives that actors face to produce the simultaneous production of individually rational and collectively successful environmental outcomes (North 1990).

Experience from anthropology suggests that this may be more difficult in practice than it appears in theory. The type of political economy, which is typical of many commons situations, is built up by face to face relations that characterize the micro-power relations of rural communities (**Hyden 2006)**. These interdependencies include different kinship and networks, which provide numerous functions, including economic and political opportunities, land tenure and inheritance mechanisms, labour relations, food security, religious practices and general support in times of ill-health (**Walley 2004**). In these situations actors, instead of automatically complying with formal institutions, are more likely to make decisions in the context of relations of dependence in which people invest to get things done (Cleaver 2002). This was affirmed through a CBNRM project at Jozani-Pete Village, which is part of Jozani Chwaka Bay Conservation Area in Zanzibar, where community members vested with enforcement authority were reluctant to use formal institutional guidelines because they were concerned to avoid generating overt conflict and divisions over conservation within the village (Saunders 2011). Cases where resource rules were contravened

were handled informally through face to face discussion and negotiation. Preference in this case was given to maintaining kinship and other social relations and obligations rather than formal compliance with the CBNRM institutional rules. This conclusion echoes findings elsewhere. Actors commonly cooperate not just on the basis of narrow economic motives but to maintain an overall interdependence (Kurian 2000). Mosse (2003) and Cleaver (2000) have found similar motivations in different cultural settings in India and Zimbabwe respectively, while de la Torre-Castro (2006) has observed this in the context of community fishing regulation in Zanzibar. These findings support the view that actors commonly cooperate not just on the basis of narrow economic motives (i.e. resource use) but to maintain an overall interdependence (Cleaver 2000, 2012; Mosse 2003). So despite the allowance to incorporate social norms (in terms of values, attitudes, behaviours) into project design, through a process of 'local contextualization', how this aspect of CPR theory is operationalized in the complex multi-institutional sites of practice is less clear.

Assumptions of community homogeneity have been implicated in problems of commons practice (Tsing et al. 2005). To illustrate this problem more clearly, **we can take the case of forest resources as a common pool resource. The values put on specific uses will vary depending on the use or interest of the various community actors. Forests provide multiple common goods and services** to a diverse range of local users (e.g. **firewood, fodder, medicines, etc.) and remote beneficiaries (e.g. biodiversity conservation, carbon sequestration**). Leach et al. (1999) developed the environmental entitlements framework to describe the entanglement of local forest resource institutions and interests. The findings of this study are illustrative of the complexity that faces commons projects. In practice, the 'collective choice' of CPR is implemented in commons contexts where variegated values and interests cross-cut with other stratifications to create complexities that need to be integrated into workable institutions. Other stratifications may include age, gender, wealth and kinship status and personal history, among others. In these extremely uncertain and uneven conditions, project planners seek to find collaborative agreement among local actors on the 'right' mix of incentives and sanctions to invoke 'new' CPR institutional norms to direct collective action towards common pool resource goals.

While the commons theory literature has dealt quite extensively with the question of community heterogeneity (**Bardhan and Dayton-Johnson 2002**; Baland and Platteau 2003; Poteete and

Ostrom 2004; Naidu 2009) within the confines of setting standardised signals to influence behaviour it is difficult to see opportunities to perceive individuals according to their place in the social structure (Cleaver 1999; King 2007). Therefore heterogeneity, such as that described above, even in small-scale projects, would seem exceedingly difficult to consider and manage in practice through crafting institutions set up through commons projects (**Murombedzi 1998**). Nevertheless, CPR theory proponents argue that one way to handle it is by taking more time to draft better rules (**Varughese and Ostrom 2001**). As Dressler et al. (2010) contend, it is also doubtful whether the local participants, many whom are poor, can afford the 'extra time' associated with rule design and maintenance, without considerable and ongoing 'external support' or additional hardship. However, in most interventions this is problematic, as commons project planners commonly have time and budget imperatives that work against a long process of rule refinements in project situations.

The new institutional economics inspired, **'thin'** CPR theory interpretation of individuals as autonomous rational actors contrasts with an alternative **'thick'** perspective, which combines perspectives from anthropology and political economy. A thick perspective sees the same actors embedded and situated in numerous relations of interests and reciprocal commitments at different scales (**Benjaminsen and Lund 2002;** Bardhan and Ray 2006). The argument is that without understanding the specific and broader socio-economic setting or context (historically and spatially) in which actors are 'embedded' it is unlikely that we can know the circumstances that affect individual decision-making over resource use (Agrawal 2003; Johnson 2004). The implication of this conclusion is that we cannot therefore give specific projects local meaning and content if norms governing individual choice are not understood. This perspective implies that that we will not be able to better understand these complex and interrelated phenomena unless in-depth social science research is undertaken prior to project design and planning.

Political ecologists adopting a 'thick' approach, challenge the assumption that through the careful design of rules, collective action at the local level can be achieved without examining or challenging power structures that these collectives have to contend with (Mohan and Stokke 2000; Robbins 2004). A key critique of commons projects forwarded by these commentators has been a failure to deal with wider structures of injustice that impinge on project beneficiaries. Prominent

factors cited are *limited property rights or weak tenure* (**Murombedzi 1998**; DeGeorges and Reilly 2009; Hatcher et al. 2009); *communities only granted access to low value forest resources* (Agrawal and Ribot 1999; Jones 2004); *an inability to benefit from tourism because of poor infrastructure, structural exclusion or control by remote based tourism interests* (Britton 2004; Grossman and Holden 2007; Saunders 2011); *government resistance to devolving power* (**Murombedzi, 1997**; Lind and Cappon 2001; Saunders et al. 2010). A 'thick' approach focuses more on disclosing asymmetrical power relations around rights of access and situations of poverty. It also explores how diverse social institutions influence rights to, and uses of, resources dependent on economic status, gender, ethnicity, religion, and political power, among other stratifications. While this approach provides valuable insights into how historical and wider scale structural constraints interact with, and influence, local rationalities and choice, its results are concerned with broader moral and political questions not so easily linked to existing policy frames. Therefore this approach may be more suited to providing complex explanations of specific cases rather than offering a standardised methodology useful for commons policy intervention (**Murombedzi, 1997**; Lind and Cappon 2001; Saunders et al. 2010).

SELF ASSESSMENT EXERCISE

1. Explain the basic theory of common resources.
2. Discuss briefly the "thin" and "thick" perspectives of CPR.

3.3. Packaging of CPR Design Principles into Commons Projects

This unit discusses the problems of transferring assumptions of long-evolving, efficient resource institutions to deliberately designed commons projects.

Ostrom (1990) argues that natural resource institutions evolve through social learning processes. This view combines aspects of rational choice with communicative planning theories and implies some sort of unfolding and intentionally positive adaptation through trial and error to progressively more effective and efficient institutions – thereby describing a process of 'self-organising'. It also holds that over time, the repeated benefits of cooperation facilitated with enforcement will weed out 'rational egotists', thereby resulting in an evolutionary projection of collective action and

therefore increasing efficiency of institutional arrangements **(Ostrom 2000**). Presumably, this assumes that institutional evolution occurs in interaction with resources and on its own terms – with mostly 'endogenous' influences – although this is unclear. This interpretation would at least provide an explanation as to why CPR theory assumes relatively isolated, homogeneous and small-sized rural communities as the objects of analysis or diagnosis. Poteete and Ostrom (2002) sum up this view when they describe how CPR theory assumes a trajectory of increasing institutional functionality and efficiency, as norms converge over time around resource use and cooperation is enhanced. More recently polycentricity has gained popularity as an analytical and normative concept that reflects an emphasis on the ability of groups of individuals to work out problems for themselves while embedded in complexes of diverse institutional arrangements, including the coordinating structures of government (**Ostrom 2010b)**. In some ways this concept reinforces the existing assumptions of CPR theory by emphasising that small localised governance units are vital for designing institutions that are relevant and able to adapt to changing institutional and environmental conditions. While the implications of this concept for the commons are still being worked through, questions remain about how to achieve a 'balance' between steering policy and local autonomy in projects. In the commons literature more elaborated ideas are beginning to emerge about polycentricity with the dominant interpretation being to link community level action to other levels of governance through systems of representation (Cleaver 2012). However, there is still considerable doubt whether heterogeneous community interests can be strengthened in such multi-scale institutional arrangements (Nelson and Agrawal 2008). For example, Ribot et al. (2006, 18) show that decentralization of forest institutions, in nested institutional arrangements, in a number of Central African case studies have not resulted increased decision-making capacity at local levels.

In CPR theory, and by extension commons projects, the creation of conditions to support collective action to generate social learning and institutional evolution, largely revolve around the creation of trust. The democratic creation and enforcement of formalised resource rules are seen as the keys to motivate resource users not to 'free ride' with the result of increasing trust (through the building of social capital) and enhanced bonds of reciprocity. This view builds on Axelrod's (1984) argument that changed pay-offs will enhance reciprocity and cooperation between actors and

therefore develop collective aims consistent with actors' goals. The formation of trust, facilitated through institutional certainty (or of other actors' likely actions) and increasing homogeneity of interests in support of resource use goals, is seen to be central in controlling the 'free rider problem'. There are at least three fundamental reasons why CPR theorists believe that building of trust and cooperation is more likely in small and isolated commons settings: (1) when people are few it is more conducive for individuals to reveal and signal their intended plans of action and to learn about others' intentions; (2) because of the usual presence of social ostracization mechanisms and (3) presence of a collective identity or closely shared roles **(Baland and Platteau 1996, 77;** Platteau and Abraham 2002).

SELF ASSESSMENT EXERCISE

What is the relationship between CPR design principles and common projects?

4.0 CONCLUSION

In this unit we can conclude that common pool resources are goods that exhibit the characteristics of both private and public goods. But, unlike a true public good—which can be consumed without reducing its availability to other individuals—common-pool resources have a finite supply and provide diminished benefits to everyone, if each individual pursues their own self-interest. Common-pool resources are susceptible to overuse and congestion. Because individual and group interests are in conflict, they create incentives for users to ignore the social costs of their extraction decisions, as the group has to bear the cost of managing, protecting and nurturing the resource. This is why they are prone to the tragedy of the commons, when every individual tries to reap the greatest benefit from a given resource.

5.0 SUMMARY

In this unit, we have discuss extensively on theories of managing common pool resources such as the history of common pool resources, theories of common pool resources such as Tying the Knot –Firming the Relationship between CPR and CBNRM while packaging of

CPR design principles into common projects was also examined as a follow up to extension of theories of CPR.

6.0 TUTOR-MARKED ASSIGNMENT

1. Discuss the history of Common Pool Resources.

2. Briefly explain the theories of common pool resources.

3. Discuss briefly the thin and 'thick' perspective of common pool resources

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UNIT 3 PUBLIC GOODS AND THE FREE RIDER PROBLEM

CONTENTS

1.0 INTRODUCTION

This unit examines the problems that arise for the allocation of resources when there are goods without market prices. Governments can sometimes improve market outcomes. When a good does not have a price attached to it, private markets cannot ensure that the good is produced and consumed in the proper amounts. In such cases, government policy can potentially remedy the market failure and raise economic well-being.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- identify the different kinds of goods
- know meaning the meaning of public goods
- explain how public Goods operate especially the free rider problem

3.0 MAIN CONTENT

3.1 Different Types of Goods

How well do markets work in providing the goods that people want? The answer to this question depends on the good being considered. A market can provide the efficient number of ice-cream cones: The price of ice-cream cones adjusts to balance supply and demand, and this equilibrium maximizes the sum of producer and consumer surplus. Yet, the market cannot be counted on to prevent roofing zinc manufacturers from polluting the air we breathe: Buyers and sellers in a market typically do not take into account the external effects of their decisions. Thus, markets work well when the good is ice cream, but they work badly when the good is clean air. In thinking about the various goods in the economy, it is useful to group them according to two characteristics:

- Is the good **excludable**? That is, can people be prevented from using the good?
- Is the good **rival in consumption**? That is, does one person's use of the good reduce another person's ability to use it?

Using these two characteristics, Table 2.1 divides goods into four categories:

1. **Private goods** are both excludable and rival in consumption. Consider an ice-cream cone, for example. An ice-cream cone is excludable because it is possible to prevent someone from eating an ice-cream cone—you just do not give it to him. An ice-cream cone is rival in consumption because if one person eats an ice-cream cone, another person cannot eat the same cone. Most goods in the economy are private goods like ice-cream cones: You do not get one unless you pay for it, and once you have it, you are the only person who benefits. When analyzing supply and demand, we implicitly assumed that goods were both excludable and rival in consumption.
2. **Public goods** are neither excludable nor rival in consumption. That is, people cannot be prevented from using a public good, and one person's use of a public good does not reduce another person's ability to use it. For example, a tornado siren in a small town is a public good. Once the siren sounds, it is impossible to prevent any single

person from hearing it (so it is not excludable). Moreover, when one person gets the benefit of the warning, such person does not reduce the benefit to anyone else (so it is not rival in consumption).

3. **Common resources** are rival in consumption but not excludable. For example, fish in the ocean are rival in consumption: When one person catches fish, there are fewer fish for the next person to catch. Yet these fish are not an excludable good because, given the vast size of an ocean, it is difficult to stop fishermen from taking fish out of it.
4. **Club goods** are excludable but not rival in consumption. For instance, consider fire protection in a small town. It is easy to exclude someone from using this good: The fire department can just let his house burn down. Yet fire protection is not rival in consumption: Once a town has paid for the fire department, the additional cost of protecting one more house is small. (Club goods again are one type of a natural monopoly) (Mankiw, 202).

Table 3.1: Different Types of Goods

		Rival in consumption?	
		Yes	**No**
Excludable?	**Yes**	**Private Goods** • Ice-Cream Cones • Clothing • Congested toll roads	**Club Goods** • Fire protection • Cable TV • Uncongested non toll roads
	No	**Common Resources** • Fish in the ocean • The environment • Congested non toll roads	**Public Goods** • Tornado siren • National defense • Uncongested non toll roads

Although Figure 2.1 offers a clean separation of goods into four categories, the boundaries between the categories are sometimes fuzzy. Whether goods are excludable or rival in consumption is often a matter of degree. Fish in an ocean may not be excludable because monitoring fishing is so difficult, but a large enough coast guard could make fish at least partly excludable. Similarly, although fish are generally rivalry in consumption, this would be less true if the population of fishermen were small relative to the population of fish. (Think of North American fishing waters before the arrival of European settlers.) For purposes of our analysis, however, it will be helpful to group goods into these four categories.

In this unit and the following unit, we examine goods that are not excludable: public goods and common resources. Because people cannot be prevented from using these goods, they are available to everyone free of charge. The study of public goods and common resources is closely related to the study of externalities. For both of these types of goods, externalities arise because something of value has no price attached to it. If one person were to provide a public good, such as a tornado siren, other people would be better off. They would receive a benefit without paying for it—a positive externality. Similarly, when one person uses a common resource such as the fish in the ocean, other people are worse off because there are fewer fish to catch. They suffer a loss but are not compensated for it—a negative externality. Because of these external effects, private decisions about consumption and production can lead to an inefficient allocation of resources, and government intervention can potentially raise economic well-being.

SELF ASSESSMENT EXERCISE 3.2

Enumerate and explain the different types of goods you know.

3.2 The Free Rider Problem of Public Goods

To understand how public goods differ from other goods and why they present problems for society, let us consider an example: a fireworks display. This good is not excludable because it is impossible to prevent someone from seeing fireworks, and it is not rivalry in consumption because one person's enjoyment of fireworks does not reduce anyone else's enjoyment of them.

The citizens of Lagos town, Nigeria, like seeing fireworks on the 24th of December. Each of the town's 5000 residents places a N100 value on the experience for a total benefit of N500,000. The cost of putting on a fireworks display is N100,000. Because the N500,000 benefit exceeds the N100,000 cost, it is efficient for Lagos town to have a fireworks display on the 24th of December. Would the private market produce the efficient outcome? Probably not. Imagine that Mrs. Adetula, a Lagos town entrepreneur, decided to put on a fireworks display. Adetula would surely have trouble selling tickets to the event because her potential customers would quickly figure out that they could see the fireworks even without a ticket. Because fireworks are not excludable, people have an incentive to be free riders. **A free rider is a person who receives the benefit of a good but does not pay for it.** Because people would have an incentive to be free riders rather than ticket buyers, the market would fail to provide the efficient outcome.

One way to view this market failure is that it arises because of an externality.

If Adetula puts on the fireworks display, she confers an external benefit on those who see the display without paying for it. When deciding whether to put on the display, however, Adetula does not take the external benefits into account. Even though the fireworks display is socially desirable, it is not profitable. As a result, Adetula makes the privately rational but socially inefficient decision not to put on the display.

Although the private market fails to supply the fireworks display demanded by Lagos town residents, the solution to Lagos town's problem is obvious: The local government can sponsor a 24th December celebration. The town council can raise everyone's taxes by N20 and use the revenue to hire Adetula to produce the fireworks. Everyone in town is better off by N80—the N100 at which residents value the fireworks minus the N20 tax bill.

Adetula can help the town reach the efficient outcome as a public employee even though she could not do so as a private entrepreneur.

The story of the town is simplified but realistic. Moreover, the story shows a general lesson about public goods: Because public goods are not excludable, the free-rider problem prevents the private market from supplying them. The government, however, can potentially remedy the problem. If the government decides that the total benefits of a public good exceed its costs, it can provide the public good, pay for it with tax revenue, and make everyone better off (Mankiw, 2012).

SELF ASSESSMENT EXERCISE 3.2

Give and explain an example of free a rider problem you know.

3.3 Some Important Public Goods

There are many examples of public goods. Here we consider three of the most important public goods.

1. National Defense: The defense of a country from foreign aggressors is a classic example of a public good. Once the country is defended, it is impossible to prevent any single person from enjoying the benefit of this defense. Moreover, when one person enjoys the benefit of national defense, he does not reduce the benefit to anyone else. Thus, national defense is neither excludable nor rival in consumption. National defense is also one of the most expensive public goods. In 2018, the Nigerian federal government spent a total of $661 billion on national defense, more than N2,150 per person. People disagree about whether this amount is too small or too large, but almost no one doubts that some government spending for national defense is necessary. Even economists who advocate small government agree that the national defense is a public good the government should provide.

2. Basic Research: Knowledge is created through research. In evaluating the appropriate public policy toward knowledge creation, it is important to distinguish general knowledge

from specific technological knowledge. Specific technological knowledge, such as the invention of a longer-lasting battery, a smaller microchip, or a better digital music player, can be patented. The patent gives the inventor the exclusive right to the knowledge he or she has created for a period of time. Anyone else who wants to use the patented information must pay the inventor for the right to do so. In other words, the patent makes the knowledge created by the inventor excludable. By contrast, general knowledge is a public good. For example, a mathematician cannot patent a theorem. Once a theorem is proven, the knowledge is not excludable:

The theorem enters society's general pool of knowledge that anyone can use without charge. The theorem is also not rival in consumption: One person's use of the theorem does not prevent any other person from using the theorem. Profit-seeking firms spend a lot on research trying to develop new products that they can patent and sell, but they do not spend much on basic research. Their incentive, instead, is to free ride on the general knowledge created by others. As a result, in the absence of any public policy, society would devote too few resources to creating new knowledge. The government tries to provide the public good of general knowledge in various ways. Government agencies, such as the National Institutes of Health and the National Science Foundation, subsidize basic research in medicine, mathematics, physics, chemistry, biology, and even economics. Some people justify government funding of the space program on the grounds that it adds to society's pool of knowledge (although many scientists are skeptical of the scientific value of manned space travel). Determining the appropriate level of government support for these endeavors is difficult because the benefits are hard to measure. Moreover, the members of Congress who appropriate funds for research usually have little expertise in science and, therefore, are not in the best position to judge what lines of research will produce the largest benefits. So, while basic research is surely a public good, we should not be surprised if the public sector fails to pay for the right amount and the right kinds.

3. Fighting Poverty: Many government programs are aimed at helping the poor. The welfare system (officially called the Temporary Assistance for Needy Families program)

provides a small income for some poor families. Similarly, the Food Stamp program subsidizes the purchase of food for those with low incomes, and various government housing programs make shelter more affordable. These antipoverty programs are financed by taxes paid by families that are financially more successful. Economists disagree among themselves about what role the government should play in fighting poverty. Here we note one important argument: Advocates of antipoverty programs claim that fighting poverty is a public good. Even if everyone prefers living in a society without poverty, fighting poverty is not a "good" that private actions will adequately provide. To see why, suppose someone tried to organize a group of wealthy individuals to try to eliminate poverty. They would be providing a public good. This good would not be rival in consumption: One person's enjoyment of living in a society without poverty would not reduce anyone else's enjoyment of it. The good would not be excludable: Once poverty is eliminated, no one can be prevented from taking pleasure in this fact. As a result, there would be a tendency for people to free ride on the generosity of others, enjoying the benefits of poverty elimination without contributing to the cause. Because of the free-rider problem, eliminating poverty through private charity will probably not work. Yet government action can solve this problem. Taxing the wealthy to raise the living standards of the poor can potentially make everyone better off. The poor are better off because they now enjoy a higher standard of living, and those paying the taxes are better off because they enjoy living in a society with less poverty (Tietenberg, 2011; Mankiw, 2012.

SELF ASSESSMENT EXERCISE

Enumerate and explain different types of public goods you know.

4.0. CONCLUSION

In this unit, we can conclude that public goods is a good that is both non-excludable and non-rivalrous in that individuals cannot be excluded from use or could be enjoyed without

paying for it, and where use by one individual does not reduce availability to others or the can be effectively consumed simultaneously by more than one person.

5.0 SUMMARY

In this unit, we have discussed extensively on different types of goods with particular reference public goods. The free-rider story of the town is simplified but realistic. Moreover, the story shows a general lesson about public goods: Because public goods are not excludable, the free-rider problem prevents the private market from supplying them. The government, however, can potentially remedy the problem. If the government decides that the total benefits of a public good exceed its costs, it can provide the public good, pay for it with tax revenue, and make everyone better off.

6.0. TUTOR-MARKED ASSIGNMENT

1. What is the free-rider problem? Explain with example.
2. Why does the free-rider problem induce the government to provide public goods?
3. How should the government decide whether to provide a public good or not?

7.0 REFERENCES/FURTHER READINGS

Mankiw, N.G. (2011). Principle of Microeconomics. South Western Cangage Learning

Tietenberg, T. and Lewis, L. (2012). Environmental and Natural Resource Economics (Ninth Edition), USA: Pearson Education Inc.

UNIT 4 COMMON POOL RESOURCES

CONTENTS

1.0 INTRODUCTION

Common pool resources (CPRs) are characterized as resources for which the exclusion of users is difficult (referred to as excludability), and the use of such a resource by one user decreases resource benefits for other users (referred to as subtractability). Common resources, like public goods, are not excludable: They are available free of charge to anyone who wants to use them. Common resources are, however, rival in consumption: One person's use of the common resource reduces other people's ability to use it. Thus, common resources give rise to a new problem. Once the good is provided, policymakers need to be concerned about how much it is used. This problem is best understood from the classic parable called the **Tragedy of the Commons**.

5 OBJECTIVES

At the end of this unit, you should be able:

- Explain the concept of common pool resources
- Describe common resources and the parable of the tragedy of the commons

- Identify the different types of common resources
- Discuss the knowledge of the importance of property rights in common resources issues.

3.0. Main Content

3.1. Common Resources and the Tragedy of Commons

Consider life in a small medieval town. Of the many economic activities that take place in the town, one of the most important is raising sheep. Many of the town's families own flocks of sheep and support themselves by selling the sheep's wool, which is used to make clothing.

As our story begins, the sheep spend much of their time grazing on the land surrounding the town, called the Town Common. No family owns the land. Instead, the town residents own the land collectively, and all the residents are allowed to graze their sheep on it. Collective ownership works well because land is plentiful. As long as everyone can get all the good grazing land they want, the Town Common is not rivalry in consumption, and allowing residents' sheep to graze for free causes no problems. Everyone in the town is happy.

As the years pass, the population of the town grows, and so does the number of sheep grazing on the Town Common. With a growing number of sheep and a fixed amount of land, the land starts to lose its ability to replenish itself. Eventually, the land is grazed so heavily that it becomes barren. With no grass left on the Town Common, raising sheep is impossible, and the town's once prosperous wool industry disappears. Many families lose their source of livelihood.

What causes the tragedy? Why do the shepherds allow the sheep population to grow so large that it destroys the Town Common? The reason is that social and private incentives differ. Avoiding the destruction of the grazing land depends on the collective action of the shepherds. If the shepherds acted together, they could reduce the sheep population to a size

that the Town Common can support. Yet no single family has an incentive to reduce the size of its own flock because each flock represents only a small part of the problem.

In essence, the Tragedy of the Commons arises because of an externality. When one family's flock grazes on the common land, it reduces the quality of the land available for other families. Because people neglect this negative externality when deciding how many sheep to own, the result is an excessive number of sheep.

If the tragedy had been foreseen, the town could have solved the problem in various ways. It could have regulated the number of sheep in each family's flock, internalized the externality by taxing sheep, or auctioned off a limited number of sheep-grazing permits. That is, the medieval town could have dealt with the problem of overgrazing in the way that modern society deals with the problem of pollution.

In the case of land, however, there is a simpler solution. The town can divide the land among town families. Each family can enclose its parcel of land with a fence and then protect it from excessive grazing. In this way, the land becomes a private good rather than a common resource. This outcome in fact occurred during the enclosure movement in England in the 17th century.

The Tragedy of the Commons is a story with a general lesson: When one person uses a common resource, he or she diminishes other people's enjoyment of it. Because of this negative externality, common resources tend to be used excessively. The government can solve the problem by using regulation or taxes to reduce consumption of the common resource. Alternatively, the government can sometimes turn the common resource into a private good.

This lesson has been known for thousands of years. The ancient Greek philosopher Aristotle pointed out the problem with common resources: "What is common to many is taken least care of, for all men have greater regard for what is their own than for what they possess in common with others."

SELF ASSESSMENT EXERCISE

Give example and explain the tragedy of commons you know as it relates to common pool resource.

3.2. Congestion and Over Use

Common-pool resources often suffer from being overused or becoming congested by use. It is largely due to the fact that such resources usually possess a primary resource, or stock variable, as well as smaller units that can be extracted and used, or the flow variable of the resource.

With common-pool resources, overuse occurs because of subtractability (rivalry). For example, consider a pasture. If the land is not necessarily privately owned and is shared between multiple farmers grazing their cattle, then the pasture is a common-pool resource because it cannot be effectively exclusive to any of the farmers.

However, as cattle are rotated between areas of the pasture, each area then becomes substantially less valuable to every farmer down the line, with the potential for overgrazing that will make the pasture not usable for any cattle, at least for a period of time. Here, the general acreage of the pasture space would be the primary resource or stock variable and the grass, then, would be the flow variable (Hackett, 2006; Mankiw, 2011; Tietenberg, 2012).

SELF ASSESSMENT EXERCISE

How do congestion and over use relate to common resources?

3.3. Some Important Common Pool Resources

There are many examples of common resources. In almost all cases, the same problem arises as in the Tragedy of the Commons: Private decision makers use the common resource too much. Governments often regulate behavior or impose fees to mitigate the problem of overuse.

1. **Clean Air and Water:** Markets do not adequately protect the environment. Pollution is a negative externality that can be remedied with regulations or with corrective taxes on polluting activities. One can view this market failure as an example of a common-resource problem. Clean air and clean water are common resources like open grazing land, and excessive pollution is like excessive grazing. Environmental degradation is a modern Tragedy of the Commons.
2. **Congested Roads:** Roads can be either public goods or common resources. If a road is not congested, then one person's use does not affect anyone else. In this case, use is not rivalry in consumption, and the road is a public good. Yet if a road is congested, then use of that road yields a negative externality. When one person drives on the road, it becomes more crowded, and other people must drive more slowly. In this case, the road is a common resource. One way for the government to address the problem of road congestion is to charge drivers a toll. A toll is, in essence, a corrective tax on the externality of congestion. Sometimes, as in the case of local roads, tolls are not a practical solution because the cost of collecting them is too high. But several major cities, including London and Stockholm, have found increasing tolls to be a very effective way to reduce congestion. Sometimes congestion is a problem only at certain times of day. If a bridge is heavily traveled only during rush hour, for instance, the congestion externality is largest during this time. The efficient way to deal with these externalities is to charge higher tolls during rush hour. This toll would provide an incentive for drivers to alter their schedules, reducing traffic when congestion is greatest. Another policy that responds to the problem of road congestion is the tax on gasoline. Gasoline is a complementary good to driving: An increase in the price of gasoline tends to reduce the quantity of driving demanded. Therefore, a gasoline tax reduces road congestion. A gasoline tax, however, is an imperfect solution, because it affects other decisions besides the amount of driving on congested roads. For example, the gasoline tax discourages driving on uncongested roads, even though there is no congestion externality for these roads.

3. **Fish, Whales, and Other Wildlife:** Many species of animals are common resources. Fish and whales, for instance, have commercial value, and anyone can go to the ocean and catch whatever is available. Each person has little incentive to maintain the species for the next year. Just as excessive grazing can destroy the Town Common, excessive fishing and whaling can destroy commercially valuable marine populations. Oceans remain one of the least regulated common resources. Two problems prevent an easy solution. First, many countries have access to the oceans, so any solution would require international cooperation among countries that hold different values. Second, because the oceans are so vast, enforcing any agreement is difficult. As a result, fishing rights have been a frequent source of international tension among normally friendly countries. Within the United States, various laws aim to manage the use of fish and other wildlife. For example, the government charges for fishing and hunting licenses, and it restricts the lengths of the fishing and hunting seasons. Fishermen are often required to throw back small fish, and hunters can kill only a limited number of animals. All these laws reduce the use of a common resource and help maintain animal populations.

SELF ASSESSMENT EXERCISE

List some common examples of the commons

3.4.1. Managing Common Pool Resources

The adequate management of a common-pool resource requires a deep understanding about the causes of (potential/existing) conflict in resource use. Adams et al. (2003) emphasise that conflicts over the management of common-pool resources are not simply material, as they also depend on the perceptions of the protagonists. Since the problem definition is a critical phase in the policy-making process, it is essential to carefully and transparently consider the different stakeholders, their knowledge of the empirical context, their institutions, beliefs, myths and ideas. It is essential to promote an effective dialogue to find an adequate policy regime. Ostrom (2008) maintains that the advocacy of a single idealised solution for all common-pool resources has been a key part of the problem instead of the

solution. She also considers that many of the most pressing problems future generations will face are on a global scale and that establishing effective governance arrangement on this scale has proved to be more difficult than on a local one.

In order to make sure that Common Pool Resources retain their non-excludability and to work against the tendency toward overuse or congestion, protocols are typically established. The protocols include important items such as the following:

- Establishing the boundaries of the resource, making it clear what space is part of the resource
- Agreements between all users of the resource (planned or expected), or making assurances that all potential users are aware of the space and rules
- Careful monitoring of the resource
- Penalties put in place to sanction users who don't abide by established agreements on the proper use of the resource
- Some forum or plan of action for resolution of conflicts if/when they arise

With most common-pool resources, legislation, the establishment of rules, and conflict resolution are done at a local level so that the resources aren't opened up further to overuse or exploitation. The government typically only steps in or is involved if the resources are part of a trade agreement or if disputes over the resources exceed the ability of local governors or other officials to control.

In some cases, the government must be included so that overuse of the resource – or exploitation of it – does not harm the broader community or the country, or create a global impact.

One of the greatest challenges we face when managing natural resources for long-term human benefit is the "common pool" problem. This is the tendency for individual users to exploit limited resources to capture benefits that would otherwise go to their competitors. In a common pool situation users who forgo exploitation to conserve the resource do not

benefit from their actions because their competitors simply exploit more. This can prompt overexploitation by all users that ultimately provides less benefit to everyone. There are many familiar examples, including management of mineral resources, fisheries, air quality, and agricultural water supplies. In this ESI project, we focus on a critical renewable resource: fresh water. We use differential game theory to show that cooperative allocation of water based on well-defined ownership rights can provide greater benefit to all users than a non-cooperative arrangement that leads to overexploitation. Water markets provide a particularly promising means to achieve this greater benefit. We show this in a detailed analysis of water market data from the Murray-Darling river basin in Australia. The analytical methods developed in the project accommodate more physically and economically realistic descriptions of the resource and its users than previous work and provide a substantive advance in understanding of practical common pool problems (Perman, Ma, McGilvray and Common, 2003; Mankiw, 2012).

SELF ASSESSMENT EXERCISE

Explain in your own words what you understand by managing common pool resources

6 CONCLUSION

In this unit, we can conclude that Common-pool resources' are characterised by divisibility, which makes a difference to public goods, and include open-access resources as well as common-property resources, in opposition to private property resources. The latter are held by individuals and firms creating the basis for the functioning of markets. Common-pool resources are sufficiently large that it is difficult, but not impossible, to define recognised users and exclude other users altogether. Further, each person's use of such resources subtracts benefits that others might enjoy'. For instance, one person using open air to breath, does not hamper anybody's else's use, while using the atmosphere as a dumping ground for large amounts of sulphur dioxide or carbon dioxide, prevents other people from making (without damage to all) a similar use of it.

5.0 SUMMARY

In this unit, we have discussed vividly common resources and the tragedy of the commons. Common-pool resources are those owned by a community, without specific assignment of private property rights to individuals or firms. No rules limit use of open-access resources, which leads to overuse and sometimes to the collapse of the resource's ecological functions. Examples include common grazing land, clean air, and congested roads. Because people are not charged for their use of common resources, they tend to use them excessively. Therefore, governments use various methods to limit the use of common resources.

6.0. TUTOR-MARKED ASSIGNMENT

1. Why do governments try to limit the use of common resources?
2. Define and give an example of a common resource. Without government intervention, will people use this good too much or too little? Why?
3. With concrete example, explain the tragedy of the commons in relation to common pool resources.
4. Congestion and over use are terms related to common pool resources. Discuss.

7.0 REFERENCES/FURTHER READINGS

Mankiw, N.G. (2011). Principle of Microeconomics. South Western Cangage Learning

Tietenberg, T. and Lewis, L. (2012). Environmental and Natural Resource Economics (Ninth Edition), USA: Pearson Education Inc.