COURSE GUIDE

ESM 292
ENVIRONMENTAL ECONOMICS

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CONTENTS **PAGE**

INTRODUCTION

Environmental economics is an area of economics that studies the financial impact of environmental policies. Environment economists perform studies to determine the theoretical or empirical effects of environmental policies on the economy. This field of economics helps users design appropriate environmental policies and analyse the effects and merits of existing or proposed policies.

Environmental problems are however the result of our pursuit of affluence. However, we have to reconsider the method of pursuing affluence. In other words we have to reconsider the economic activities. For a long time, economists had focused on only economic activities. We obtain materials and energy from the environment and inflict burdens on the environment. Therefore, economic activities and the environment are not mutually exclusive. We thus have to consider both the economic activities and the environment.

Environmental Economics (ESM 292) is a second semester core course which carries three credit units for third year Environmental Management students in the Faculty of Science and Technology at the National Open University, Nigeria. This coursework will be useful in your academic pursuit and help to gain in-depth insight in macroeconomic theory and practice.

This course guide is built on prerequisite knowledge (i.e. some fundamental bedrock that is expected to have been learnt in the previous levels.

However, its simplicity will make you assimilate faster and practice questions at the end of each unit and also prepare you for the examination. The course guide suggests some general guidelines for the amount of time required of you for each unit in order to achieve the aims and objectives of the course successfully. It also provides you with some guidance on your tutor-marked assignments (TMAs) as contained herein.

COURSE CONTENT

The course is made up of five units (two modules) spread across five lecture hours and covering areas such as the Meaning, Definition and Scope of Environmental Economics: Structure of the Environment, the Human Economy and the Natural Environment. Module 2 covers Scarcity and Resources; the Concept of Demand, Supply and Market Equilibrium.

COURSE AIMS AND OBJECTIVES

The course attempt to explain the determinants of the magnitude of these aggregates and their rate of change over time. It also aims to give you an in-depth understanding of the environmental economic theory and practice, and equally prepare you with policy mix with which environmental economic challenges could be tackled. Also, the course is prepared in a way in which it would easily enhance your previous knowledge of environmental resources management. The course also aims to help you develop critical thinking skills, learn how to evaluate environmental economic arguments, and understand the roles of environmental economic thought in guiding current environmental economic policies and debates.

However, the overall aims of the course will be achieved by:

- analysing the relationship between economy and the environment
- determining the maintenance of balance between ecology and economic development
- understanding the welfare framework of environmental economics as a discipline and
- explaining the impact of 'clean technology' as rational for the use of natural resources and energy for the protection of the environment.

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. 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 10 weeks to complete and some components of the course are outlined under the course material sub-section.

COURSE MATERIALS

The major component of the course is made up of what you have to do and how you should allocate your time to each unit in order to complete the course successfully on time. Such components are listed as follows:

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

5. Presentation schedule.

STUDY UNITS

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

Module 1

Unit 1	Environmental Economics: Meaning, Definition and Scope
Unit 2	Structure of the Environment
Unit 3	The Human Economy and the Natural Environment

Module 2

Unit 1	Scarcity and Resources
Unit 2	The Concept of Demand, Supply and Market Equilibrium

REFERENCES AND OTHER RESOURCES

Every unit contains a list of references and further reading. Try to get as many as possible of those textbooks and materials listed. The textbooks and materials are meant to deepen your knowledge of the course.

ASSIGNMENT FILE

There are assignments on this course and you are expected to attempt all of them by following the schedule prescribed for them in terms of when to attempt them and submit same for grading by your tutor. The marks you obtain for these assignments will count towards the final mark you obtain for this course. Further information on assignments will be found in the Assignment File itself 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 TMA questions in units 1 – 3 of module 1
Assignment 2 - All TMA questions in units 1 – 2 of module 2

PRESENTATION SCHEDULE

The presentation schedule included in your course materials gives you important dates for this year in which to complete your tutor-marked assignments and attend tutorials. Remember, you are required to submit

all your assignments on due date. You are expected to guide against falling behind schedule in this course.

ASSESSMENT

There are two types of assessment in this course. First, is the tutor-marked assignments; secondly, 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. This examination will also count for 70% of your total course mark.

TUTOR-MARKED ASSIGNMENT

There are four tutor-marked assignments in this course. While you are enjoined to work all the questions thoroughly, you are expected to submit all the assignments for grading. The TMAs alone constitute 30% of your total score in this course.

Assignment questions for the units in this course are contained in the Assignment File. You are to complete your assignments from the information and materials contained in your text 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 are unable to 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 cogent reasons to do that.

FINAL EXAMINATION AND GRADING

The final examination will be of three hours 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. Use the time between finishing the last unit and sitting for the examination to revise the entire course material. 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.

S/N	Assessment	Marks (%)
1	Assignment (best three assignments out of the four)	30
2	Final examination	70

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 suits 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 in 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 reading 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 accomplish.

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. Secondly, 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 end 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 immediately for advice. 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.

Read this Course Guide Thoroughly

1. Organise 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 put 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 your own dates for working breach unit.

2. Once you have created your own study schedule, do everything you can to stick to it. The major reason why students fail is that they left behind in their course work. If you get into difficulties

with your schedule, please let your tutor know immediately before it is too late to ask for help.

3. Turn to unit 1 and read the introduction and the objectives for the unit.

4. 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 text books on your desk at the same time.

5. 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 some sections from your text books or other articles. Use the unit to guide your reading.

6. Up-to-date course information will be continuously delivered to you at the study centre.

7. Work before the relevant due date (i.e. about 4 weeks before due dates), and get the Assignment File for the next required assignment. Remember that you will learn a lot by carefully completing the assignments. 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.

8. Review the objectives for each study unit to confirm that you have achieved them. If you are unsure of any of the objectives, review the study material or consult your tutor.

9. 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.

10. When you have submitted an assignment to your tutor for marking do not wait for it to be returned 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.

11. 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-hour sessions) provided in support of this course. You will be notified of the date, time and location of these tutorials in addition to the name and telephone number(s) 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 before due date 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 through 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 reading
- 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 opportunity to have face-to- face contact with your tutor and to ask questions which will be answered instantly. You may 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

Environmental economics requires a transnational approach. An environmental economist could identify aquatic depopulation, resulting from overfishing, as a negative externality to be addressed.

The Nigerian government could impose regulations on its own fishing industry, but the problem wouldn't be solved without similar action from many other nations that also engage in overfishing. The global character of such environmental issues has led to the rise of non-governmental organisations (NGOs) like the International Panel on Climate Change (IPCC), which organises annual forums for heads of state to negotiate international environmental policies.

On successful completion of this course, you would have developed critical thinking skills with the material necessary for efficient and effective discussion of economic issues and events, both theoretically and practically. However, to gain a lot from the course please try to apply anything you learn in the course to term papers writing in other environmental economic courses.

We wish you success in the course and hope that you will find it interesting and functional.

MAIN COURSE

CONTENTS **PAGE**

MODULE 1

UNIT 1 ENVIRONMENTAL ECONOMICS: MEANING, DEFINITION AND SCOPE

CONTENTS

1.0 INTRODUCTION

In the early tradition of economic thought, laid down by the classical and neo-classical economists, economics was conceived as the study of the allocation of scarce resources among alternative, competing ends, in the quest to satisfy human wants. The classical and neo-classical economists underestimated the environmental issues of production and consumption, since they considered these as social issues. Consequently, the impacts of production and consumption on the natural environment were not explicitly brought into the mainstream of economic theory. The environment was taken as given and can last ad infinitum. However, in the early 1970s, the reality of economic thought brought to a halt the perception of economics

merely as a science of production and distribution. In the new thinking, economics is no longer perceived as the science of production and distribution which neglects the environmental repercussions of economic activities. This means that economics as a subject cannot exist in isolation. It must take into consideration the effects of resource use in production and distribution on the natural environment which supplies these resource inputs. Thus, any study on the economic content of production, distribution, consumption, development, etc. cannot be completed without touching upon the environmental aspects like pollution of the environment (e.g. water and air pollution), environmental damage, environmental resource exhaustion and depletion, global warming, biodiversity, social externalities and the likes.

In order to account for the environmental impact of economic activities, a new field of study called environmental economics thus emerged. The call for an evaluation of environmental impact of economic activities necessitates the regulation of these activities for environmental sustainability. This regulation therefore brings into bear the issue of environmental policy, which nearly all countries all over the world now spend resources to formulate at national and international levels. Although, this branch of economics can be traced to the 1950s and the 1960s, with important contributions from the think-tank on resources for the future, the field really took off from the 1970s and has been booming ever since. Environmental economics can therefore be seen as an applied part of economics which deals with the relationship between economic activities and the environment and studies the ways and means by which the former is not impeded nor the latter impaired.

2.0 OBJECTIVES

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

- analysis the relationship between economy and the environment
- determine the maintenance of balance between ecology and economic development
- discuss the welfare framework of environmental economics as a discipline
- explain the impact of ‘clean technology’ as rational for the use of natural resources and energy for the protection of the environment.

3.0 MAIN CONTENT

3.1 Definition of Environmental Economics

Before we define environmental economics, the concepts of the environment and economics should be discussed.

3.2 What is Environment?

The word environment was derived from the French word 'Environer' which means to surround. Literary, environment means the surrounding of external conditions influencing development or growth of people, animal and plants; living or working conditions, etc. This involves:

3.2.1 What is Surrounded?

The answer to this question is living objects in general and man in particular.

3.2.2 By what are Surrounded?

The physical attributes are the answer to this question, which become environment. In fact, the concern of all education is the environment of man. However, man cannot exist or be understood in isolation from the other forms of life and from plant life. However, environment refers to the sum total of condition, which surrounds every point in space and time. The scope of the term 'environment' has been changing and widening by the passage of time. In the primitive age, the environment consisted of only physical aspects of the planted earth's land, air and water as biological communities. As time goes on, man extended his environment through his social, economic and political functions.

3.2.3 Where is Surrounded?

The answer to this is in nature that physical components of the planet earth, viz. land, air, water, etc, support and affect life in the biosphere. From the foregoing, the word environment can, thus, be defined as the sum total of all the external forces, influences and conditions, which affect the life, nature, behavior and the growth, development and maturity of living organisms.

3.3 Scope of Environment

The environment consists of four segments as follows:

(a) Atmosphere: The atmosphere implies the protective blanket of gases surrounding the earth. It is composed of nitrogen and oxygen, besides argons, carbon dioxide and trace gases.
(b) Hydrosphere: This comprises all types of water resources like oceans, seas, lakes, rivers, reservoir, polar icecaps, glaciers and ground water.
(c) Lithosphere: This is the outer mantle of the solid earth. It consists of minerals occurring in the earth's crusts and the soil, e.g. minerals, organic matter, air and water.
(d) Biosphere: Biosphere means the realm of living organisms and their interactions with the environments, viz. atmosphere, hydrosphere and lithosphere.

3.3.1 Elements of the Environment

The environment is constituted by the interacting systems of physical, biological and cultural elements inter-related in various ways, individually as well as collectively.

(a) Physical elements: These are space, landforms, water bodies, climate soils, rocks and minerals. They determine the variable character of the human habitat, its opportunities as well as limitations.
(b) Biological elements: These elements include plants, animals, microorganisms and human beings.
(c) Cultural elements: Cultural elements such as economic, social and political elements are essentially man-made features, which made up the cultural milieu.

3.3.2 Environmental Economics Defined

Environmental economics is concerned with the analysis of the impact of the economy on the environment, the significance of the environment to the economy and appropriate way of regulating economic activity so that balance is achieved among environmental, economic and other social objectives. It should be noted that environmental study requires a synthesis of the various branches of knowledge like science, economics, philosophy, ethics, anthropology, etc. Therefore, the study of the environment may be approached from different perspectives and environmental economics may borrow from such perspectives in its analysis.

3.3.3 Need for a Special Course in Environmental Economics

Environmental and natural resources should be allocated in the same way we want to allocate all resources. That is, efficiently and equitably. In this case, there is no theoretical need to have a separate course for natural and environmental resources.

Then why do we offer courses in environmental and natural resource economics?

Economic analysis of the environment is challenging and important precisely because environmental value is not always conveniently revealed in a market, and thus, is subject to inappropriate use. Indeed, lots of people are particularly worried about the allocation of environmental and natural resources and a lot of people think they are being misallocated. This has generated some concerns which gave credence to the separate treatment of environmental and natural resources.

Some of these concerns are:

i. Natural resources are finite and stocks are dwindling and so may soon exhaust.
ii. Increasing concern about non-catastrophic pollution. This result from increasing information about the effect of pollutant on the health of living organisms.
iii. Concern about catastrophic pollution; that is, pollution that could lead to a widespread ecological disaster such as green-house effect, loss of the ozone layer and radiation from bombs or leaks.
iv. Concern over the preservation of natural environments: Wilderness areas, National Parks, the rain forests, the Arctic, etc, hence Green Association such as Sierra Club, Friends of the Earth, National Wildlife Federation etc.
v. Concern over preservation of animal species. The possibility of extinction is a growing concern for many species; hence we have conservation groups such as Greenpeace, World Wildlife Fund, Trout Unlimited, Ducks Unlimited, Conservation International (CI) and International Union for the Conservation of Nature (IUCN), etc.
vi. Consequently, economist are increasingly being called upon to help guide the process of environmental management and to provide measurable criteria by which environmental policies can be evaluated. Hence, the need for a study on environmental economics.

3.4 Core Objectives of Environmental Economics

i. **Analysis of the relationship between economy and the environment:** Environmental economics is primarily concerned with the impact of economic activities on the environment and its implications for the individual firm, industry and the economy as a whole. Economists have formulated economy-environment models to explain the various economic activities and their external effects. For example, the Material Balance Model and the Leontief Abatement Model explain these externalities.

ii. **Maintenance of Balance between ecology and economic development:** The main objective of environmental economics is to maintain a balance between economic development and environment quality. In order to achieve this, environmental economists have to explore the various socio-economic possibilities to reduce pollution and uplift the standard of living of the people.

iii. **Welfare:** Environmental economics has emerged as a discipline to tackle environmental problems from an economic welfare framework. The welfare framework covers scarce resources and market failures due to property rights and ethical aspects of different problems of pollution. Thus, it suggests the best possible means to tackle the environmental problems.

iv. **Clean technology:** Presently, environmental pollution is caused by misuse of existing technology and failure to develop better one. However, environmental economists are in favour of appropriate and clean technologies which provide the most rational use of natural resources and energy and to protect the environment.

3.5 The Scope of Environmental Economics

As a sub discipline of economics, environmental economics originated in the early years of the so-called environmental movement. However, despite its brief history over the past three decades, it has become one of the fastest-growing fields of study in economics. The growing popularity of this field of inquiry parallels the increasing awareness of the interconnectedness between the economy and the environment; more specifically, the increasing recognition of the significant roles that nature plays in the economic process as well as in the formation of economic value.

The nature and scope of the issues addressed in environmental economics are quite varied and all-encompassing. Below is a list of some of the major topics addressed in this field of study.

1. The causes of environmental degradation.
2. The need to re-establish the disciplinary ties between ecology and economics.
3. The difficulties associated with assigning ownership right to environmental resources.
4. The trade-off between environmental degradation and economic goods and services.
5. The ineffectiveness of the market, if left alone, in allocating environmental resources.
6. Assessing the monetary value of environmental damage.
7. Public policy instruments that can be used to reduce, halt and reverse the deterioration of environmental resources and/or the over-exploitation of renewable and non-renewable resources.
8. The macroeconomic effects of environmental regulation and other resource conservation policies.
9. The extent to which technology can be used as a means of ameliorating environmental degradation or resource scarcity in general; that is, limits to technology.
10. Environmental problems that transcend national boundaries, and thus require international cooperation for their resolution.
11. The limits of economic growth.
12. The extent to which past experience can be used to predict the future events that are characterised by considerable economic, technological and ecological uncertainties.
13. Ethical and moral imperatives for environmental resource conservation-concern for the welfare of future generations.
14. The interrelationship among population, poverty and environmental degradation in the developing countries of the world.
15. The necessity and viability of sustainable development.

This list by no means exhausts the issues that can be addressed in environmental economics. However, the issue in the list does provide important clues to some of the fundamental ways in which the study of environmental economics is different from other sub-disciplines in economics.

First, the ultimate limits to environmental resource availability are imposed by nature. That is, their origin, interactions and reproductive capacity are largely governed by nature.

Secondly, most of these resources have no readily available markets: for example, clean air, ozone, the genetic pool of a species, etc.

Thirdly, no serious study of environmental economics can be entirely descriptive. Normative issues such as intergenerational fairness and the distribution of resources between the poor and rich nations are very important.

Fourthly, uncertainties are unavoidable consideration in any serious study of environmental and natural resource issues. These uncertainties may take several forms, such as prices, irreversible environmental damage, or unexpected and sudden species extinction. Such is the nature of the subject matter of environment economics.

SELF-ASSESSMENT EXERCISE

i. What are the main objectives of environmental economics?
ii. What do you understand by the word 'environment'?

3.6 Biodiversity

3.6.1 What is Biodiversity?

Biodiversity can be defined as the degree of variation of life-forms within a given species, ecosystem, biome or an entire planet. It is a measure of the health of ecosystems. It covers the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part; this includes diversity within species, between species and of ecosystems.

There are four (4) types of biodiversity which are:

a) Genetic Diversity
b) Species Diversity
c) Ecological Diversity
d) Functional Diversity

3.6.2 Genetic Diversity

This refers to the variation at the level of individual genes and provides a mechanism for populations to adapt to their ever-changing environment. The level of homogeneity or heterogeneity in the genetic make-up of a population of the same species indicates to what extent genetic material can be exchanged between populations and still maintains a species-specific gene pool. Genetic diversity is the "raw material" that permits species to

adjust to a changing world whether these changes are due to natural factors or are caused by human factors.

3.6.3 Species Diversity

Species diversity is a measure of the diversity within an ecological community that incorporates both species richness (the number of species in a community) and the evenness of species' abundance. Species diversity is one component of the concept of biodiversity that is influenced by species richness other things being equal. Therefore, communities with more species are considered to be more diverse.

3.6.4 Ecological Diversity

Ecological diversity is the variety of biological communities, such as forests, deserts, grasslands and streams that interacts with one another and with their physical and chemical (non-living) environments. It relates to the different forms of life which are present in any one particular area. In mere specific terms, it concerns the different species of a particular genus which are present in an ecological community.

3.6.5 Functional Diversity

Functional diversity refers to the diversity of ecological processes that maintain and are dependent upon the other components of diversity. It includes the many ecological interactions among species; e.g. competition, prediction, parasitism, mutualism, etc. as well as ecological processes such as nutrient retention and recycling.

3.6.6 Why is Biodiversity Important?

The importance of biodiversity can be discussed under the followings:

(a) Biodiversity boosts ecosystem productivity: Biodiversity makes the ecosystem productive in the sense that when a larger number of plant species exist, there will be greater variety of crops. Also, greater species diversity ensures natural sustainability for all life firms. Healthy ecosystems can better withstand and recover from a variety of disasters.

(b) A healthy biodiversity offers many natural services:

(i) Ecosystem Services: These are ecosystem services such as protection of water resources, soil formation, nutrient storage and recycling, pollution breakdown, contribution to climate stability and recovery from unpredictable events.
(ii) Biological Resources: This includes food, medical resources, wood products, ornamental plants, breeding stocks, future resources, diversity in genes, species and ecosystems.
(iii) This is social benefits in terms of research, education and monitoring, recreation, tourism and cultural values.

(c) Biodiversity improves human health:
(i) Biodiversity supports food security and dietary health: Genetic diversity in food systems provides the foundation of crop development and food security and promotes resistance and resilience to environmental stresses including pests and diseases.
(ii) Biodiversity provides important resources for medical research: Studies of wildlife anatomy, physiology and biochemistry can lead to important developments in human medicine.
(iii) Biodiversity plays a role in the regulation and control of infection diseases: Biodiversity loss and ecosystem change can increase the risk of emergence of spread of infectious diseases in animals, plants and humans, including economically important livestock diseases.
(iv) Biodiversity provides important resources for traditional and modern medicine: Biodiversity loss can impact on community traditions and livelihoods centered on traditional medicinal practices that utilises wild animals and plants, particularly for indigenous and local communities.
(v) Biodiversity is essential for climate change adaptation: Climate change will have a range of significant impacts on human health; many of which are directly associated with climate impacts on ecosystems.

(d) Biodiversity drives business and industry: Many industrial materials are derived directly from biological sources. These include building materials, fibres, dyes, rubber and oil. Biodiversity is also important in securing resources such as water, timber, and paper. Therefore, biodiversity loss is a significant risk factor in business development and a threat to long term economic sustainability.

(e) Biodiversity enriches leisure, cultural and aesthetic value: Biodiversity enriches leisure activities such as hiking, bird watching or natural history study. In addition, biodiversity inspires musicians, painters, sculpture and other artists. Many cultures view themselves as an integral part of the natural world which requires them to respect other living organisms.

3.6.7 Threats to Biodiversity

(1) Habitat destruction

Habitat destruction has played a key role in extinctions, especially as it relates to tropical forest destruction. Factors contributing to habitat destruction are overpopulation, deforestation, pollution (air, water and soil contamination) and global warming or climate change. It should be noted that habitat size and numbers of species are systematically related physically larger size species and those living in forests or oceans are more sensitive to reduction in habitat size. Most countries of the world lack property rights or tax law regulatory enforcement to prevent biodiversity loss.

(2) Introduction of invasive species

These include barriers such as large rivers, seas, oceans, mountains and deserts which encourages diversity by independent evolution of either side of the barrier. Invasive species occur when those species are blurred. Without barriers, such species occupy new niches, substantially reducing diversity. Repeatedly, humans have helped those species circumvent these barriers, introducing them for food and other purposes.

(3) Genetic pollution

Endemic species can be threatened with extinction through the process of genetic pollution, i.e. uncontrolled hybridisation, introgression and genetic swamping. Genetic pollution leads to homogenisation or replacement of local genomes as a result of either a numerical or fitness advantage of an introduced species.

(4) Over exploitation

Overexploitation occurs when resources are consumed at an unsustainable rate. This occurs on land in the form of over hunting, excessive logging, poor soil conservative in agriculture and illegal wildlife trade.

(5) Climate change

Global warming is also considered to be a major threat to biodiversity. For example, it was discovered that coral reefs – which are biodiversity

hotspots will be lost in 20 to 40 years if global warming continues at the current trend.

(6) Human overpopulation

The geometrical growth rate of human population in the 20th century had more impact in biodiversity than any other single factor. The consequences of overpopulation include deforestation for housing estates, proliferation of infrastructural facilities, etc., which all have significant effects on biodiversity.

4.0 CONCLUSION

At this end of this unit, you have been able to analyse the relationship between economy and the environment, determine the maintenance of balance between ecology and economic development, understand the welfare framework of environmental economics as a discipline, explain the impact of 'clean technology' as rational for the use of natural resources and energy for the protection of the environment.

5.0 SUMMARY

In this unit, we have been able to define environmental economics, the environment, explain the scope and elements of the environment, explain the need for special course in environmental economics, the scope and limitations of environmental economics, the importance and threats to biodiversity. From the discussions we have seen the interrelationship of atmosphere, hydrosphere, lithosphere, and biosphere and their impact to the environment.

6.0 TUTOR-MARKED ASSIGNMENT

1. What do you understand by environment?
2. What are elements of the environment? List and briefly discuss.
3. What do you understand by biodiversity?
4. Threats have constituted a menace to biodiversity. Explain.

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UNIT 2 STRUCTURE OF THE ENVIRONMENT

CONTENTS

1.0 INTRODUCTION

The structure of the environment can be described in terms of its interdependent components, namely; air, water, land, living systems and social structure. However, there are two other aspects that impact on the natural environment, these are:

(a) anthrosphere
(b) social environment.

2.0 OBJECTIVES

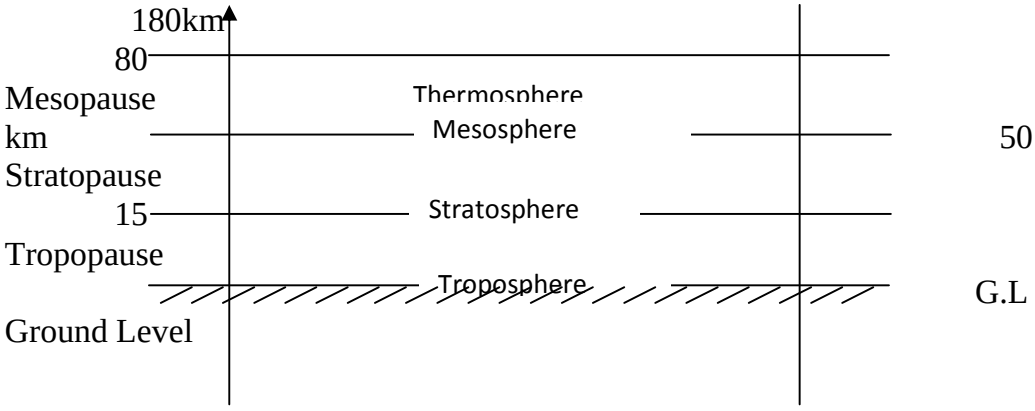
At the end of this unit, you should be able to:

- discuss the structure of the environment
- explain the interrelationship between the air environment (atmosphere), water environment (hydrosphere), land environment (geosphere) and biological environment (biosphere)
- analyse the biosphere and its dependent links and impact links to other spheres.

3.0 MAIN CONTENT

3.1 The Air Environment (Atmosphere)

The air environmental is the atmosphere. The atmosphere is the envelope of air which surrounds the earth, consisting principally of a mixture of gases – mainly oxygen (21%), Nitrogen (78%), carbon dioxide (0.03%), Argon (approx. 1%), Helium and other rare gases (0.01%) in dry air and with a variable quantity of water vapour. The atmosphere reaches over 10,000 kilometers above from the surface of the earth and structurally composed of the troposphere, stratosphere, mesosphere and thermosphere as shown in the diagram.



Structure of the Atmosphere (Stroller, 1975)

Below are some significance of the atmosphere as outlined:

a) The atmosphere contains life-supporting gasses for plants and animals. The presence of carbon-dioxide and oxygen is essential for the co-existence of the basic living systems of plants and animals.
b) Nitrogen gas present in the atmosphere is an essential component of plants, animals and microbes.
c) The atmosphere is a shield that protects life on earth from the hostile conditions of the outer spheres.
d) The atmosphere offers mankind a field of study called meteorology that deals with weather and climate change which have profound influence on other spheres of the environment.
e) A major layer in the atmosphere is the ozone layer which protects human, plants and other animals from hazardous radiation from the sun.

3.1.1 Water Environment (Hydrosphere)

The water environment constitutes three-quarters of the planet Earth. All plants and animals (including humans) on earth depend on the availability and quality of water for survival. The importance of water cannot be overemphasized, it includes but not limited to the following:

i. All forms of life depend on water for survival, for instance:
   a) Water energises food particles, which are able to supply the body with energy during digestion.
   b) Water increases the rate of absorption of essential substances in food.
   c) Water increases the efficiency of red blood cells in collecting oxygen in the lungs.
   d) Water carries every nutrient, mineral, vitamin, protein, hormone and chemical messenger in the body to its destination.
   e) Water is essential to the cleaning process of the body (cleanses internal organs and eliminates toxins from the bloodstream), etc.

ii. Water is an essential requirement for all agricultural, aqua-cultural and industrial activities of man. In the light of the above, we can see that water environment is needed both for the maintenance and sustenance of plant and animal (including humans) life, and the economy.

3.1.2 Land Environment

Land environment comprises of geospheric components like rocks, soils, and other associated constituents. The importance of land resource lies in the fact that it is the source of all our vital requirements such as building materials, minerals (rocks), fuels, soil, wilderness areas, etc. that are needed for living.

3.1.3 Biological Environment (Biosphere)

This consists of all aspects of living systems like micro-organisms, macro-plants, and macro- animals. The biosphere covers the biologically habited parts of the atmosphere, hydrosphere and lithosphere or geosphere. It should be noted that humans are a part of the biological environment and that there is a great diversity and uniqueness of life forms (biodiversity) inhabiting the biosphere. The biological environment is the global ecological system integrating all living beings and their interactions among

each other and between living things (especially humans) and the other components of the natural environment. But for the presence and interactive nature of living systems, the energy and material world would come to a grinding halt and our planet would lose its unique position among celestial bodies.

There are two ways in which the biological environment is linked to other components of the natural environment.

The first is the dependence of the entire biosphere on itself and other natural environment components.

The second is the impact link of the biological environment (the human activity sub-component) to itself and other components of the natural environment.

3.1.4 Biosphere and its Dependent Links to the other Spheres

For sustenance of life, the biosphere depends on itself and other spheres of the environment. Some of the ways the biological environment depends on other components of the natural environment are highlighted below:

a. **Dependence on atmosphere:** Life processes involve a vast number of chemical reactions, some of which either extract or emit gases from and to the atmosphere which acts as the store house for these gases. For instance, photosynthesis absorbs carbon dioxide from air and produces oxygen to the atmosphere. Hence the Atmospheric component of the environment should not be damaged so that both plant and animal (including human) life can continue to receive the support of the atmosphere.

b. **Dependence on hydrosphere:** The biological environment requires water to survive because water is essential for all living organisms in the biosphere and has played a key role in the evolution and sustenance of life on our planet. Water is also important in transporting soluble nutrients (phosphate and nitrate) that are needed for plant growth, and for transporting the waste products of life's chemical reactions. This means that the water environment component of the natural environment should not be overused or misused for the satisfaction of present needs since water is still needed to sustain life after our present generation.

c. **Dependence on geosphere:** The land (geosphere) and biological (biosphere) components of the natural environment are intimately connected through soil which consists of a mixture of air, mineral

matter, organic matter, and water. Indeed, soil is important for both plant and animal life. Minerals exploitation and mining activities for human survival also depends on the land. One pertinent environment issue is how to use land sustainably.

3.2 Biological Environment (Biosphere) and its Impact Links to other Spheres (Components) of the Environment

The biological environment (biosphere) is of great significance to us for two principal reasons:

(i) Humans are part of the biological environment and so should naturally be concerned about it.
(ii) Some changes that occur in the biosphere itself and in other spheres (components) of natural environment originated from human activities.

The point raised in (ii) emphasises that an important part of the subject matter of environmental economics is the study of human activity impact on all the components of the natural environment (please see the definition of environmental economics and identify the other two important aspects of environmental economics as defined). In order to impact on the four basic components of the natural environment, humans created another sphere of the environment called anthrosphere.

SELF-ASSESSMENT EXERCISE

How does biosphere and its dependent link to the other spheres?

3.3 Anthrosphere

The Anthrosphere is that part of the environment that is made or modified by humans for use in human activities. It is also called the techno-sphere. As human technology becomes more evolved, so do the impacts of human activities on the natural environment.

Below are some of the ways that the anthrosphere has impacted on other components of the natural environment:

a. **Atmosphere:** Industrial and agricultural activities have changed the composition of the atmosphere (the air environment). For example, we have increased the concentration of carbon dioxide in the atmosphere by not less than 26% and doubled the concentration of methane gas. The productions of chlorofluorocarbons are depleting

the earth's ozone layer, and our natural defense against ultraviolent radiation. Man has also affected the quality of air (e.g. smog), especially in urban areas which results in respiratory problems.

b. **Hydrosphere:** Humans have impacted the water environment by withdrawing large amounts of groundwater for agriculture and contaminating rivers, lakes, groundwater and oceans by organic and industrial wastes.

c. **Biosphere:** Humans have already altered the biological environment, of which they are a part, through economic activities. A prime example is the slash and burn agricultural practice in the tropics where rainforest is cut and burned and the land is converted to pasture. Today there is rapid loss of biodiversity.

d. **Geosphere:** Minerals and energy resources (coal, crude oil, iron, etc.) from the land environment have fueled the industrial revolution that has permitted the human species to increase so prodigiously in number. For example, the exploitation of fossil fuels has increased our standard of living but an unintended consequence of this action may be climate change and global warming.

However, the ultimate goal of environmental economics is to minimise the flux of pollutants and/or toxic substances across the interface between the astrosphere and other spheres while maintaining a functional technological society.

3.4 Social Environment

The social environment refers to the combined structure involving human to human interactions. The social structure of a human community is made up of:

a) The constraint environment which includes the physical, biological and chemical constraints to which human activity is a subject.

b) Infrastructure, defined here includes:
   i. Mode of production which deals with the technology and the practices employed in expanding or limiting production and the ensuing techno-environmental relationships.
   ii. Mode of reproduction which deals with the technology and practices employed for expanding, limiting and maintaining population size.

c) Structure which refers to relationships or bonds between group of individuals in a society and include:

i. Primary group structure. This includes family members, community, friendship networks, voluntary organisations which interact in an intimate basis and enforce socially acceptable values. The primary group can be a potent instrument in disseminating environmental education. They perform such functions as regulating reproduction, basic production, socialisation, education, and enforcing domestic discipline.

ii. Secondary group structure: This includes a small or large group of individuals whose members interact without emotional commitment to one another. They may include government, parties, factions, military and police, businesses and industries, media, non-governmental organisations, professional association, labour union, etc. These organisations are coordinated through bureaucracies. They perform many functions such as regulating production, reproduction, socialisation, education and enforcing social discipline. They are a potent source of environmental policy formulation and implementation.

iii. Superstructure is made up of the cultural superstructure (art, music, dance, literature, rituals, sports, games, science, etc.), mental superstructure (that is conscious and unconscious motives for human behavior (values, emotions, traditions). The superstructure influence the way humans interact with the environment.

4.0 CONCLUSION

In conclusion, we have been able discuss extensively on the structure of the environment; we however deduced that there are interrelationship between the anthrosphere and the social environment. It is expedient that the environment be devoid of all dangers that threatened its existence.

5.0 SUMMARY

From this units we have been able to explain and understood what air environment (atmosphere), water environment (hydrosphere), land environment (geosphere), biological environment (biosphere) are all about. The discussion on biosphere and its dependent links to other spheres,

anthrosphere and the social environment impact on the environment were explained.

6.0 TUTOR-MARKED ASSIGNMENT

1. What is the importance of the importance of atmosphere, hydrosphere, land and biosphere to the environment?
2. What do you understand by anthrosphere in environmental economics? Briefly discuss.
3. What do you understand by impact link of biological environment (biosphere) to other spheres (components) of the environment?
4. What is antrosphere?
5. The social environment has been described as combined structure involving human to human interactions. Explain.

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UNIT 3 THE HUMAN ECONOMY AND THE NATURAL ENVIRONMENT

CONTENTS

1.0 INTRODUCTION

The natural environment could be defined as physical, chemical, and biological surroundings that comprise the earth's endowment of life-support systems. It includes air, water, land (the earth's crust), living system, and even radiation from the sun. The natural environment is the supplier of all natural resources like arable land, wilderness areas, mineral fuels, nonfuel minerals, watersheds, ability of the natural environment to degrade waste and absorb ultraviolet light from the sun, etc. These resources can be regarded as natural capital from which human economy draws upon.

The human economy consists of all the production and consumption activities of human beings. Such production and consumption activities can occur on land, beneath the earth's crust, in seas, in the atmosphere and outer space. One main characteristic of the human economy is that it produces both useful commodities (goods and services) and non-useful materials called wastes. The inter-linkages between the human economy and natural environmental system cannot be overemphasized. Humans cannot exist in isolation of the natural system because all economic (even non-economic) activities of man are interconnected with the various other living and non-living endowments of nature. Similarly, the complex physical, chemical, and biotic factors of the natural system act on man and ultimately determine human form and survival. The economy depends upon natural capital and reconfigures that natural capital to produce products to satisfy human wants. One characteristics of the human economy is that it

produces intended useful product and some by-products. The by-products of an economic reconfiguration process are referred to as “waste” since the production of these by-products is not the central object of reconfiguration. The production of “waste” from any reconfiguration of natural capital is a necessary consequence of the first law of thermodynamics. The law says that matter is neither created nor destroyed in chemical reactions, although it may be transformed from one form to another. Any wastes from production and consumption activities are absorbed by the natural environment.

The ongoing reconfiguration of natural capital in the natural system means that the system also acts as a recycling process. This recycling role of the natural system means that it is possible for the economy to continually reconfigure natural capital for human purposes, and for that reconfiguration to be continually reversed through the natural system. Unfortunately, there are limits to the rate to which materials can be recycled through the natural system in this way. This is to say that the natural system has assimilative capacity. This is sometimes called a “throughput constraint”.

If human activity produces more “wastes” than can be naturally recycled, then, there is a flow of waste in excess of assimilative capacity. This can cause the natural system to change in possibly drastic and irreversible ways. It should be noted, however, that drastic and irreversible change in the natural system is not due solely to human activity. For example, volcanic eruptions produce vast quantities of pollution. The relationship between human economy and natural environment can be explained in the form of a “Material Balance Models” developed by Alen Kneeze and R.V. Ayres (1970). The material balance models are based on the first and second law of thermodynamics. These models consider the total economic process as a physical balanced flow between inputs and output.

Inputs are bestowed with physical property of energy which is received from the sun. The resulting output from inputs carries the same level of energy. Similar to this, there are wastes resulting from consumption activities. Materials and energy are drawn from the environment, which are used for production and consumption activities and returned to environment as waste. So far as this balance is maintained, there are no environmental issues. The material balance model of the economy is given in Figure 2.

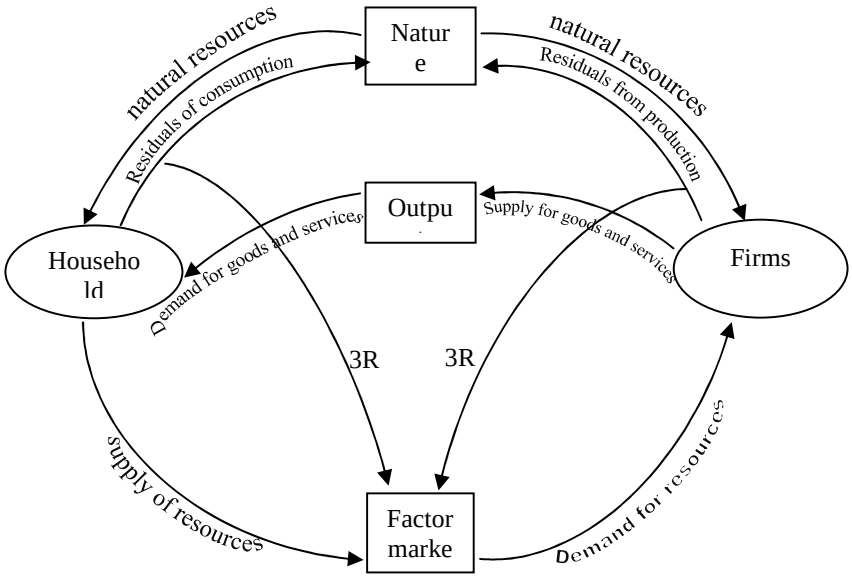

Fig. 1: The Material Balance Model: Independence of Economics and Environment

Figure 1 shows that environment is the supplier of all forms of resources like renewable and non-renewable, and it is also acting as a sinking for cleaning up of waste. Households and firms are connected to environment, and they are connected too. Households and firms depend on the nature of resources. Both households and firms send out residual consumption and production respectively to nature. As mentioned earlier, nature has the power to assimilate all forms of waste. But this power is conditional. So long as earth is not being overwhelmed by the excess amount of waste, the earth can clean up natural waste. When the earth fails to respond to 3Rs, the symptoms of environmental damage appears. Thus, there is a rhythm in the use and reuse of resources for men by men: earth cannot respond properly to man-made or artificial waste. Man-made wastes are piling up around us, and therefore, the extent of damage to the environment has been on the rise. All the waste that has been sent out cannot be cleaned up by the sink earth. As long as the earth can discharge this function of cleaning up of pollution due to waste, there would not be any environmental issue. But earth has reached the saturation point of this process, and it is helpless in cleaning up of several types of wastes resulting in major environmental issues in the world over.

The impact of the transformation of material inputs and energy into output is subject to several changes in the biosphere. The process of

transformation is better explained with the help of the laws of thermodynamics. The first two laws of thermodynamics are worth mentioning in the context. The first law of thermodynamics, which is often referred to as the law of conservation of matter and energy says that energy, like matter, can neither be created nor destroyed, but at the same time the forms of energy can be transformed. The law stresses that the total amount of energy created through production and consumption activities must be equal to the total sum of initial energy extracted from the nature. Therefore, the first law of thermodynamics implies the accounting identities of material balance model.

The second law of thermodynamics is known as the law of entropy. Entropy is usually considered as the measure of unavailability of the benefits of energy or simply wastes. When one form of energy is transformed into another (say for example, when the thermal energy of coal is converted into electrical energy) there is waste of energy, and the volume of waste depends upon the technological process. Entropy will be low, when materials and energy are highly structured and organised. When a piece of coal is kept idle, there is low entropy, but when it is burnt up, the same piece of coal is subject to high entropy since heat and carbon dioxide are dissipated, but sometimes unavailable for use. Thus, the second law says that as long as there is utilisation of material inputs and energy for production and consumption activities, the level of entropy will be high. Economic activity helps to convert low entropy resources and energy into high entropy waste; that is, resources into wastes. Economic activities cannot be stopped on account of high entropy, but at the same time, through recycling and waste management, it is possible to bring into the economic system, low entropy value. The use of natural resources, with minimal waste or damage to the environment is considered as the key theme of sustainable development. It is a form of development path that is ready to meet the needs (not greed) of the present generation, at the same time without compromising the needs of posterity. A detailed discussion of sustainable development is included as a separate chapter of this course module.

The environment discharges the following economic functions:

a) The environment is the supplier of all forms of resources.
b) The wastes are cleaned up by the environment.
c) The environment maintains genetic diversity and stabilises the ecosystem.

The above mentioned functions of the environment are interlinked. In the name of economic activity, the environmental resources are transformed into economic goods (converting low entropy resources into high entropy ones). In this process of transformation, wastes are created. Resources are also getting depleted due to the overuse. When the environment is disturbed by the overuse and the huge amount of wastes, it cannot discharge the third function that is, maintaining genetic diversity and stabilisation of ecosystems. It further affects the life and existence of flora and fauna. Therefore an integrated approach to the study of economy, ecology, and environment is essential, as all these are closely interlinked in the concept of the ecosystem.

2.0 OBJECTIVES

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

- discuss the neo-classical perspective of the human economy and the natural environment
- analyse the economic perspective of the natural environment and the human economy.

3.0 MAIN CONTENT

3.1 The Neoclassical Perspective of the Human Economy and Natural Environment

The mainstream Economists have a particular conception of the natural environment, including how it should be managed. The conception emanate from the classical and neoclassical dominant approach to economic analysis since about 1870s. The neoclassical worldview of environmental economic relationship is anthropocentric. This means that the humans are treated on pre-eminence in the natural environment. Consequently, the human economy is rated above natural environment and humans are regarded as the universe's most important entity. The natural environment therefore exists to serve the human economy and environmental resources have no intrinsic value.

Sequel to this worldview, the economy is assumed to depend on the environment for three distinctive purposes (See Figure 2):

a) the extraction of nonrenewable resources (such as iron ore, fossil fuels, etc.) and the harvest of renewable resources (such as fish of

various species, agricultural products, forest products, etc.) to be used as factors of production; (Arrow 1)

b) the disposal and assimilation of wastes; (Arrow 2) and

c) the consumption of environmental amenities (such as bird watching, canoeing, hiking, national park trails, observing a morning sunrise or an evening sunset, etc.) (Arrow 3).

Thus, broadly viewed, the economy is assumed to be completely dependent on the natural environment for raw materials, the disposal of waste material and amenities.

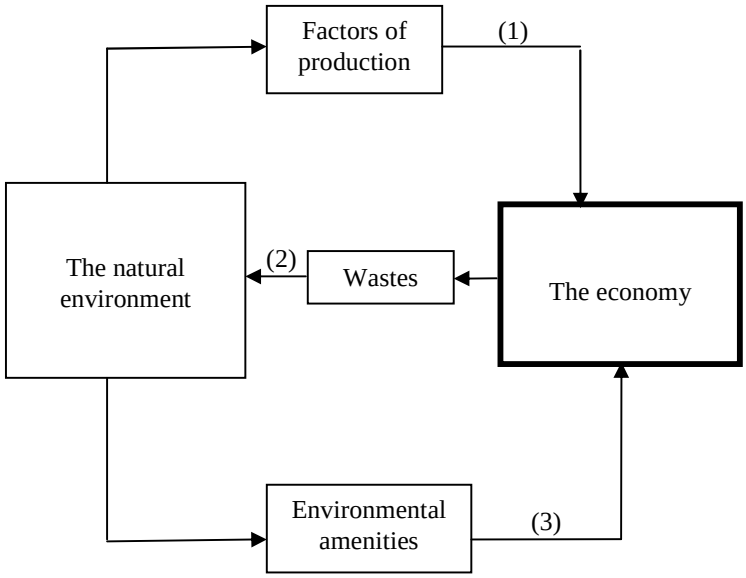

Fig. 2: A Schematic View of How the Human Economy Depends on theNatural Environment for Factors of Production, Disposal of Waste and Consumption of Amenities

Furthermore, since the earth is 'finite' there exists a theoretical upper limit for resource extraction, harvest and disposal of waste into the natural environment. The qualities of environmental amenities and the maintenance of life support systems (such as climate regulation and genetic diversity) are also affected adversely in direct proportion to the amount of resource extractions and/or harvesting and the disposal or discharge of waste into the natural environment. Thus, as with any other branch of economics, fundamental to the study of environmental economics is the problem of scarcity—the trade-off between economic goods and the preservation of environmental quality. There are some fundamental assumptions that the standard economics approach is used in addressing this subject matter; these are outlined below.

- Environmental (natural) resources are 'essential' factors of production. A certain minimum amount of natural resources is needed to produce goods and services.
- Environmental resources are of economic concern to the extent that they are scarce.
- The economic value of natural resources (including the service of natural ecosystems) is determined by consumers' preferences, and these preferences are best expressed by a freely operating private market system.
- Market price can be used as a measure (indicator) of resource scarcity, including the environment.
- In both the production and the consumption sectors of an economy, a specific natural resources can always be replaced (partially or fully) by the use of other resources that are either man-made (manufactured) or natural.
- Technological advances continually augment the scarcity of natural resources.
- Nothing is lost in treating the human economy in isolation from the natural ecosystems-the physical, chemical and biological surroundings that humans and other living species depend on as a life support. That is, the natural ecosystem is treated as being outside the human economy and exogenously determined. Note that to indicate this, in Figure 2 the human economy and the natural environment are drawn as two distinctly separate entities.

Clearly, from the above discussions, it should be evident that, at the fundamental level, central to the neoclassical economics worldview with respect to the natural environment and its role in the economic process are the following four key issues:

i. the market as a provider of information about resource scarcity
ii. resource (factor) substitution
iii. scarcity augmenting technological advance; and
iv. the nature of relationships between the human economy and the natural environment.

The rest of this chapter will address these four issues one at a time.

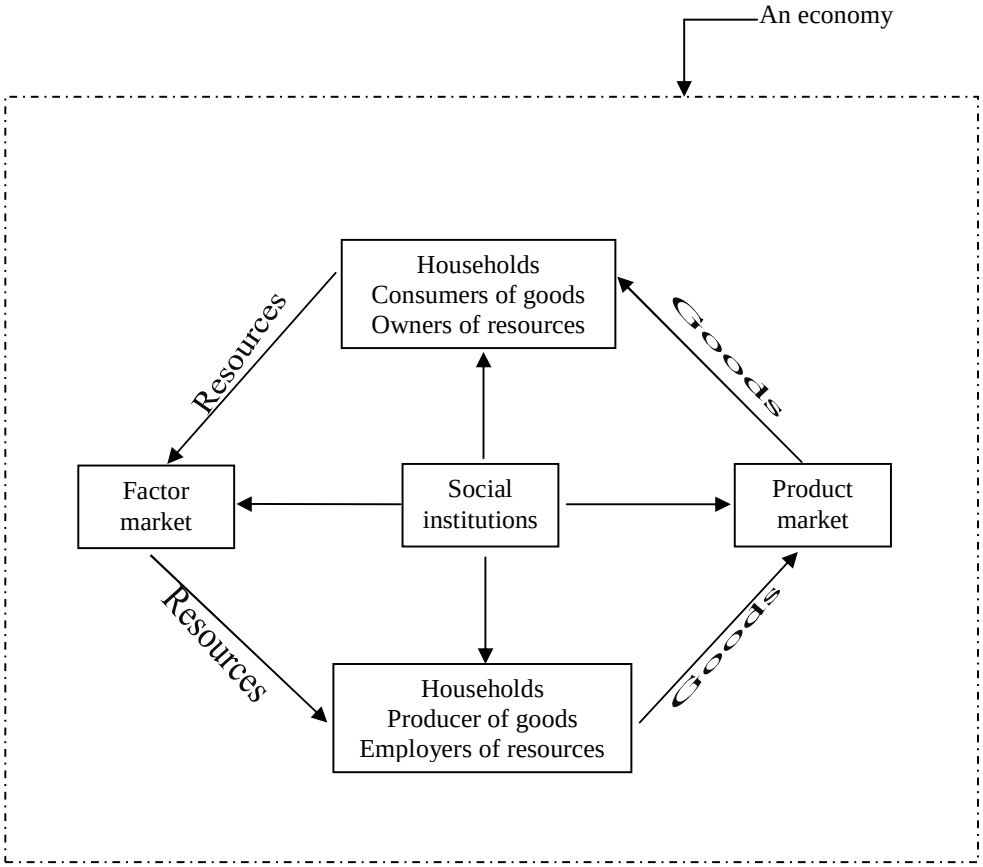

Fig. 4: Circular flow diagram of the economic process. An economy is composed of a flow of *commodities* (in the form of basic resources, goods and services): *social institutions* (primary markets and legal tenders); and *people* (broadly identified as households firms).

According to the neoclassical worldview, the human economy, as depicted in the above diagram (Fig. 4) is composed of people, flows of commodities (or flows of matter-energy at the fundamental level) and human institutions. The primary focus of the human economic system is not so much on the conversion of matter-energy that are found in nature to goods and services (i.e the production process) but generation of utility – an immaterial flux of satisfaction to humans. In this worldview, it appears that the link between the flow of matter-energy in the economic system and the natural environment is very much ignored.

SELF-ASSESSMENT EXERCISE

How does the environment discharge economic functions?

3.2 An Ecological Perspective of the Natural Environment and the Human Economy

The ecological perspective of the relationship between the natural environment and the human economy is biocentric; this implies that the human economy is not viewed in isolation from the natural ecosystems. The basic objective of the ecological perspective is therefore to establish a clear understanding of the basic principles governing the nature, structure and functions of the biosphere (and by extension, environmental resources) and the functional relationship between the biosphere and the human economy.

From a purely ecological perspective, these basic principles and linkages are identified as follows:

- Environmental resources of the biosphere are finite. Hence, environmental resources are scarce in absolute terms.
- In nature, everything is related to everything else. Moreover, survival of the biosphere requires recognition of the mutual interdependencies among all the elements that constitute the biosphere.
- At a functional level and from a purely physical viewpoint, the biosphere is characterised by a continuous transformation of matter and energy. Furthermore, the transformation of matter and energy are governed by some immutable natural laws.
- Material recycling is essential for the growth and revitalisation of all the subsystems of the biosphere, including the human economy subsystem.
- Nothing remains constant in nature. Furthermore, changes in ecosystems do not appear to occur in an absolutely linear and predictable manner. However, measured on a geological time scale, the natural tendency of an ecological community (species of plants, animals and micro-organisms living together) is to progress from simple and unstable relationships (pioneer stage) to a more stable, resilient, diverse, and complex community.
- The human economy is a subsystem of biosphere and it would be dangerously misleading to view natural resources as just factors of production lying outside the confines of the larger system.
- The natural tendency of human technology is towards the simplification of the natural system, eventually leading towards less stable, less resilient and less diverse ecological communities.

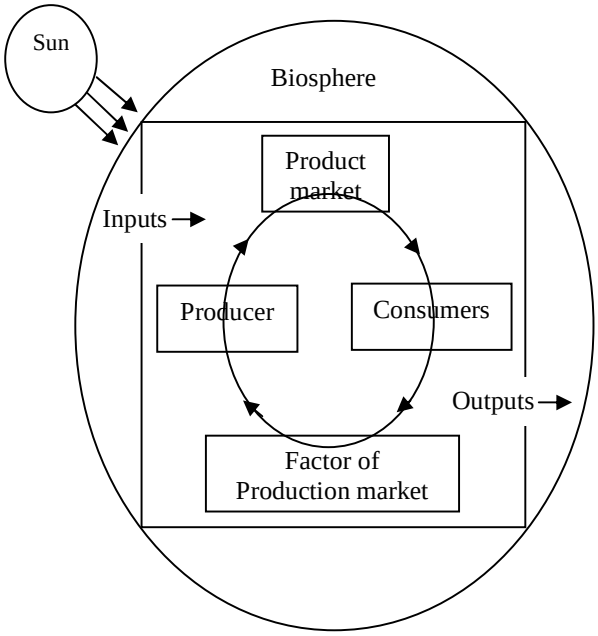

Fig. 5:Ecologically enlightened economic view. The biosphereis continuously energized by solar power. The human economy (comprising the activities in the inner circle) depends on inputs (throughout) and outputs (disposal of waste) to the biosphere. The biosphere is finite, as indicated by the outer circle

Figure 5 attempts to portray a worldview that is consistent with these principles, and more specifically the ecological (biocentric) perspective of the relationship between the biosphere and the human economy. This perspective is biocentric in the sense that it does not explicitly recognise the main output of the economic system – non-material laws of utility (enjoyment). It describes nature and the interactions that occur in nature between living and non-living matter in purely physical (energy and matter) terms.

These features are clearly evident in the following specific aspects of figure 4.

Firstly, a clearly demarcated circle, perhaps symbolising the earth and its finiteness, represents the biosphere. Secondly, by locating it inside the circle, the human economy is perceived as a subsystem of biosphere. The box inside the circle indicates that growth of the economic subsystem is ‘bounded’ by a non-growing and finite ecological sphere.

Thirdly, Figure 4 suggests that the human economy is dependent on the biosphere for its continuous withdrawal (extraction and harvest) of material

inputs and as a repository for its waste (outputs)-degraded matter and energy that are the eventual byproducts of the economic process. Fourthly, the biosphere (and hence the human economy) requires a continuous flow of external energy from the sun. Fifthly, while both the human economy and the biosphere are regarded as an "open system" with regard to energy (i.e. both systems require an external source of energy), the biosphere taken in its entirety is regarded as a "closed system" with respect to matter. Note that this is in stark contrast to the way the human economy is depicted in figure 2 – the circular-flow diagram discussed in unit three diagram actually treats the human economy as an 'open system' with regards to both energy and matter. That is, the human economy is continuously dependent on external (outside) sources for input of energy and matter and on external repositories for its outputs.

An ecological worldview as represented in Figure 4 appears to incorporate the principle that the human economy is completely and unambiguously dependend on natural ecological systems for its material needs. Furthermore, the human economy (as a subsystem) cannot outgrow the biosphere. The implication of this, is that, as mentioned earlier, the growth of the economic subsystem is 'bounded' by a non-growing and finite ecological sphere. A comprehensive and systematic understanding of the extent to which nature acts as both a source of and a limiting factor on the basic material requirements for the human economy therefore, demands some level of understanding of ecology.
Ecology is a branch of science that systematically studies the relationships between living organisms and the physical and chemical environment in which they live.

4.0 CONCLUSION

At the end of this unit, we have been able to discuss extensively on the neo-classical perspective of the human economy and the natural environment; an economic perspective of the natural environment and the human economy. However, discussion on the comprehensive and systematic understanding of the extent to which nature acts as both a source of and a limiting factor on the basic material requirements for the human economy were harnessed. This therefore, demands some level of understanding of ecology.

5.0 SUMMARY

We have been able to explain the impact of neo-classical perspective of the human economy and the natural environment; we also went further to make

explicit the economic perspective of the natural environment and the human economy. Clearly, from the our discussions, it is evident that, at the fundamental level, central to the neoclassical economics worldview with respect to the natural environment and its role in the economic process, we have the following four key issues: (i) the market as a provider of information about resource scarcity; ii. resource (factor) substitution; iii. scarcity augmenting technological advance; and iv. the nature of relationships between the human economy and the natural environment.

6.0 TUTOR-MARKED ASSIGNMENT

1. The environment is the supplier of all forms of resources. Discuss.
2. Draw a schematic view of how the human economy depends on the natural environment for factors of production, disposal of waste and consumption of amenities.

7.0 REFERENCES/FURTHER READING

Ahmed, M. Hussen (2000). Principles of Environmental Economics, Ecology and Public Policy. New York: Routledge.

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MODULE 2

Unit 1 Scarcity and Resources
Unit 2 The Concept of Demand, Supply and Market Equilibrium

UNIT 1 SCARCITY AND RESOURCES

CONTENTS

1.0 INTRODUCTION

In this module we shall be concerned with five concepts in microeconomic theory that aid our understanding of some of the issues in environmental economics. Such concepts will be considered and these are the concepts of scarcity, resources, demand and supply, market, market failure, externality and property right.

2.0 OBJECTIVES

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

- explain the concept of scarcity
- discuss the economic implication of scarcity
- analyse the operation of a market-oriented economy
- discuss the concept of resources with traditional economics classification of resources and economic assumptions about resources.

3.0 MAIN CONTENT

3.1 The Concept of Scarcity

Definition: A scarce resource is one which, when offered to people at no cost, more would be wanted (demanded) than is available (supplied). Notice that the opposite of a scarce resource is a free resource. At no price, the quantity supplied of a free good for instance exceeds the quantity demanded leading to a surplus. The definition of scarcity above is further explained graphically as shown in Figure 6 below.

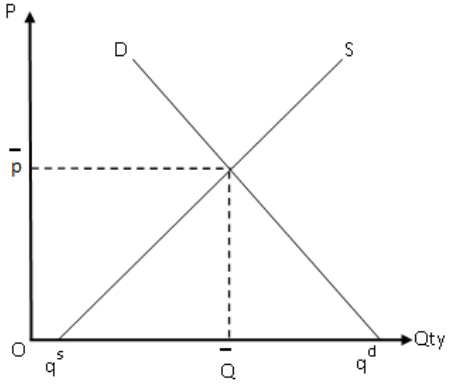

Fig. 6: Demand and Supply and Market Clearing (Equilibrium) Price for a Scarce Resource

Notice that at zero price (on the price axis, zero price coincides with the origin), quantity demanded is q^d and quantity supplied is q^s. Notice further that q^d far exceeds q^s, creating a shortage or scarcity.

On the other hand, at zero price, the quantity demanded of a free good is smaller than the quantity supplied, creating a surplus. Consider oxygen which is freely supplied by nature, the availability of oxygen from the ambient air (supply) far exceeds the quantity demanded in a non-polluted environment. Thus, the oxygen may be treated as a free good.

The demand and supply analysis for a free good is demonstrated in Figure 7 below.

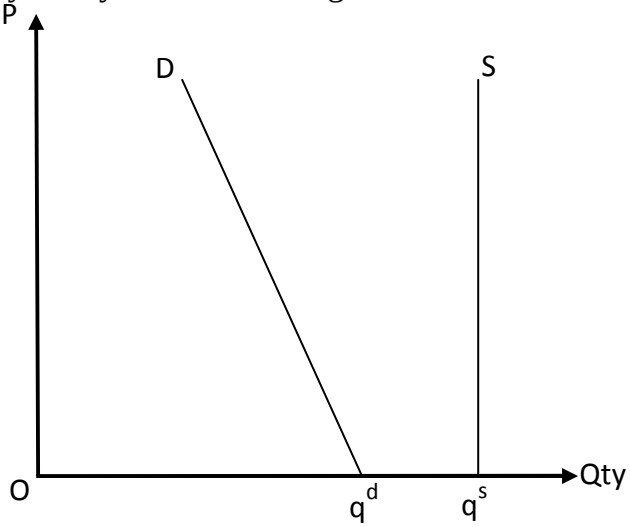

Fig. 7: Demand and Supply Analysis for a Free Good

Notice that at zero price (point on the origin), the quantity supplied far exceeds the quantity demanded as q^s is greater than q^d, counting from the origin.

In economics, the situation of scarcity arises when there is less of an economic good, service or resource than people would like to have if it were free. Scarcity reflects the fact that there are not sufficient resources (inputs) to produce everything that individuals want.

It should be noted however that in the absence of scarcity, no difficult choices would need to be made and hence no opportunity or real cost and no prices would need to be attached to anything, else the study of economics would be rendered entirely unnecessary. Furthermore, as the economist uses the concept, scarcity is present in all societies whether rich or poor in as much as there is a gap between resource need and resource availability.

3.2 Economic Implication of Scarcity

Considering that human wants for goods and services are immense and, worse yet, insatiable in a world of scarcity, what can be done to maximise the set goods and services that people of a given society can have at a point in time? This question clearly suggests that the significant economic problem involves rationing limited resources to satisfy human wants and, accordingly, has the following four implications:

- **Choice -** the most implication of scarcity is the need to make a choice from various alternatives available. That is, in a world of scarcity, we cannot attain the satisfaction of all our material needs completely. Hence, we need to make choices and set priorities.
- **Opportunity cost -** every choice we make has a cost associated to it; one cannot get more of something without giving up something else. In other words, an economic choice always entails sacrifice or opportunity cost- the highest-valued alternative that must be satisfied to attain something or satisfy a want. In a world of scarcity, "there is no such thing as a free lunch."
- **Efficiency –** in the presence of scarcity, no individual or society can afford to be wasteful or inefficient. The objective is, therefore, to maximise the desired goods and services that can be obtained from a given set of resources. This state of affair is attained when resources are fully utilised (full employment) and used for what they are best suited in terms of production (i.e., there is no misallocation of resources). Furthermore, efficiency

implies that the best available technology is being used (McConnell and Bruce, 1996).

- **Social Institutions-** as noted earlier, the essence of scarcity lies in the fact that people's desire or goods and services exceeds society's ability to produce them at a point in time. In the presence of scarcity, therefore, the allocation and distribution of resources always cause conflicts. To resolve these conflicts in a systematic fashion, some kind of institutional mechanism(s) need to be established.

For example, in many parts of the contemporary world, the market system is used as the primary means of rationing scarce resources. To serve as a rationing devise, the rationing devise for resource allocation and distribution may be based on either

(a) the market system, or
(b) the central (government) distribution system.

In the market system, price which is determined by the market forces of demand and supply serves as the rationing instrument. However, rationing through government intervention uses various non-price factors as rationing instruments.

3.3 Operation of a Market-Oriented Economy

In many parts of the contemporary world, the market system is used as the primary means of rationing scarce resources. The diagram below (Figure 8) is designed to show that the operation of a market-oriented economy is composed of the following elements, namely: economic entities (households and firms), markets and non-market public and private institutions.

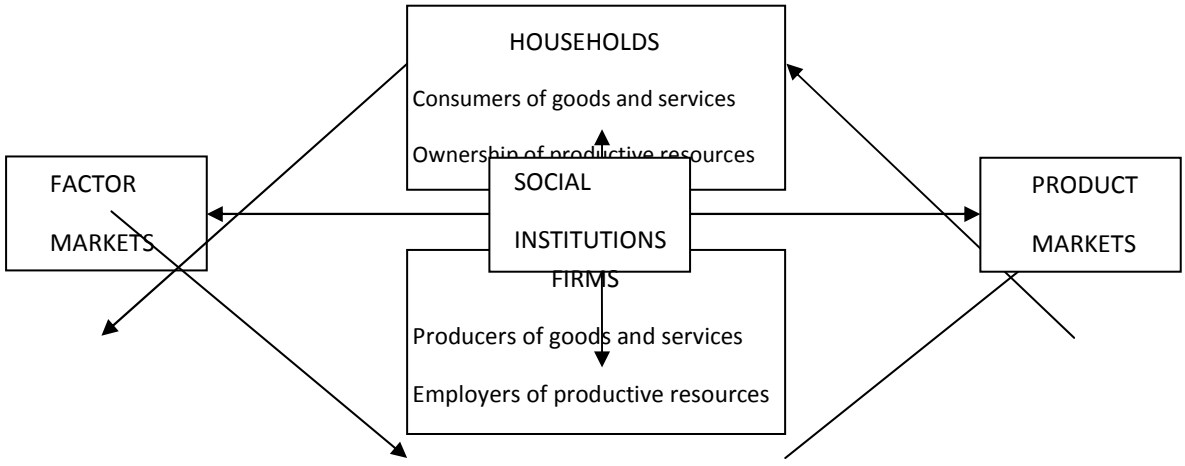

Fig. 8: Circular Flow Diagram of the Economic Process

These elements are discussed below:

- **Economic Entities (households and firms):** Households are the final users and owners of resources of goods and services. In a market economy, given the resource scarcity, the primary objective is to find effective ways to address the material needs of consumers (households). At least in principle, consumers' well-being is the primary aim of a market-oriented economy. Although households are final users of goods and services, firms enter the economic process as transformers of basic resources (labour, capital and natural resources) into goods and services, and this is done on the basis of consumers' preferences (demand).
- **Markets:** Markets represent an institutional arena in which exchanges (buying and selling) of final goods and services and factors of production (labour, capital and natural resources) take place. Traditionally, the economists classify markets into two broad categories,
  Namely; product and factor markets. The product market is where the exchange of final goods and services occurs. In this market, demand and supply provide information about households and firms, respectively. The factor market refers exclusively to the buying and selling of basic resources, such as labour, capital and natural resources. In this sub-market, demand imparts market information about firms and supply provides information about households. That is, households are the supplier of labour, capital and natural resources, while firms are the buyers, and in-turn uses these items to produce final goods and services for the product market. Clearly, then, the roles played in the factor market by households and firms respectively are the reverse of their roles in the product market.

In both the product and the factor markets, information about resource scarcity is transmitted through prices. These prices are formed through the interactions of market demand and supply; and, under certain conditions, market prices can be used as reliable indicators of both present and future resource scarcities. Furthermore, using prices from the product market, economists customarily measure aggregate economic performance of a given economy or a country by the total market value of all the goods and services produced for final use within a given period, usually a year. This is called Gross Domestic Product (GDP) when the total market value of the final goods and services produced is attributable to factors of production (labour, capital and natural resources) originating exclusively from a given country (more on this in the next section).

- **Nonmarket Public and Private Institutions.** A market does not function in a vacuum; that is, for a market to operate efficiently, ownership rights need to be clearly defined and enforced. This requires the establishment of public agencies designed to articulate and enforce the rules and regulation by which ownership rights are attained, relinquished (transferred) and enforced. In addition, competition in the market place is fostered through public intervention in some instances. The public and private entities (social institutions) that legislate the rules for assigning resource ownership rights and regulate the degree of competition in the marketplace are represented by the box at the center of figure 1. On one view, what flows from this box to households, firms and markets is not physical goods but information services. In general, the main function of these flows of information is to ensure that economic agents (households and firms) are playing by some socially pre-determined rules of the game. In this regard, ideally, social institutions are perceived as being rather like a conductor of a symphony orchestra or a traffic director at a busy intersection.

Viewed this way, social institutions have important economic functions. However, they should not be assumed to be either perfect or costless (North, 1995). When they are functioning well, the information communicated through them can distort market signals (prices) and in so doing, will significantly affect the allocation of scarce resources.

3.4 The Concept of Resources

In broad terms, resources can be defined as anything that is directly or indirectly capable of satisfying human wants. Resources can be classified from two perspectives which are;

i. traditional economics resource classification and,
ii. environmental economics resource classification.

3.4.1 Traditional Economics Classification of Resources

Traditionally, the economic notion of resources classifies resources into three broad categories: land, labour and capital.

Land: This refers broadly to natural resources which are the stock of living and non-living materials found in the physical environment, and which have an identifiable potential use to human beings. It should be noted that land is a very inadequate expression for what in a wider context amounts to the natural resources base. This is because it could be misunderstood as a place to build factories, cities and physical infrastructures like hospitals, schools, etc. By understanding land to mean all non-man made natural resources, the idea of what is in, on and over the land as included becomes clearer. Thus, in environmental

economics, it is better to say "natural resources" rather than simply "land". Agricultural land, deposits of ferrous and non-ferrous minerals, water, fisheries, and other aquatic life, wilderness and its multiple products are examples of material resources.

Labour: Labour encompasses the productive capacity of physical and/or mental efforts of human, measured in terms of ability to work or produce goods and services. Entrepreneurship is often included under labour.

Capital: This refers to a class of resources that are man-made for the purpose of creating a more efficient production process. In other words, capital is the stock of produced items available not for direct consumption, but for further production process. Examples include all sorts of machineries.

3.4.2. Economic Assumptions about Resources

Assumption 1: Resources are Factors of Production

It is rare that basic resources of labour, capital and natural resources are used for their direct consumption without modifications. Hence, resources are viewed in economics as a means to produce final goods and services that are capable of directly satisfying human wants. This is to say that basic resources are a means to an end and not end in themselves.

Assumption 2: Resources have no Intrinsic Value

Related to assumption 1 above is the notion that the economic value of resources is strictly anthropocentric. This implies that the economic value of any resource is defined by human needs and nothing else. This idea treat humans as preeminent as all other resources are deemed to exist for human economy and not for themselves. Non-economic values of resources are not considered. This has important consequences for the conservation of biodiversity.

Assumption 3: Only Scarce Resources are of Economic Concern

In economic analysis, each of the above resource categories is of economic concern to the extent that they are scarce, i.e. found in limited quantities and/or qualities. Any resources that are not limited in supply are not of economic concern.

Assumption 4: Resources are used in Combination

This means that to produce a good or service require that various forms of resources are combined together to effect transformation into the required good or service. For instance, producing bricks for building requires a combination of sand, water, human skill, cement, block-making machine, shovel, etc, in certain proportions. Resource combination and substitutability can be depicted by the following table. For simplicity, we assume there are just two resources, labour and capital to produce a given level of output.See Figure 9.

Table 1: Resource Combination and Substitutability of Labour and Capital

Quantity of Output	Quantity of Labour	Quantity of Capital
10	10	30
10	15	25
10	35	10

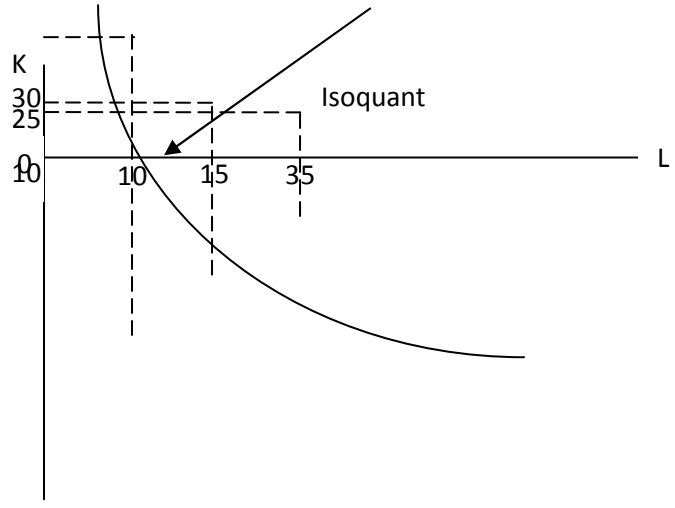

Fig. 9: Isoquant Depicting Different Combination of Labour and Capital

Assumption 5: Resources are fungible

This implies that resources are substitutable. That is, one kind of resources (such as machine) can be replaced by another (such as labour) in the production process; or one type of energy resources (e.g.

petroleum) can be replaced by another form of energy (such as natural gas). Fungibility implies that no particular resource is considered to be absolutely essential for production of goods and services. It should be noted however that fungibility does not in any way suggest an escape from general problem of resource scarcity because there is the extent to which resources substitution can occur in production.

Resources can also be classified according to whether they are replenishable or not. Thus, we have the following categories:

- **Renewable resources:** Resources are said to be renewable if they are replaced by natural processes at a rate comparable or faster than their rate of consumption by humans. In other words, renewable resources have a natural rate of replenishment sufficient to augment the stock. Thus, renewable resources naturally regenerate over time; e.g. fish, trees, wildlife, grazing lands. The environmental economic issues revolve round the consideration of the impact of a renewable resource use (extraction or harvest) on the rate of replenishment. If too much is harvested, the rate of replenishment may not be sufficient to leave enough resources for the future. If too little is harvested, opportunities for gains are lost. The harvest decision involves a comparison of marginal benefit with marginal cost.

This can be represented as follows

If $MB_{harvest} > MC_{harvest,}$ more harvest is justified, otherwise (If $MB_{harvest} < MC_{harvest}$) further harvest is not advised.

- **Non-renewable resources**: These are resources for which there is no replenishment or the rate of growth is so slow as to be imperceptible in human life span. Thus, for non-renewable resource, the natural rate of replenishment is negligible in terms of augmenting the stock of the resource. Examples include oil, gas, uranium, aluminum, etc. The three stages of non-renewable resource use to be considered in economics are exploration, development and extraction. The exploration, development or extraction decision also involves a comparison of the marginal benefit to marginal cost.

4.0 CONCLUSION

In this unit, we have been able to explain the concept of scarcity, understand the economic implication of scarcity, analyse the operation of a market-oriented economy, know and understand the concept of resources with traditional economics classification of resources and economic assumptions about resources.

5.0 SUMMARY

A scarce resource is one which, when offered to people at no cost, more would be wanted (demanded) than is available (supplied). Understand that the opposite of a scarce resource is a free resource. At no price, the quantity supplied of a free good for instance exceeds the quantity demanded leading to a surplus. It should be noted however that in the absence of scarcity, no difficult choices would need to be made and hence no opportunity or real cost and no prices would need to be attached to anything, else the study of economics would be rendered entirely unnecessary. Furthermore, as the economist uses the concept, scarcity is present in all societies whether rich or poor in as much as there is a gap between resource need and resource availability.

6.0 TUTOR-MARKED ASSIGNMENT

1. What do you understand by the concept of scarcity? Discuss.
2. What are the economic implications of scarcity? Briefly explain.
3. List free traditional economics classification of resources. Briefly explain any two of them.
4. Scarce resources are said to be of economic concern as one of the assumptions of economic resources. Briefly explain.

7.0 REFERENCES/FURTHER READING

Ahmed, M. Hussen (2000). Principles of Environmental Economics, Ecology and Public Policy. New York: Routledge.

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UNIT 2 THE CONCEPTS OF DEMAND, SUPPLY AND MARKET EQUILIBRIUM

CONTENTS

1.0 INTRODUCTION

In a market oriented economy, the majority of price and output decisions are determined in the market through the market forces of demand and supply. The concept of demand and supply remains the most fundamental in economic analysis and constitute the backbone of a market economy.

2.0 OBJECTIVES

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

- explain what demand and demand schedule is all about
- analyse the demand curve
- state how the law of demand is applied to quantity of demand for goods and services
- explain the law of demand and how changes are determinant factors in the quantity of demand for goods and services.

3.0 MAIN CONTENT

In this unit we shall be discussing all that pertains to demand as it relates to goods and services.

3.1 Demand: Demand is the quantity of a commodity a buyer wishes to purchase at each conceivable price.

3.1.1 Demand Schedule: is a table showing how much of a given commodity a buyer would be willing to buy at different prices.

The table below illustrates a demand schedule.

Table 2: Demand Schedule

Price	Qty
5	35
4	45
3	60
2	80
1	110

3.1.2 The Demand Curve: is a graph illustrating how much of a given commodity buyers would buy at different prices. Demand curves are usually derived from a demand schedule. Using the demand schedule above, we can obtain a demand curve by plotting the values of prices (vertical axis) against the values of quantity bought (horizontal axis) to obtain the downward sloping demand curve (Figure 10).

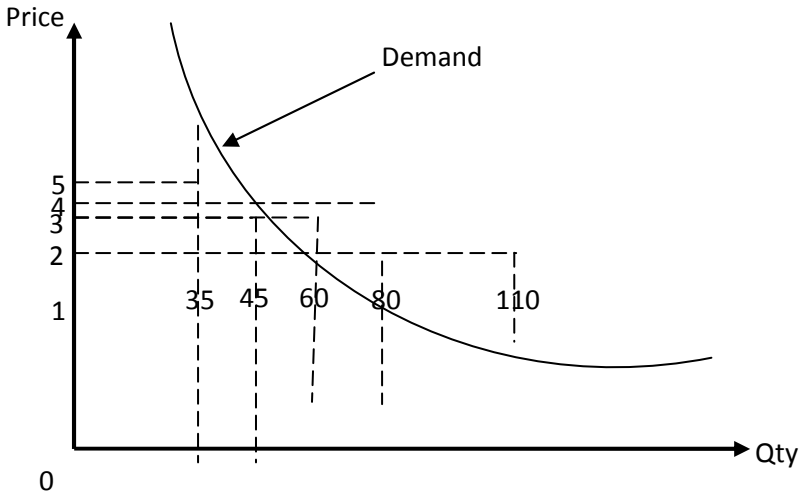

Fig. 10: Demand Curve

3.1.3 The Law of Demand: The law of demand states that other things being equal, as price increases, the quantity demanded of a commodity decreases. The law is saying that there is a negative or inverse relationship between price and quantity demanded of a commodity. This law is also illustrated by the downward sloping nature of the demand curve.

3.1.4 Explanation of the Law of Demand: The three reasons provided to explain the downward slopping nature of the demand curve.

a. **Diminishing marginal utility**: Utility is satisfaction derived from the consumption of a commodity. Marginal utility is the satisfaction derived from the consumption of one more extra unit of the commodity. The law of demand can be explained by diminishing marginal utility. The explanation is this: the decrease in added satisfaction as one consumes additional units causes one to consume more units in order to get the same level of satisfaction.

b. **Income effect:** A lower price increases the purchasing power of money income, enabling the consumer to buy more at lower prices without having to reduce demand for other goods. Conversely, a higher price reduces the purchasing power of money income, making the consumer to buy less at higher prices.

c. **Substitution effect:** A lower price induces the consumer to buy more of the good with the lower price and less of the relatively high-priced substitutes.

3.1.5 Market Demand Schedule: Demand for a good or service can be defined for an individual household, or for a group of households that make up the demand side of the market. Market demand is the sum of individually demanded quantities at the various prices. The table below illustrates the derivation of a market demand schedule assuming there are two households or individual in the market.

Table 3: Market Demand Schedule

Price	**Quantity Demanded by Household 1 (A)**	**Quantity Demanded by Household 2 (B)**	**Market Demand 1(A) + 2(B)**
3	40	60	100
4	30	40	70

The transition from individual demand curve to a market demand curve is similarly done as shown in Figure 11.

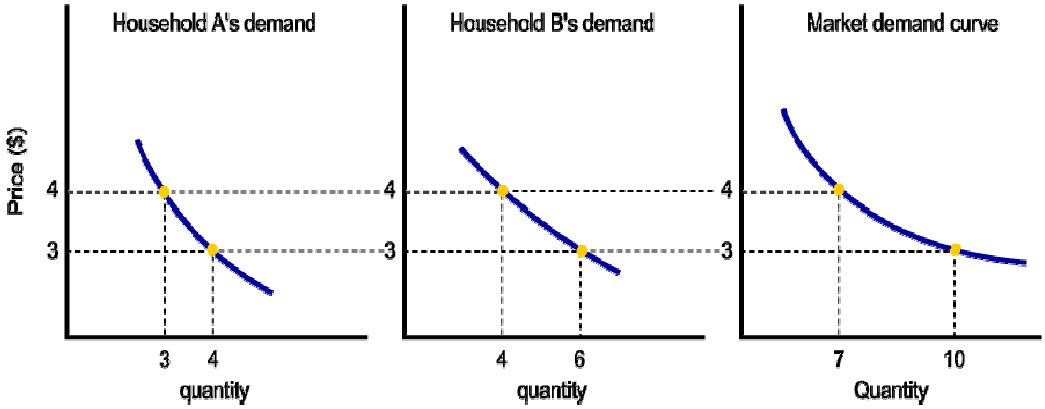

Fig. 11: Market Demand Curve

3.1.6 Other Determinants of Demand

a. **Tastes** – favourable changes lead to increase in demand; unfavourable changes lead to decrease in demand.
b. **Number of buyers** – more buyers lead to an increase in demand; fewer buyers lead to a decrease in demand.
c. **Income** – more income lead to an increase in demand; less income leads to decrease in demand for normal goods. (The rare case of goods whose demand varies inversely with income is called inferior goods).

d. Prices of related goods also affect demand

i. Substitute goods (those that can be used in place of each other): The price of the substitute good and demand for the other goods are directly related. If the price of Coke rises (because of a supply decrease), demand for Pepsi should increase.

ii. Complementary goods (those that are used together like tennis ball and rackets). When goods are complementary, there is an inverse relationship between the price of one and the demand for the other.
e. **Consumer expectations** – consumer view about future prices and income can shift demand.

SELF-ASSESSMENT EXERCISE

1. What is demand?
2. What is the law of demand? Explain briefly how it affects demand for quantity of goods and services.

3.2 Change in Demand

This means a shift of the entire demand curve to the right or to the left of the initial demand curve. A shift of the demand curve to the right indicates an increase in demand while a shift to the left implied a decrease in demand as a result of changes in the determinants of demand expected price. Figures 12 and 13 illustrate these two possibilities.

(i) Increase in demand

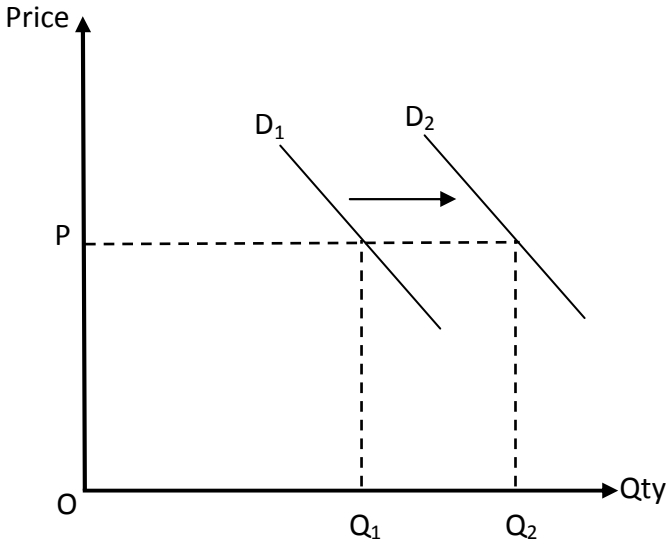

Fig. 12: Increase in Demand (Outward Shift of Demand Curve)

Notice that at the same price (p), a forward shifts in demand from D1 to D2 causes the quantity demanded to increase from Q1 to Q2 even when price remains constant.

(ii) The following is a summary of what can cause an increase in demand:

a) Favourable change in consumer tastes.
b) Increase in the number of buyers.
c) Rising income if product is a normal good.
d) Falling incomes if product is an inferior good.
e) Increase in the price of a substitute good.
f) Decrease in the price of a complementary good.
g) Consumers expect higher prices or incomes in the future.

a. (i) Decrease in demand

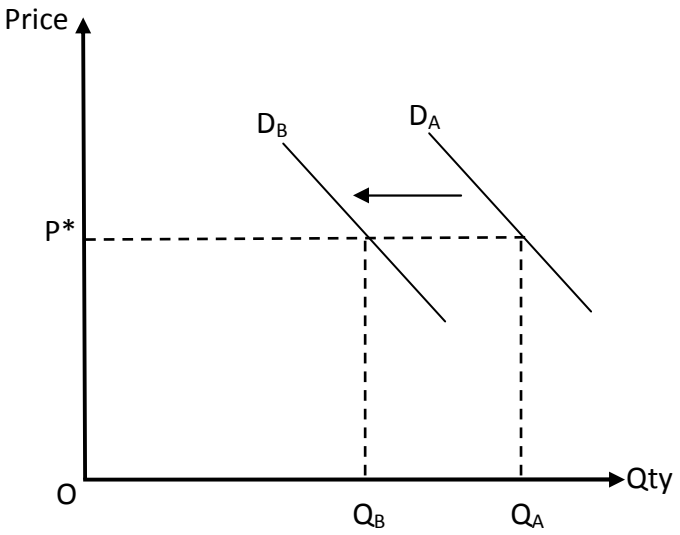

Fig. 13: Decrease in Demand (Inward Shift of Demand Curve)

Notice that with decrease in demand, lower quantity that is demanded at the same price P*, as demand shifts backwards from DA to DB.

(ii) The following is a summary of what can cause a decrease in demand. This is presented below:

a) Unfavourable change in consumer tastes.
b) Decrease in the number of buyers.
c) Falling income if product is a normal good.
d) Rising incomes if product is an inferior good.
e) Decrease in price of a substitute good.
f) Increase in price of a complementary good.
g) Consumers' expectation of lower prices or incomes in the future.

3.2.1 Change in Quantity Demanded

Change in quantity demanded refers to movement along a demand curve as a result of changes in the price of a commodity.

A change in quantity demanded can either **increase or decrease**

i. Increase in quantity demanded occurs as a movement downwards on a demand curve when price falls and other determinants of demand remain constant. (See Figure 14)

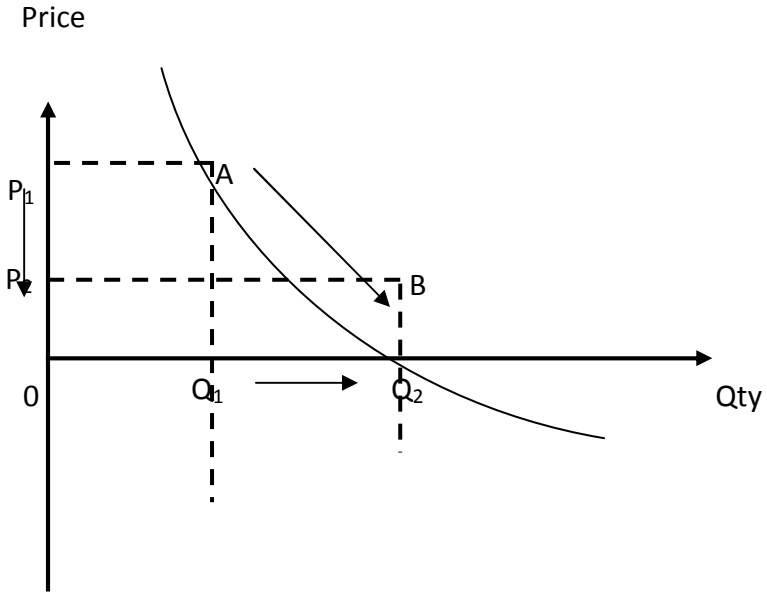

Fig. 14: Increase in Quantity Demanded (Downward Movement along a Demand Curve)

Increase in quantity demanded from Q1 to Q2 as price reduces from P1 to P2.

ii. Decrease in quantity demanded occurs as an upward movement along a demand curve when price of the commodity increases but other demand determinants remain constant. (Figure 15).

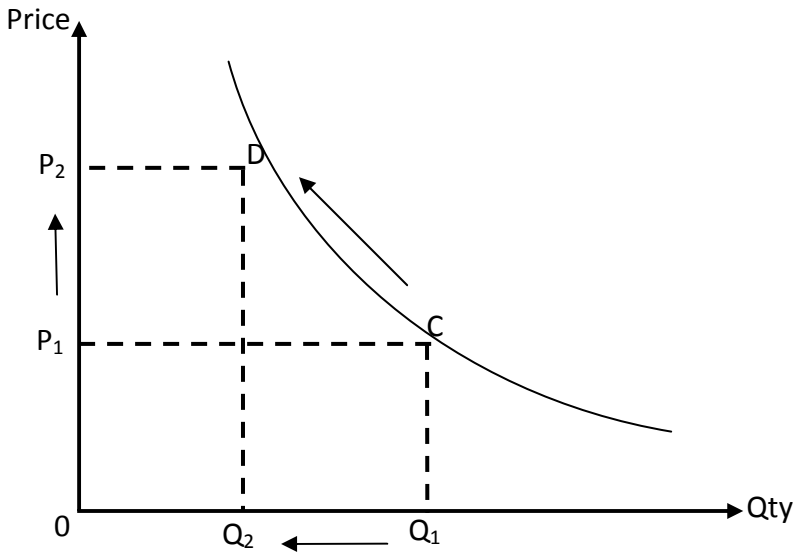

Fig. 15: Decrease in Quantity Demanded (Upward Movement along a Demand Curve)

Decrease in quantity demanded from Q1 to Q2 when price rises from P2 to P1.

3.2.2 Supply: Supply is the quantity of a commodity sellers wish to sell at each conceivable price.

3.2.2.1 Supply Schedule: This is a table showing how much of a given commodity a seller would be willing to sell at different prices. The table below illustrates a supply schedule.

Table 4: Supply Schedule

Price	Quantity
2	15
4	20
6	25
8	30
10	38

Notice that as price increases from 2 to 10 Naira, Quantity supplied increase from 15 to 38 units.

3.2.2.2 Supply Curve: The Supply Curve is a graph illustrating how much of a given commodity sellers (firms) would sell at different prices. Supply curves are derived from supply schedules by plotting price against the quantity supplied with price on the vertical axis and quantity supplied on horizontal axis (Figure 16).

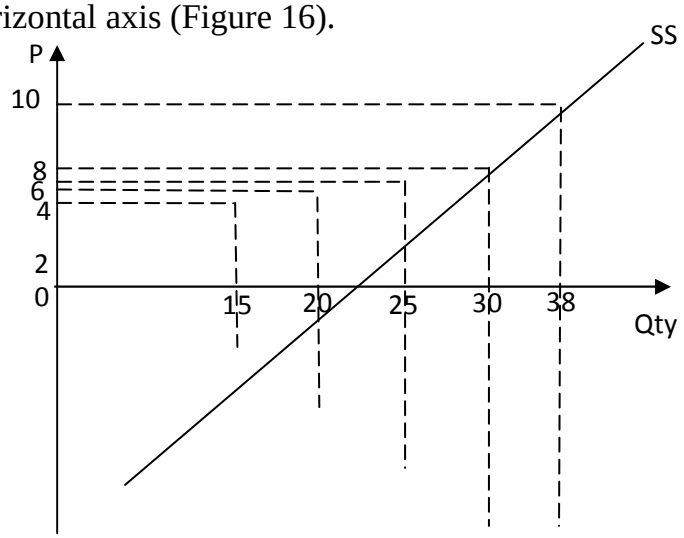

Fig. 16: Supply Curve

Notice that the supply curve is upward sloping and hence has a positive slope.

3.2.2.3The Law of Supply: This states that the higher the price of a commodity, the higher the quantity supplied, if all other things are unchanged.

3.2.2.4Explanation of the Law of Supply: With given product costs (i.e. if cost of production remains unchanged), a higher price means greater profits and thus an incentive to increase the quantity supplied.

3.2.2.5Market Supply: The supply for a good or service can be defined for an individual firm, or for a group of firms that make up the supply side of the market. Market Supply is the sum of all the quantities of a good or service per period by each firm at the various prices. The table below shows the derivation of a market supply schedule assuming we have three firms making up the industry.

Table 5: Market Supply Schedule

Price	Quantity Supplied by Firm (A)	Quantity Supplied by Firm (B)	Quantity Supplied by Firm (C)	Market Supply (A)+ (B)+(C)
3	10,000	30,000	25,000	65,000
1.75	5,000	10,000	10,000	25,000

As with market demand, **market supply** is the horizontal summation of individual firms' supply curves. Thus, the table above can be translated to the following curves as shown in Figure 17.

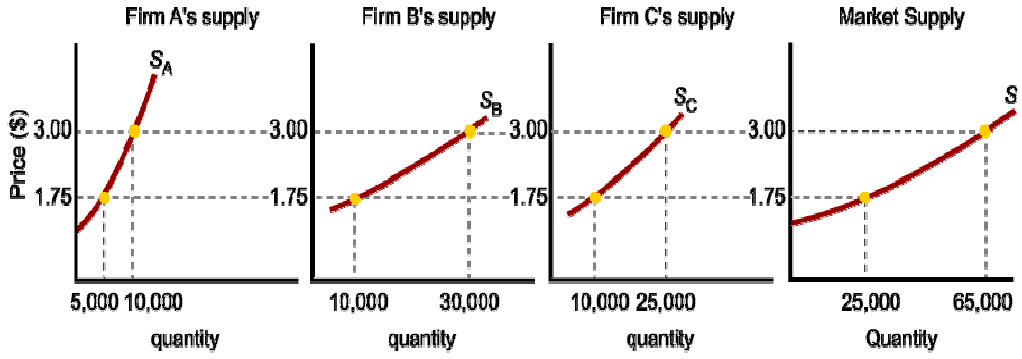

Fig. 17: Market Supply Curve

3.2.2.6 Other Determinants of Supply

These are factors (or variables) that determine supply except price of the commodity. These factors are briefly discussed as follows:

a) **Resource Prices** - a rise in resource prices will cause a decrease in supply or leftward shift in supply curve; a decrease in resource

prices will cause an increase in supply or rightward shift in the supply curve.

b) **Technology** - a technological improvement means more efficient production and lower costs, so an increase in supply, or rightward shift in the curve results.

c) **Taxes and Subsidies** - a business tax is treated as a cost; so decreases supply; a subsidy lowers cost of production; so increases supply.

d) **Prices of related goods** - if price of substitute production good rises, producers might shift production towards the higher priced good, causing a decrease in supply of the original good.

e) **Producer expectations** - expectations about the future price of a product can cause producers to increase or decrease current supply.

f) **Number of sellers** - generally, the higher the number of sellers, the greater the supply.

4.0 CONCLUSION

At this end of this unit, we were able to explain and understand what demand and demand schedule is all about; analyse the demand curve, know how the law of demand is applied to quantity of demand for goods and services and also explain the law of demand and how changes are determinant factors in the quantity of demand for goods and services.

5.0 SUMMARY

It could be seen that the whole of this unit was discussing why there are changes in demand and supply of goods and services in the market. However, emphasis was placed on the index that affects the change of movement in the curves of demand and supply. It is also important that you understand how this curve movement affects the purchasing power of the customers in the market. It is believed that the study of this environmental economics would have broadened your knowledge about the whole concepts and the implication or impacts to all humans and their surroundings.

6.0 TUTOR-MARKED ASSIGNMENT

1. What is demand schedule?
2. Change in quantity demanded refers to movement along a demand curve as a result of changes in the price of a commodity. Graphically explain what you understand by this.
3. What is supply curve?

7.0 REFERENCES/FURTHER READING

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