MODULE 2

UNIT 1 GLOBAL WARMING AND GREEN HOUSE EFFECT

CONTENT

1.0 INTRODUCTION

The last module, Unit 1-5 focused on the environment as an ecosystem and how human population has raised global environmental issues such as deforestation, biodiversity loss and desertification.

The next five Units- Module 2 will focus on global environmental issues related to climate change, sea pollution coastal erosion. Burning of fossil fuel to ensure human survival and support comfortable lifestyles have induced global warming. This Unit intends to explain the relationship between global warming and green house gases are discussed and the consequences and control measures for global warming

2.0 A: OBJECTIVES

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

- Explain the term global warming
- Mention the consequences of global warming
- Analysis the impact of the major four green house gases.
- Outline control measure taken to control global warming.

2.0B: HOW TO STUDY THIS UNIT

1. You are expected to read carefully through this unit twice before attempting to answer the activity questions. Do not look at the solution or guides provided at the end of the unit until you are satisfied that you have done your best to get all the answers.
2. Share your difficulties in understanding the unit with your mates, facilitators and by consulting other relevant materials or internet.
3. Ensure that you only check correct answers to the activities as a way of confirming what you have done.
4. Note that if you follow these instructions strictly, you will feel fulfilled at the end that you have achieved your aim and could stimulate you to do more.

3.0 MAIN CONTENT

The glass-roofed structure where plants are grown is called a greenhouse. Usually the walls are also made of glass. A green house creates an artificial environment by careful control of temperature, light, humidity, air quality, soil moisture and heat levels. (A hove, 2001)

The glass windows of a greenhouse allows in sunlight. The sunlight warms up objects inside the greenhouse. These objects then give off heat. The glass of the green house, however, does not let out the heart. If the green house lacks ventilation all the heat stays locked inside and the temperature rise. The green house effect also accounts for the fact that the inside of a car become hot if its windows are wound up in a sunny day.

Reflection: - What happens when you open the door of the car described above.

The earth and its atmosphere are like a giant green house. Like the glass windows of a green house, the atmosphere is nearly transparent to short wave and visible solar radiation. Part of the energy absorb on by the Earth is radiated to the atmosphere as long wave vapour, which absorbs much of the long wave radiation before partial radiation back to the surface of the earth. This cause the earth and its atmosphere to warm up which had remained nearly constant until the 20^{th} Century. When the burning of fossil fuel such as coal, fuel oil, petrol, Kerosen, diesel and natural gas began to release large quantities of carbon dioxide into the atmosphere.

The combustion of fossil fuel has brought about an ever- increasing rise in the carbon dioxide concentration in the atmosphere. The rapid eradiation of the tropical rainforests- is depleting the earth's plant growth and diminishing their capability for absorbing carbon dioxide. The unabsorbed carbon dioxide rises to the upper atmosphere and blocks the re-radiation of solar energy back into space. This precipitates a global temperature increase called the "greenhouse effect" which scientists say is causing the ice caps to melt.

The term greenhouse effect is used as an analogy to illustrate the global warming phenomenon.

Global warming may be described as the gradual increase in global temperature as a result of the effects of greenhouse gases. The greenhouse effect is the phenomenon experienced in a greenhouse used for plant where heat or warmth are trapped within.

This experience of heat within the greenhouse is what is used as an analogy to illustrate the globe as a giant greenhouse where heat is trapped leading to global warming

Carbon dioxide emissions from the combustion of fossil fuels coal, oil, gas) play a crucial role in accentuating the greenhouse effect and, by extension, global warming. These emissions are still increasing. Since 1950, they have multiplied fourfold over the past five years they increased by 5.5%, as against 7.4% over five preceding years. However, this slight shrinking is due mainly to the collapse of the eastern block countries.

Chins, with a number of developing countries (Braizil, India, Indonesia etc,) has considerably increased their emissions. But albeit to a lesser degree, so have the United States, which spews more carbon dioxide into the atmosphere than any other country, Japan-another major producer- and, the countries of Europe.

Table 5.1 Global carbon Dioxide Emissions (%) By Developed Countries

S/N	Country	Global $C0_2$ Emission (%)
(a)	United States	23
(b)	China	14
(c)	Russia	7
(d)	Japan	5

3.1 Green House Emissions

These green house gases are projected to cause an increase in the average temperature of the troposphere. According to Miller (1991) the major ones are:

(1) Carbon dioxide
(2) Chloro-fluro-carbon (CFC)
(3) Methane
(4) Nitrous oxide

Carbon dioxide (CO_2)
This gas is thought to be responsible for 49% of human- caused input of greenhouse gases. Major sources are Fossil-fuel burning (80%) and deforestation (20%). Industrial countries account for about 76% of annual emission. It remains in the atmosphere for 50-200 years.

Chlorofluorocarbon (CGC2) These gasses are responsible for 14% of the human input of greenhouse gasses and by 2020 will probably be responsible for about 25% of the input. CFCs also deplete ozone in the stratosphere. Major sources are leaking air conditioners and refrigerators, evaporation of industrial solvents, production of plastic, forms and propellants aerosol spray cans. CFCs remain in the atmosphere for 65-135 years, depending on the type but generally have 1,500-7,00 times the impact per molecule on global warming than each molecule of carbon dioxide. It takes between 10-20 years to reach the stratosphere.

Methane (CH) This gas is responsible for about 18% of the human input of greenhouse gases. It is produced by bacteria that decompose organic matters in oxygen poor environments. About 40% global methane emissions come from water - logged soils bogs, marshes and rice paddies. 1C warming may increase methane emissions from these sources by 20% -30% and thus amplify global warming. Other sources of billions of cattle, sheep, the guts of termites, the digestive tracts of billions of cattle, sheep, pigs, goats, horses, and other livestock. Some methane also leaks from coal seams, natural gas, wells, pipelines, storage tanks, furnaces, dryers and stoves. Natural sources produce an estimated on third of the methane in the atmosphere, and human activities produce the rest. CH, remains in the troposphere for7-15 years and each molecule is about 25 times more effective in warming the atmosphere than a molecule of carbon dioxide.

Nitrous Oxide (N_20) This gas is responsible for 6% of the global warming. It is released from the breakdown of nitrogen fertilizers in the soil, livestock wastes, and nitrate -contaminate ground water, and by biomass burning. Its average stay in the troposphere is 120 years. It also depletes ozone in the stratosphere. The global warming for each molecule of this gas is about 230 times that that of a carbon dioxide molecule. These gases are referred to as greenhouse gases not because they are green in colour but because they induce the greenhouse phenomenon on earth.

3.2 Consequences of Global Warming

- A warmer global climate could have a number of possible effects. Changes in food production, which could increase in some areas and drop in others. Current climate models project 10-70% declines in the global yield of key food crops and a loss in current cropland area of 10-50% especially in most poor countries.
- Global warming would also reduce water supplies in some area. Lakes, streams, and aquifers in some areas that have provided water to ecosystems croplands and cities for centuries could shrink or dry up altogether. This would force the entire population to migrate to areas with adequate water supplies- if they could
- Global warming will also lead to a change in the makeup and location of many of the world’s forests. Forests in temperate and subarctic regions, leaving more grassland shrubland in their wake
- Climate change would lead to reductions in biodiversity in many areas. Large-

scale forest die backs would cause mass extinction of plant and animal species that cannot migrate to new areas. Fish would die as temperatures soared in streams and lakes and as lowered water levels concentrated pesticides.

- In a warmer would, water in the world's oceans would expand and lead to a rise in sea level. Even the modest rise of 48 centimeters (19inches) projected to occur by 2100 one-third of the would destroy most coral reefs, contaminate coastal aquifers with salt water storing oil and other declining global fish catches. The warming at the pole will cause ice sheets and glaciers to melt even partially, the global sea level would rise the more.
- In a warming world, weather extremes are expected to increase in number and severity. Prolonged heat waves and droughts could become the norm in many areas, taking a huge toll on many humans and ecosystems. As the upper layers of seawater warm damaging hurricanes, typhoons, tornadoes, and violent storms will increase in intensity and occur more frequently.
- Atmosphere warming also affects the respiratory tract by increasing air pollution in winter months and increasing exposure to dust, pollens, and smog in summer months. Sea level rise spread infectious disease by flooding coastal number of environment refuges.
- Global warming also poses threats to human health. According to 1995 International Panel on Climate Change (IPCC) report, global warming would bring more hear waves. This would double or triple heat-related deaths among the elderly and people with heart disease. The spread of warmer and wetter tropical climates from the equator would bring malaria yellow fever, dengue fever, and others insect-borne diseases to formerly temperate zones.

EXERCISE 3.1

State three consequences of global warming you witnessed in your community or state.

3.3 Controlling Global Warming

Dealing with global warming, we have two options (Miller, 1991). We either slow it down or adjust to its effect. It may be wiser to employ the two options without wasting much time, because human and many other species learn to live under necessary changes. Steps that can be taken in dealing with this problem include.

1. Banning all production and uses of chlorofluoro carbon and halons. This is one of the best steps we must take, because we can either do without these chemicals or introduce substitutes to protecting the atmosphere from both global warming and ozone depletion.
2. Cutting current fossil fuel use 20% y 2000 and 50% by 2010 and 70% by 2030. The largest users of fossil fuel such as the United States and Russia should cut their use by about 35% by the year 2000. 160 countries signed the 1997 kyoto protocol which requires industrial nations reduce their greenhouse emissions to an average of 5.2% below 1990 levels between the years 2008 and 2012. As weak as the treaty appears, it continues to generate controversies among

government of nations especially between the U.S. and Japan. Since the U.S. Senate hasn't even considered is anti-fossil fuel cut, the Japanise Government also decided (in July, 2001) that she will not rectify the Koyoto protocol.

- Greatly improving energy efficiency. This is the quickest, cheapest, and most effective method to reduce emissions of carbondioxide and other air during the next two to three decades.
- Shifting to perpetual and renewable energy resources that do not emit CO_2 over the next 30 years. Ultimately the world must move away from fossil fuels for most of its energy, even if we cut carbon dioxide emissions in half. Otherwise emissions would begin to rise because of increasing population and industrialization.
- Increasing the use of nuclear power to produce electricity if a new generation of much safer reactors can be developed and the problem of how to store nuclear waste safely for thousands of years can be solved. Israel and France are noteworthy examples in his area.
- Placing heavy taxes on gasoline and emissions fees on each unit of fossil (especially coal) burned to reduce emission of carbon dioxide and other air pollutants. Some of the tax revenue should be used to improve the energy efficiency of dwellings and heating systems for the poor in Developed Countries and less Developed Countries and to provide them with enough energy to offset higher fuel prices.
- Sharply reducing the use of coal, which emits 60% more carbon dioxide per unit of energy produced than any other fossil. Using the world's estimated coal supplies would produce at least six fold or eight -fold increase in atmospheric carbon dioxide.
- Switching from coal to natural gas for producing electricity and high temperature heat in countries, such as the United States and the Russia, that have ample supply of natural gas which emits only half as much carbon dioxide per unit of energy as coal. Switching to natural gas also sharply reduces emissions of other air pollutants because burning natural gas still emits CO_2. This is only a short -term method that helps buy time to switch to an age of energy efficiency and renewable energy
- Slowing population growth. If cut greenhouse gas emissions in half and population doubles, we are back where we started. Especially in countries with high illiteracy rate and poverty.
- Planting trees. Everyone -even student should plant and care for at least one tree every six months. This is an important form of earth care, but we should recognize that tree planting is only a stopgap measure for slowing carbon -dioxide emissions. Trees must be continually faster than they are cut down and burned or die and rot, both processes release carbon-dioxide in the atmosphere. To absorb the carbon dioxide putting into atmosphere each year, would have to plant an average of 1,000 trees per person per year.
- Recycling CO_2 carbon-dioxide released during industrial processes.

- Building lakes to protect coastal areas from flooding as the Dutch have done for hundred of years.
- Banning new constructions on low-lying coastal areas. This should be enforced strictly especially Lekki on the Victoria Island of Lagos State, Nigeria where several hectares of wetland have been used for construction of houses.
- Storing large supplies of key foods throughout the world as insurance against disruptions in food production

Exercise 3.2

Based on your knowledge, explain four techniques you will employ to control the consequences you mentioned in Exercise 3.1

4.0 CONCLUSION

We have known about the greenhouse effect and its possible consequences for decades. We also know what needs to be done at the international, national local and individual levels. Research must be expanded to help clear up the uncertainties that continue to exist. But to most environmentalists and many climatologists this is no excuse for doing nothing or very little now.

5.0 SUMMARY

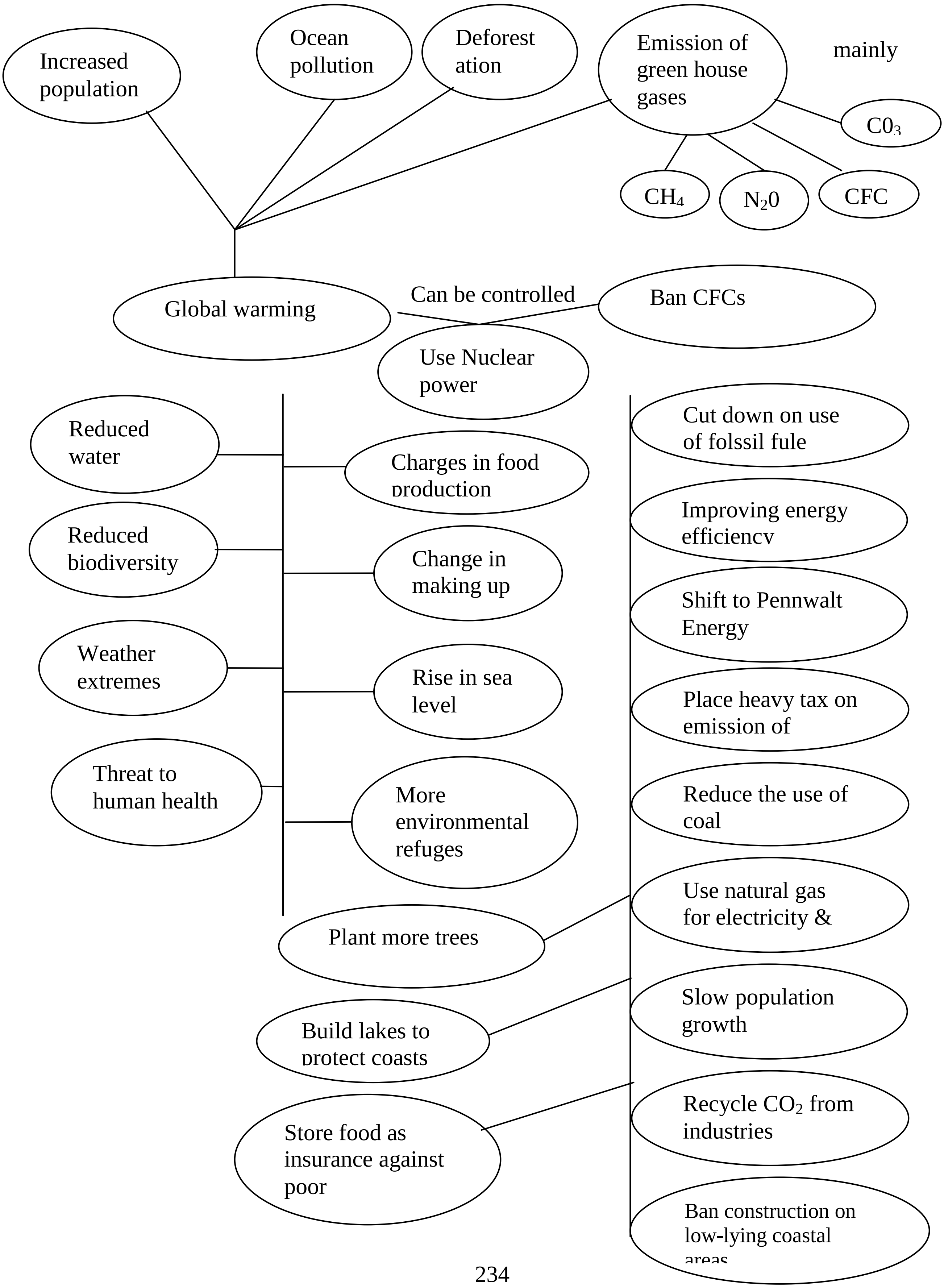
This unit set out to discuss on a contemporary climatic global problem-global warming. Global Warming was defined as the gradual increase in global temperature as a result of green house emissions induced by humanity over several decades. Green house effect is the phenomenon of experienced in a green house, where plants are kept for nursery and warmth is retained. This experience is analogous to our experience of a warmer world over the years.

The causes of global warming are basically as a result of:

- Increase in population
- Deforestation
- Emission of greenhouse gases
- Ocean pollution

Four major greenhouse gases were highlighted these are: Carbondioxide, Chloro-fluoro-Carbon, Methane and Nitrous Oxide. Eight consequences of global warming were discussed which include among others rise in sea level, weather extremes and threats to human health. Fourteen strategies for controlling global warming were analysised.

Fig 6.1: Concept mapping highlighting in summary the causes, consequences and control of global warming



6.0 TUTOR MARKED ASSIGNMENT

1. Explain the term global warming
    a. Mention the names and symbols of the four major greenhouse gases.
    b. Analysis the global warming impact made by human emissions of (1) carbondioxide (II) any other named green house gas.
2. Why is carbodioxide the major culprit among the four greenhouse gases.

7.0 REFERENCES AND OTHER RESOURCES

Ahove, M.A.N (2001). Environmental Management and Education: An introduction. Lagos Golden pen books.

Miller G.T. (1991). Environmental Science Working with the Earth. Mc-GrawHill. New York.

UNIT 2 OZONE LAYER DEPLETION

CONTENT

1.0 INTRODUCTION

In the previous Unit we talked about a major global environmental issue related to climate change global warming. This Unit we will also discuss on another very important global environmental problem. This time around we are talking about Ozone Layer Depletion.

I often like to describe global warming and Ozene Layer Depletion as the twin environmental issue affecting climate change. This is because the consequences of this twin are not only similar but interwovened-causing climate change.

I strongly believe you will get the best out this unit as long as you keep focused. We shall talk about the discovery of ozone, Ozone as a natural screen and the cause of its depletion. Furthermore we will highlight the consequences of Ozone layer depletion on humanity, other organisms and the physical environment. The strategies adopted so far in the control of Ozone layer depletion will also be retriated.

2.0 A: OBJECTIVES

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

- Mention major Ozone layer depleting substances
- Outline the consequences of Ozone layer depletion
- Discuss any four strategies for the control of Ozone layer depletion

2.0 B: HOW TO STUDY THIS UNIT

In this unit you are expected to :

1. Read through the course contents on your own
2. First attempt the activities, then the TMA without looking at the hints provided by the author
3. Make observations on all your difficulties to your facilitator
4. Confirm your work on the activities after you have done your best to get all correct

3.0 MAIN CONTENT

According to Charles Bigelow in his article, "Hole in the ozone screen" the world was sensitised to the ozone problem in 1986. In may 1986, a paper written by scientists from the British Antarctic survey at Halley Bay appeared in the scientific Journal Nature. In this paper they described what came to be known as the hole in the Ozone layer, or ozone screen. The research at Halley Bay collected data on many different characteristic of the atmosphere, including the total concentration of ozone in the cloumn of air over their heads. The Halley Bay scientists used a device called Debson's spectrophotometer, which measures the absorption of sunlight by ozone. Their observations and others made subsequently, shows that every spring time in Antarctica, there is a massive depletion of the atmosphere concentration of Ozone. Exercise 6.11. Using your world map, locate the region- Antarctic.

EXERCISE 6.1

Using your world map, locate the region Antarctic

3.1 The Ozone Screen

Both dioxygen and trioxygen have very important physical function for us in that they screen out harmful ultraviolet light wavelengths below 24nm, and troioxygen screens our the equally dangerous U V B from 240to 320nm. Our sun emits the radiation that keeps us warm and alife. Most of the radiation is in the visible region of the spectrum, where it can be seen, but some is in the invisible ultraviolet region. Ultraviolet light is high energy light meaning that when it is absorbed by molecules, it may break chemical bonds, thereby changing the molecule. This is way ozone is formed in the stratosphere. UV-C is absorbed by dioxygen molecules which are then slit into two oxygen atoms (o). each of these combines with another 02 molecule to make 0_3 molecules. Two things are needed to makes ozone in the stratosphere oxygen (0_2) and UV light.

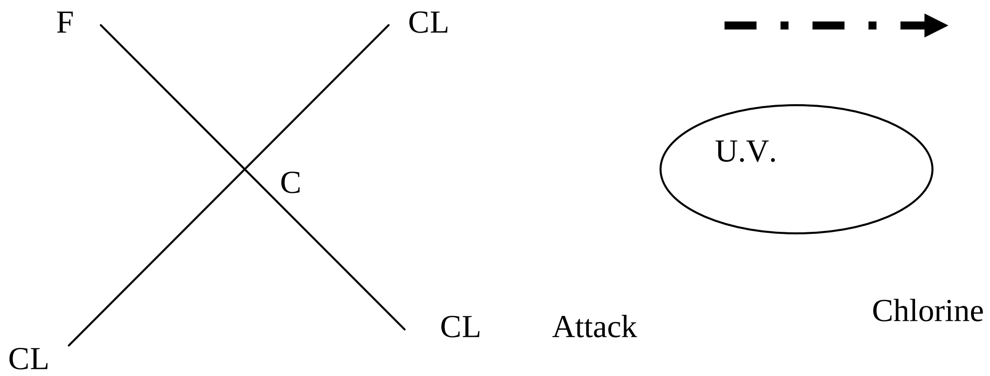
Ozoen (0_3) also absorbs UV light, but in the B-region. Large quantity of Uvray would cause unwanted reactions leading to cataracts, skin damege cancer, and mutation. Life survives on land because the ozone screen is in place filtering out UV-B. the ozone screen is sometime called ozone layer, because its highest concentration occurs in the stratosphere, about 25km above the surface of the Earth. However, the ozone screen is in an equilibrium concentration which is the result of a steady formation and destruction.

3.2 Chemistry of the Ozone Layer Depletion

A University of California scientist called Rowland, has wondered about an important industrial chemical called chlorofluorocabons (CFCs). This compound was invented about the late 1930s has been found to have very important applications because they had desirable physical properties, and one very important chemical property is that CFCs are essentially inert. They do not react with anything, so they don't react with living organisms, including humans, they are therefore non-toxic, and perfectly safe around people, if any few cylinders of these gases were emptied in crowded room, nobody would notice.

Rowland knew that industries world over had been using about one million tonnes of CFCs a year, and that it ultimately end up in the atmosphere. He asked himself this question: what is happening to all this stuff? He thus speculate that the CECs, once in the atmosphere, would move slowly up to the stratosphere, which may take a maximum of about 25 years to attack the ozone layer.

His reaction he explained experimentally when he found that UV light can break the CFCs molecules (stepi) knocking chlorine atoms out of them.



$Cl + 0_3$ ‑ ‑ ‑ ▶ $Clo + 0_2$ (Step ii)

Fig. 6.1:

He discovered that if he added some ozone in his reaction vessels, the chlorine atoms destroyed it, thus liberating diatomic oxygen (Step ii).

So the so-called chemically inert CFCs will react if you expose them to highly energetic UV light. Rowland's work led him to the conclusion that the actual chemical culprit was not just the chlorine atom, but rather an unusual molecule made up of one atom of chlorine and oxygen called chlorine monoxide-CLO. He thus further explains how this CLO continues to deplete the ozone layer with the equations below.

Breaks up

$CLO \longrightarrow CL + O$

$CL + O_3 \longrightarrow CLO + O_2$

$O + O_3 \longrightarrow 2O_2$

When CLO absorbs UV light, it splits into chlorine atom and one - oxygen atom, each of which can attack ozone molecules, The CLO is not used up in the process, and can go on and on, destroying more ozone molecules. CLO is infact what is called catalyst in chemistry.

3.3 Major Ozone Depleting Chemicals

1. Cloroflurocarbon (CFCs) It was first discovered by a chemist Thomas Midgley. They are derivatives of simple hydrocarbons (Methane, ethane etc) with the hydrogen atoms completely replaced by chlorine and fluorine atoms. Developed in the late 1930s as stable odour less, non-toxic, noncorrosive and noflammable refrigerants. These highly versatile chemicals are also found in widespread use as aerosol spray propellants, form-blowing agents and sloveents. CFCs are completely synthetic, with no natural sources; the absence of hydrogen atoms makes them largely non-reactive with other chemicals in the lower atmosphere. The ozoen depletion porentials of CFCs range from 0.6 to 1.0 with most having the value 1.0. last in the stratosphere for 65-110 years and can attack 100,000 molecules of O3. It is removed by forming downward to the troposphere and is removed by rain.

2 Halons: They are synthetic chemical similar to CFCs that invludes bromine, chlorine and hydrogen. Developed as non-corosive fire extinguishers, they are substantially more powerful ozone depleters than CFCs. These halons are classified below
   a. Methly Chloroform (CH3CCL3): This is also a synthetic industrial solvent used for cleaning precision parts and metal surfaces and for dry cleaning. Because of its hydrogen atoms, it is chemically reactive in the lower atmosphere. Thus, less of the methlychoroform emitted at the Earth's surface reaches the stratosphere and destroys ozone, giving it an ozone depleting potential (ODP) of 0.1
   b. Carbon tetrachloride (CCL_4) is a synthetic chemical with an ODP OF 1.1 almost all production in industrial countries serves as feedstck in the production of other chemicals.
   c. Methyl Bromide (CH_3B_r) is the only currently world wide controlling ozone depleting chemical with both human and natural sources. Oceanic algae emit 60 -160 thousand metric tons per year, while human emissions come primarily from biomass burning (10-50 thousand tons) and agricultural use as a soil or crop fumigant. It's ODP is currenly estimated as 0.6

d. Hydrochlorofluorocarbon (HCFCs) were developed as substitutes for CFCs. They are similar in structure, but retain some hydrogen atoms. Consequently, they react chemically in the lower atmosphere and have less effect on stratosphere ozone. Their ODPs range from 0.01-0.11. Production and use of HCFs is now increasing rapidly as CFCs are phased out.

e. Hydrofluorocarbons (HFCs) were also developed as CFCs substitutes. Because neither nor bromine, they do not deplete ozone (ie their ODP is 0.0), but they have been proposed for control because they are powerful greenhouse gases. Collectively, all ozone depleting compounds are called ODCs.

3.4 Consequences of Ozone Layer Depletion

With less ozone in the stratosphere more biologically harmful ultraviolet radiation will reach the earth's surface. This form of UV radiation damages DNA molecules in animals including our very skin. Do you realise that for every 1% loss of ozone leads to a 2% increase in the UV radiation striking the earth? And consequently leasing to 5% -7% increases in skin cancer?

The following are the effect of Ozone depletion:

1. Increase in the cases of skin cancers running into millions annually. His includes curable and incurable cancers.
2. A sharp increase in eye cataracts (the clouding of the eye that causes blurred vision and eventual blindness) and severe sunburn in people and eye cancer in cattle.
3. Suppression of the human immune system which would reduce our defenses against a variety of infection diseases, an effect similar to AIDS virus.
4. Decreased yields of important food crops such as corn, rice Soyabean and wheat, due to gradual loss of chlorophyll in plants.
5. Reduction in the growth of ocean phytoplankton that forms the bases of ocean chains and webs and help remove carbondioxide from the atmosphere.
6. Degradation of paints (building, etc), colours (from cars materials including wears especially when exposed to too much sunlight), plastics and other polymer materials.
7. Increase in global temperature and its attendant consequences.

Exercise 7.1

Form a group of three and discuss with your course mate on how these consequences has affect each one and families

3.5 Controlling Ozone Layer Depletion

Models of atmospheric processes indicate that just to keep CFCs at 1987 levels would require an immediate 85% drop in total CFC emissions throughout the world. Analysists believe that the first step toward this goal should be an immediate worldwide ban on the use of CFCs in aerosol spray cans and in producing plastic form products. Cost effective substitutes are already in use is some electrical appliances like refrigerators and aerosols. Automotive service shops should be required to recycle CFCs from auto motive air conditioners and the sale of small cans of CFCs used by consumers to charge leaky air conditioners should be banned totally. CFCs have been phased put currently in several developed and developing countries with few excerptions.

The next step would be to phase out all other users of CFCs, halons, carbon tetrachloride, and methyl chloroform. Substitute coolants in the refrigeration and air codition will probably cost more. But compared to the potential economic and health consequence of ozone depletion, such cost increases would be minor.

Other international co-operation to protect the ozone layer in the past include the following:

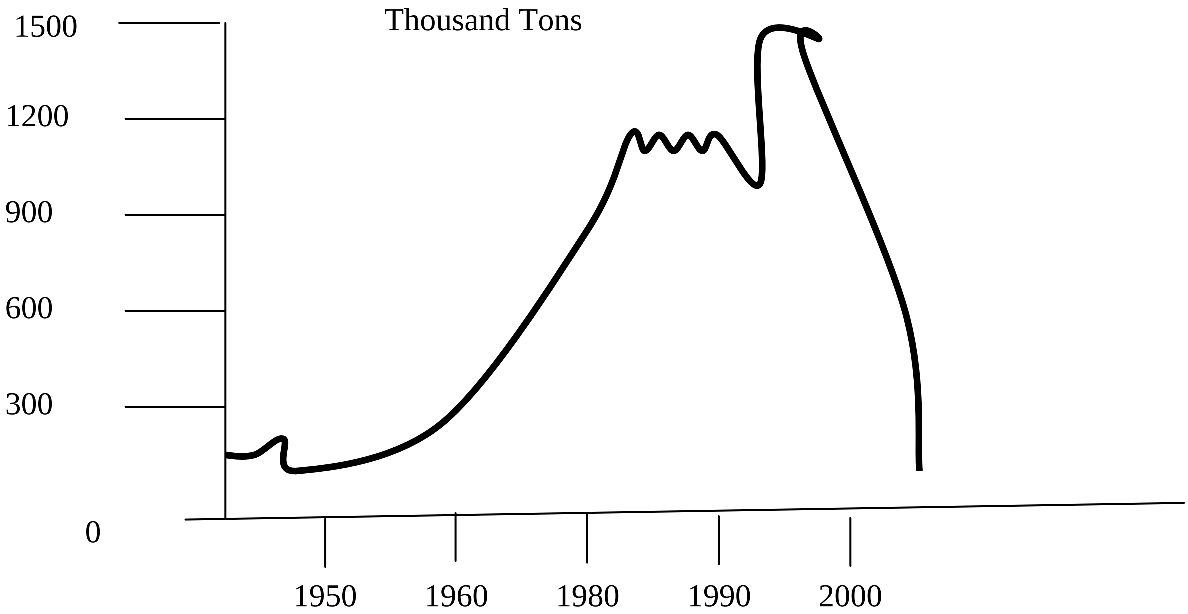
- March 1977: a meeting sponsored by the United Nation Environmental Programme (UNEP) in Washington, D.C., prepared a non-binding "world plan of Action" to protect the ozone layer and established a small international scientific advisory body.
- January 1982: international negotiations for a treaty on the ozone layer began.
- March 1985: twenty nations and the European Community (EC) singed the Vienna Convention after three years of negotiations. The convention included measures to co-operate on research and monitoring but contained no controls on ozone depleting substances. A resolution signed at the same time authorised continuing negotiations toward a treaty to include controls.
- September 1987: Twenty-four nations and the EC signed the Montreal protocol committing themselves to reduction production and use of CFCs by half by 1998 and to freeze production and use of halons by 1992. Developing countries were granted a 10 years period to meet both obligations.
- May 1989: At their first meeting in Helsinki, parties to the protocol made no change to core commitments but decided that their next meeting would both consider stronger control measures and seek to develop financial mechanism to support developing countries in controlling ozone depleting substances. The meeting also sought to clarify a number of ambiguous terms in the protocol and to define procedural obligations such as reporting.
- June 1990: The London Amendments to the Montreal Protocol adopted at the meeting of the conference of the Parties, increased the stringency of control measures. The amendments required elimination of both CFCs innovations by 2000 (with possible exemptions for "essential uses" to be specified); broadened the set of controlled chemicals to include methyl chloroform, carbon

tetrachloride and a few CFCs not originally covered by protocol. It also established a multilateral fun of 16-24 million dollars over three years to support phase outs in developing countries consuming **l**ess than 0.3 kilograms per capital ("Article 5 Countries"). Developing countries retained their 10 years grace period for all controls.

- June 1991: The third meeting of the conference of the Parties, in Nairobi, made no changes to core commitments. The meeting addressed such matters as defining the tasks of the Implementation Committee and clarifying the protocol's sanction provision.
- November 1992: At the fourth meeting of the parties, the Copenhagen amendments advanced the phase out dates to 1994 for halons and to 1996 for CFCs, methyl chloroform, and carbon tetrachloride. HCFCs were placed under control for the first time with all but 0.5 percent to be eliminated by 2020 and the remainder by 2030.
- Industrial countries production of methyl bromide was frozen at 1991 level starting in 1995. Developing countries obligations regarding HCFCs and methyl bromide were left while unspecified, wile they retained their 10 year grace period for their phase outs. The multilateral fund was reauthorized on a permanent basis.
- November 1993: the fifth meeting of the parties, in Bangkok, made no changes to core commitments but confirmed three-year funding of 510 million dollars for the Multilateral fund (more than double the previous funding level) and following an assessment panel's recommendation that three be no essential use exemption to the 1994 halon phase out in industrial countries.
- October 1994. The sixth meeting of the parties, in Nairobi, again left core commitments unchanged, but followed an assessment panel's recommendation that 11,000 tones of essential use exemptions be granted in the case of the 1996 CFC phaseout
- November 1995: The seventh meeting of the parties was held in Vienna to commemorate the tenth anniversary of the Vienna Convention and considered revisions to the protocol's commitments.
- In 1997, 160 countries signed the Koyoto protocol, which requires industrial nations to reduce their greenhouse emissions to an average of 5.2% below 1990 level between the years 2008 and 2012. There is currently a deadlock on this reduction of carbon dioxide, emitted from fossil fuel especially among developed nations. Alternatively, reduction of other greenhouse gases such as methane, and Nitrous oxide should be focused on negotiations carbondioxed reduction is still on. This is essential because, these other greenhouse gases in totality is responsible crisis, even through each gas is present in the atmosphere in much smaller quantities relative to carbondixide.

4.0 CONCLUSION

Fig 6.1 CFC, AT LEAST ONE SUCCESS STORY



Source: UNESCO SOURCES, 1997

Yet, as this last graph show, the worst is not inevitable. The international community managed to reach an agreement on cutting the amount of ozone -destroying chlorofluorocarbons (CFCs released into the atmosphere and stayed on target. The ingredients of success were a scientific alert, public awareness and-especially-economically viable alternatives. But the cuts will not come too soon. Even if all countries respect the commitments they have made, the ozone layer will not return to "normal" before the middle of this century (2050). In the meantime, abnormally high levels of ultra- violet radiation will continue.

5.0 SUMMARY

In this Unit, you have learnt about one of the most essential global environment issue- Ozone Layer depletion. You have learnt that ozone layer is a natural screen that was uncovered by Rowland about 1986.

You will also recall that this unit highlighted how the Ozone layer is being eaten-up by human made chemicals, using equations for each stage.

Two broad categorizes of Ozone depleting substances were mentioned these are:

- Chlorofluorocarbons
- Halons

The consequences of and control measures for checking Ozone layer depletion were discussed.

6.0 TUTOR MARKED ASSIGNMENT

1. What is the relevance of Ozone in the stratosphere to humanity?
2. State three consequences of Ozone layer Depletion on humanity.

7.0 REFERENCES/FURTHER READING

Ahove, M.A.N (2001). *Environmental Management and Education: An introduction*. Lagos: Golden pen books.

Miller, G.T. (1991). *Environmental science working with the earth.* New York: Mc-GrawHill.

UNIT 3 AIR POLLUTION AND ACID RAIN

CONTENTS

1.0 INTRODUCTION

The pervious unit focused on ozone layer depletion being global atmospheric problem induced by human activity.

This unit will yet discuss on another global problem induced by human activity although it this common in industrial urban location. Unit Eight therefore has air pollution and acid rain as its focus.

2.0 A: OBJECTIVES

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

- Mention the names and symbols of major air pollutants
- State the effect of air pollution on human health
- Outline the consequences of air rain on living organism and the physical environment

2.0 B: HOW TO STUDY THIS UNIT

1. You are expected to read carefully through this unit twice before attempting to answer the activity questions. Do not look at the solution or guides provided at the end of the unit until you are satisfied that you have done your best to get all the answers.
2. Share your difficulties in understanding the unit with your mates, facilitators and by consulting other relevant materials or internet.
3. Ensure that you only check correct answers to the activities as a way of confirming what you have done.
4. Note that if you follow these instructions strictly, you will feel fulfilled at the end that you have achieved your aim and could stimulate you to do more.

3.0 MAIN CONTENT

As clean air moves across the earth's surface, it collects various chemicals produced by natural events and human activities. Once in the troposphere, these potential air pollutants mix vertically and horizontally, often reacting chemically with each other or with natural components of the atmosphere. Air movements and turbulence help dilute potential pollutants, but long-lived pollutants are transported great distances before they return to the earth's surface as solid particles, liquid droplets, or chemical dissolved in precipitation.

Hundreds of air pollutants are found in the troposphere. However trace amounts of the nine major classes of pollutants cause most outdoor air pollution:

1. Carbon oxides - carbon monoxide (CO) and carbon dioxide (CO)
2. Sulphur oxide - sulphur dioxide (SO) and sulphur trioxide (S0)
3. Nitrogen oxide - nitric (No), nitrogen dioxide (NO2) and nitrous
4. Volatile organic compounds (VOC) - hundreds of compounds such as methane (CH_4)
5. Suspended particulate matter (SPM) - thousands of different types of solid particles such as dust (soil), soot (carbon), asbestos, and lead, arsenic, cadmium, nitrate (N) and suphate (SO) salts, and liquid drop-lest of chemicals such as tetraoxo sulphate (VI) Acid (H SO_4) oil dioxins, and various pesticides
6. Photochemical oxidants - ozone (O_3), hydrogen peroxide (HO_2) hyfroxyl radicals (OH_2), and aldehydes such as formaldehyde (CH O) formed in the atmosphere by the reaction of oxygen, nitrogen oxides, and volatile hydrocarbons under the influence of sunlight.
7. Radioactive substances -radon -222, iodine-131, strontium -90, plutonium-239, and other radio-isotopes that enter the atmosphere as gases or suspended particulate matter.
8. Heat- produced when any kind of energy is transformed from one form to another, especially when fossil fuel are burned in cars, factories, homes, and power plants.
9. Noise- produced by motor vehicles, airplanes, trains, industrial machinery, construction machinery, law moweres, vacuum cleaners, sirens, earphones, radios, cassette players and live concerts.

A primary air pollutant, such as sulphur dioxide, directly enters the air as a result of natural events or human activities. A secondary air pollutant, such as sulphur acid, is one that is formed in the air through a chemical reaction between a primary pollutant and one or more air components.

3.1 Some Effects of Air Pollution

3.1.1 Effect on Human health

Human respiratory has a number of mechanisms that help protect us from air pollution.

Hair in our nose filters out large particles. Sticky mucus in the lining of our upper respiratory track captures small particles and dissolves some gaseous pollutants.

Automatic sneezing and coughing mechanisms expel contaminated air and mucus when pollutants irritate our respiratory system. Our upper respiratory track is lined with hundreds of thousands of tiny, mucus-coated hairs called cilia. They continually wave back and forth. Transporting mucus and the pollutants they trap to our mouth. Where it is either swallows or expelled.

Years of smoking and exposure to air pollutants can overload or deteriorate these natural defenses, causing or contributing to a number of respiratory diseases such as lung cancer, and chronic bronchitis. Elderly people, infants, pregnant women, and persons with heart disease, asthma, or other respiratory diseases are especially vulnerable to air pollution- Recent evidence on test animals indicates that nitrogen dioxide- a common pollutant from automobile exhaust- may encourage the spread of cancer throughout the body especially deadly melanoma.

Fine particles are particularly hazardous to human health because they are small enough to penetrate the lung's natural defenses. They can also bring with them droplets or other particles of toxic or cancer causing pollutants that become attached to their surfaces.

3.1.2 Effect on Plants

Several exposures of leaves to air pollutants can break down the waxy costing that helps prevent excessive water loss and damage from diseases, pests, drought, and frost. Such exposure also interferes with photosynthesis and plant growth, reduces nutrients uptake, and causes leaves or needles to turn yellow or brown and drop off. The effects of chronic exposure of some trees to multiple air pollution may not be visible for several decades. But suddenly large numbers being dying off because of soil nutrient depletion and increased susceptibly to pest, diseases, fungi moss and drought. This phenomenon is known as waldsterben (forest death).

3.1.3 Effects on Materials

Each year air pollutants cause tens of millions of dollars in damage to various materials. The fallout of soot and grit on buildings, cars, and clothing requires costly clearing Air pollutants have discolored irreplaceable marble statues, historic buildings and stained glass Windows throughout the world.

EXERCISE 8.1

1a. Identify three Air pollutants within your community
b. Write down the names of these pollutants and compare them with the 9 major air pollutant you learnt in this unit

3.2 Acid Rain

When electric power plants and industrial plants burn coals oil their smoke stacks emit large amounts of sulphur dioxide, suspended, particulate matter, and nitrogen oxides. To reduce local air pollution and meet government standards to spew pollutants above the inversion layer. As more power plants, and industries began using this fairly cheap output approach to controlling local pollution in the 1960s and 1970s pollutant in downwind areas began to rise.

As emissions of sulphur dioxide and nitric oxide from stationary sources are transported long distances by winds, they form secondary pollutants such as nitrogen dioxide, nitric acid vapour, and droplet containing solutions of Sulphate and nitrate salts. These chemicals descent to the earth's surface in wet form as acid rain or snow and in dry form as gases, fog, dew, or solid particles. The combination of dry deposition and wet deposition of acids and acid- forming compounds on the surface of the earth is known as acid rain. Other contributions to acid deposition comes from emissions of nitric oxide from massive numbers of automobiles in major urban areas.

3.3 Common Effect of Acid Rain

Acid deposition has a number of harmful effects, especially when the PH falls below 5.1. Including:

1. Damaging statues, building, metals and car colours
2. Killing fish aquatic plants, and micro- organisms in lakes and streams
3. Weakening or killing tress, especially conifers at high elevations, by leaching calcium, potassium and other plants nutrients from soil.
4. Damaging tree roots by releasing ions of aluminum, lead, mercury and cadmium into the soil.
5. Making trees more susceptible to attacks by diseases, drought and fungi and moss that thrive under acidic conditions.
6. Stunting the growth of crops such as tomatoes, soyabeans, carrots and cotton.
7. Leaching toxic metals such as copper and lead from city and home water pipers into drinking water.
8. Causing and aggravating many human respiratory diseases and leading to premature death.

4.0 CONCLUSION

The problem of Air pollution and Acid rain is a reality the consequences of which are obviously noticed on human hearth animals' plants and several other materials

We need to improve on our health air pollution monitoring technique legislation and enforcement. If we do these our world we be better for this - I mean your world - Nigeria.

5.0 SUMMARY

So far we have endeavored to talk together on Air pollution and Acid rain. We described how air pollution occurs and outlined nine major air pollutants these are Co_2, SO/SO, NO/N0, VOCs and SPM. Others are photochemical oxidants. Radio active substances, heat and Noise pollution

Effects of pollution on human health other organism including and other materials were discussed.
Acid rain or acid precipitation was also discussed. The effects of this deposit on human, animals, pants and other materials were outlined.

6.0 TUTOR MARKED ASSIGNMENT

1. Mention the names and symbols of any five major air pollutants
2. State two effects of air pollution on human health.
3. State one each of the consequences of acid rain on
   i. Plants
   ii. Cars
   iii. Metals
   iv. Building
   v. Human.

7.0 REFERENCES/FURTHER READING

Miller, G.T, (2001). *Environmental science working with the earth*. Mc Graw-Hill. New York.

UNIT 4 OCEAN: USE AND ABUSE

CONTENT

1.0 INTRODUCTION

In the previous Unit we discussed on air pollution and acid rain as global environmental problem induced by human activity. This unit on ocean- use and abuse seeks to explain the role or usefulness of the ocean to the earth and especially to humanity.

Unfortunately the beneficial of the ocean (humans) are the one working against the potential benefits acquirable from the ocean. This unfavourable action may be summed as pollution.

2.0 A: OBJECTIVES

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

- Discuss on the roles of the ocean to human
- Outline global observations on ocean pollution
- Mention specifically substances that are commonly known as ocean pollutants.

2.0 B: HOW TO STUDY THIS UNIT

1. You are expected to read carefully through this unit twice before attempting to answer the activity questions.
2. Do not look at the solution or guides provided at the end of the unit until you are satisfied that you have done your best to get all the answers.
3. Share your difficulties in understanding the unit with your mates, facilitators and by consulting other relevant materials or internet.
4. Ensure that you only check correct answers to the activities as a way of confirming what you have done.
5. Note that if you follow these instructions strictly, you will feel fulfilled at the end that you have achieved your aim and could stimulate you to do more.

3.0 MAIN CONTENT

The water that we use comes from two sources: surface water and groundwater. Water that not infiltrates into the ground or return to the atmosphere by evaporation or transpiration is called surface water. Surface water includes Oceans, seas, lakes, streams, wetlands, and so on.

Some water seeps into the ground and fill pores (spaces or cracks) in the soil and rocks in the earth's crust. The area where all available pores are filled by water is called ground water (Miller, 2001)

It was not unit the first colour picture of Earth came back from space that we knew our planet look blue and not red like mars. But little understanding of Geography may help anyone to guess (Ahove, 1998). Over 70% of the surface of the globe is ocean about 330 million square kilometers or 360 million square km when coastal water is also include. In fact all the landmass of the Earth would fit into the pacific Ocean alone and with room to space.

The ocean plays a vital role in sustaining life on Earth and the picture that is emerging from shared observations world over is not comforting for modern science, the sea is the very source of life on Earth. It is so to speak, the amniotic fluid which all living forms spring. Throughout history, the oceans have been vital to human civilization as a resource base, as a route to other lands and other people or as an outlet for population overflow. Over 90% of the planet's living and non-living resources are found within a few hundred kilometers of the coasts. On or near these coasts live two third or 60% of the world's population (UNESCO Sources, 1998).

3.1 Usefulness of Ocean to Humanity

1. Monetary

The ocean is not just a kind of vast, self-replenishing stock cupboard it is more like a giant economic community providing significant a resources the marine ecosystem is. If we had to pay for all the services and goods the ocean provides, such as regulating gases in the atmosphere, cycling nutrients, biological control, food production, raw materials and recreation, the total bill, the authors of the analysis, say would come to about 21,000 billion U.S Dollarsa pere coastal ecosystems (IYO, 1998).

Food for Humans

About 80 percent of the world's biodiversity live in the ocean, much of it undiscovered. The largely unexplored deep sea may be home to 10 million species we know nothing about. According to the United Nations food Agriculture Organization (FAO), an estimated 12.5 million fishermen vessels, land around 90 million tones of fish per year, the fishing industry provides a livelihood directly or indirectly to about 200 million people of small islands and coastal areas of developing counties, such as West Africa, seafood is main source of animal protein.

But according to FAO this once abundant resources has been fished near to exhaustion. Says FAO, 70 percent of fish stocks are currently either fully exploited, overfished or in the process of recovering from overfishing. Every year about 27 million tones of fish are thromn. Back, dead, either because they are inedible, unwanted or are too small to be marketed. Meanwhile factory trawlers rake the seabed for bottom- feeding species, destroying their fragile habitat rather like harvesting a vegetable garden with a bulldozer.

3. Energy from the Seas

The ocean contains very large-but finite- reserves of fossil fuels -oil and gas that are a valuable potential energy sources. The available figures as at 1992 put global off shore reserves to oil 36.5 billion tones and of gas at 21.4 trillion tones. These resources are already being exploited in many parts of the world. Other potential sources of energy include mechanical energy from waves, tides and currents and the thermal energy from the heat stored in the sea. So far, it is the ethnological and economic obstacles to tapping these resources that makes them so expensive.

4. Minerals

The abyssal plains of the deep -sea bed in many areas strewn with mineral nodules-mostly made of manganese, but also containing copper, nickel and cobalt. Pipelines could, theoretically, be used to 'vacuum" the nodules into ships, but this is till too expensive to be worthwhile. The ocean floor is also a major reserve of sand and gravel which are needed for construction.

5. New Life Forms

In 1993, divers exploring the continuous seabed more than 3,500 meters under the North - Eastern Pacific discovered a community of giant tube worms, and bacteria that live in underwater volcanic vents, without oxygen or sunlight, under great pressure, in temperatures well over 200C and in a highly toxic environment containing poisonous hydrogen sulphide. Similar communities have been discovered in deep vents off the coasts of Japan. These totally new life forms do not depend on photosynthesis, but actually thrive on the superheated, hostile, poisonous water and smoke.

Scientists - especially from the Woods Hole Oceanographic institution in the USA and the Japan Marine Science and Technology Centre (JAMESTEC) have found that these "thermopile" (heat loving) bacteria live in symbiosis with the large organisms, transforming the hydrogen supplied into nutrients'. These bacteria have potential uses for waste treatment, food processing oil well services, paper processing, mining applications, and in the U.S dollars per year. Japan is already investing research into potential value is 3 billion industrial use for these new life forms.

6. Marine Biotechnology

According to Elisabeth Mann Borgese, marine biotechnology may still be in its infant, but Japanese scientists, who are leaders in the fleld, have already isolated 3.000 pharmaceutically active substances from marine animals and plants. A successful product, especially if it is an antiviral or anti -cancer drug, can be worth 1 billion U.S. dollars or more annually in world sales one such drug, used to treat herpes, currently maintains sales up to 1000 million U.S. dollars a year.

7. Marine Rainforests

In tropical areas, mangrove swamps and coral reefs provide complex living communities that protect the coastline from erosion and serve as habitats for an extraordinary diversity of plants and fishes.

Mangrove forests are resilient, unique ecosystems that provide breeding ground for fish as well as protecting coasts from erosion and the effects of storms, while filtering some noxious chemicals. They are, however, sensitive to oil spills and disturbances to the freshwater content of their environment. In some countries, mangrove forests are being cleared at a catastrophic rate to provide space for aquaculture fishponds - do not perform the vita ecological functions of the mangroves yet create toxic effluent.

8. A Vast, Interconnected System

Although the oceans and their adjacent seas each have their own names, they are more like an entwined, moving snake than the massive lakes we may imagine them to be. At the surface, water warmed by the tropical sun (sometimes reaching 30c) is transferred by an ocean current system towards high latitudes and the poles.

Where the atmosphere is very clod (for example, at the poles) there can be a major vertical transfer between the deeper layers of the ocean and the warmer surface water. Warm water from the tropic travels towards higher latitudes, where it meets clod air. Here, some of this water evaporates (forming fog and rain) and, as a result, the surface layer becomes cooler (as low as - 20c), denser and more saline. This denser water slowly sinks as it returns towards the equator on the global conveyor belt. This conveyor belt moves very slowly- about I mm/ sec taking as long as 1,000 years for a complete cycle.

3.2 Ocean Abuse: Pollution

Without the Ocean the earth would be as barren and inhospitable as Mars. Top on the list of the catalogue of problem facing the Ocean is pollution. More than 77% of marine pollution originates from land and nine- tenths of this is concentrated along the coasts where the ecological equilibrium is incredibly fragile. The major culprits are agriculture, waste- water and other industrial effluents. Fertilizers and pesticides contaminate rivers and other waterways they carry to the sea oil spills, one among the most obvious forms of pollution.

The steel, paper, textile, and agrochemical industries, among others, also pour their effluents into watercourse as factories spew toxic gases into the atmosphere. Traces of DDT can be found as far away as Antartica. About 0% of the total atmosphere pollution falls directly into the Oceans or may be carried down by rain. Traces of metals including posonous mercury are omnipresent in Seas and Rivers. Organic and inorganic matters are increasingly found at the extreme end of the food chain, notable in the mammary glands of whales and dolphims. Plastic objects and containers of all kinds, abandoned nets and other fishing equipment lead each year to the death of millions of animals that swallow or get trapped in the debris.

When the United Nations General Assembly agreed to declare 1998 the International year of the Ocean, they hoped it would serve to draw attention to the essential, but finite resources of the Ocean to show that there are already signs of stress from human activity, and to stimulate individuals, communities, organisations, and government to take action now to use the Ocean in ways that can be sustained for future generations. The year of the Ocean aims to obtain a commitment towards adequate protection of our Ocean resources. The health of the Oceans, and the wise, safe and sustainable use of the Ocean resources, should be an axiom for all government to accept and honour for the term benefit existence of their respective and collective peoples.

The capacity of the Ocean is huge, in terms of heat transfer, recycling so-called green house gases linked to global warming, absorbing pollution and sustaining marine life. But this capacity is infinite, not limitless. The Ocean is also very slow to react but when signs of stress appear, their effects can carry on for decades, even centuries. This evidence of stress often first appears around the edges, on the coasts.

He mounting tide of pollutants dumped into the ocean is a biological time -table of unknown megatonnage, with a fuse of indeterminate period, that threatens the very existence of not only Marine life, but all life on earth" says Elizabeth Dowdewell, Executive Director of the United Nations Environment Programme (UNEP). An estimated 100.000 man made chemical have been introduced into our daily life. Most of them end up in the Ocean (IYO, 1998).

The UNEP global Environment Outlook as at 1998 made some alarming observations on marine pollution:

1. An estimated 75% of Marine pollution's land -based, not accidents such as oil spills but human's daily activities;
2. About 70% of the waste discharged into the pacific receive no treatment;
3. Large quantities of agricultural and other contaminants are discharged to streams that flow into the Caribbean resulting in pollution from phosphorus, nitrates and pesticides;
4. About 50% of the Countries in West Asia have an oil -based economy which supply some nations the resources to develop an extremely intensive agriculture which have resulted to the pollution of the food chain, of rives and marine areas;

An alarming 1.2 million barrels of oil are spilled into the persian Gulf each year. In addition to these, Sewage deposit provides an overabundance of nutrients in the coastal waters, that cause algae rapidly to proliferate and decay, starving the water of oxygen, consequently the death of fish and other Marine life. Some species of algae bloom are toxic and can lead to food poisoning via shellfish.

This has led to the ban of the consumption of shellfish from some areas of Europe and North America. The drain of pesticides and fertilizer into water surface are example of what are known as "persistent organic pollutants "POPS". For example, the Arctic is being hit POPS arriving from other parts of the world. These are affecting the reproductive capacity and disease resistance of some predators in the region. Consequently, reports show that higher than normal levels of some of these chemicals have been found in the bodies of people in this region (of POPS) who have a diet rich in the fat of Marine animals.

4.0 CONCLUSION

You have learnt that our beautiful blue planet remains so as long as we “take good care” of the oceans of the world. To do this is for our benefits knowing fully well that we cannot really fathom the depth of the benefits humanity have and will continue to gain from a clean sea.

The only choice is to keep the oceans clean and free from pollution so we get the very best from our ocean anywhere it is located.

5.0 SUMMARY

We have come to the end of the ninth Unit of this course.

So far, we discussed on some essential facts, that the ocean is a basic source of water on earth. Also that there is an interaction between surface and ground water- but ocean is an example of surface water. 70% of the earth is covered by ocean little wonder the earth looks blue from outer space.

We also discussed in details the relevance or usefulness of the ocean. These usefulness includes financial benefits,, food, energy, mineral resources and discovery of organisms that would be of benefits to some aliment. This may also be solution to some diseases that are yet to find cure.

The effects of ocean pollution and some specific pollutants were mentioned.

6.0 TUTOR MARKED ASSIGNMENT

1. Explain why the earth looks blue from space and not red like Mars.
2. Discuss on any five roles the ocean plays as benefits to human.
3. Outline global observations on the state of ocean pollution.

7.0 REFERENCES/FURTHER READING

Iyo (1998). International years of the ocean. Paris. UNESCO.

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UNIT 5 GLOBAL FRESH WATER

CONTENT

1.0 INTRODUCTION

Fresh water is an natural resource of fundamental importance. Without fresh water life is a disaster on earth. There is no known alternative to fresh water especially for humans. No other liquid can be replace it. In this unit, our focus is on fresh water.

2.0 A: OBJECTIVES

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

- Give a profile for the global distribution of fresh water
- Discuss the limits of global fresh resource
- List the causes of wastage and degeneration of fresh water resource

2.0 B: HOW TO STUDY THIS UNIT

1. You are expected to read carefully through this unit twice before attempting to answer the activity questions. Do not look at the solution or guides provided at the end of the unit until you are satisfied that you have done your best to get all the answers.
2. Share your difficulties in understanding the unit with your mates, facilitators and by consulting other relevant materials or internet.
3. Ensure that you only check correct answers to the activities as a way of confirming what you have done.
4. Note that if you follow these instructions strictly, you will feel fulfilled at the end that you have achieved your aim and could stimulate you to do more.

3.0 MAIN CONTENT

There is a large quantity of fresh water on Earth, almost 1500 million cubic kms, but most of it is useless for us as it contains too much of salt. Total amount of available fresh water on our planet is only about 84.4 million cubic kms. The total global distribution of fresh water on earth's crust including ground water and water present as vapours in the atmosphere is given in table 10.1. Much of the water on earth's surface and ground water represents deposits which have accumulated over along period of time. Its input via precipitation exceeds the output; small amounts of fresh water accumulate as left over stock in ice-deposits lakes and reservoirs or underground. This is however large and the deposit may tend to disturb the natural system and the resource base in the long run and is detrimental to the environment (Okebukola & Akpan, 2006).

Table 10.1 Global distribution of Fresh Water

1.	Water in snow – caps, ice sheets, glaciers etc.	24,000,000
2.	Surface ponds, lakes and reservoirs	280,000
3.	Water in streams and rivers	1,2000
4.	Water present as soil moisture	85,000
5.	Underground water	60,000,000
	Total amount of fresh water on our planet	84,366,200

3.1 FRESH WATER AVAILABILITY

One essential source of fresh water for terrestrial life is precipitation. The moisture condenses in the atmosphere and forms rain, dew or snow which are brought back to earth's surface. Table 10.2 gives information about the quantities of fresh water which evaporates form earth's surface, the total amount of precipitation and annual surface runoffs. Etc.

Exercise 10.1

1. Make a list of sources of fresh water in Nigeria

Table 10.2: Annual water budget of our planets

Evaporation from sea surface	452,600
Evaporation from land surface	72,500
Precipitation of ocean surface	411,600
Precipitation on land surface	113,500
Surface and ground water runoff	41,000
Total evaporation from land and sea surface	525,100
Total precipitation on land and sea surface	525,100

You will observe from table 10.2 that oceans contribute about 4,52,600 cubic kms of water annually to atmosphere but receive only 4,11,600 cubic kms as precipitations.

The deficit is balanced by 41,000 cubic kms of surface and sub-surface runoff which they receive. On the other hand, land surface receives 1, 13,500 cubic kms of water as precipitation. The excess amount of drained off as surface and ground water runoff to oceans so he amount of water present in sea, on land surface, underground water, water present in atmosphere as vapor etc. are in a state of dynamic equilibrium. The excess water received by land surface, about 41,000 cubic kms has to flow back to sea- it can not be retained on earth's crust ordinarily.

The total annual precipitation of 5,25,100 cubic kms is not evenly distributed over earth's surface at a given point of time, the amount of perceptible moisture present in the atmosphere is maximum at equator begin equivalent to about 44mm of rains. At a latitude of 40^0 - 50^0 North and South, the available perceptible moisture would e about 25mm during summers and 10mm during winters as rain equivalent. At poles this yield ranges from 2mm in winters and 8mm in summers as rain equivalent. The amount of perceptible moisture in atmosphere is subject to large variations which depend on a number of factors. Whoever, it does make the equatorial belt the wettest zone. Rainfall decreases as we move out on either side of equator acquiring a seasonal character

3.2 Limitations of Global Fresh Water

Just like any natural resources, global fresh water resources, also have their own limitations. There is a final limit upto which humankind can draw water available in various deposits on earth's crust, without damaging the natural resources base or without causing any adverse changes in the environment around. What is this limit? Or to what extent will the withdrawal of fresh water by humanity be ecologically sustainable?

We have huge deposits of fresh water on earth's surface as well as in its sub-surface layers. Water in these deposits is in a state of perpetual movement from one compartment to another. However, inputs in each compartment are balanced by an equal output, so that a state of dynamic equilibrium is maintained. If withdrawal from any of these exceeds the input, the pool size diminishes. Total annual precipitation on land surface has been estimated to be 1, 13500 cubic kms and loss via evapo-transpiration about 72, 500 cubic kms. Therefore, there is a net annual gain of about 41, 000 cubic kms on land surface, which trickles out, drains down and flows back to the sea. This is the extra amount which can be safely used by humankind without causing any detrimental effect on ecology or environment because it use does not disturb the existing deposits n earth's surface. Any over-draft beyond this quantity either from surface deposits of ground water diminishes the natural resources base which in turn could bring about adverse changes in a drastic change and desertification follows.

Of this 41, 000 cubic kms of surplus water about 27, 000 cubic kms consist of flood flow which rush down to sea, too quickly to be of use. It is only about 9, 000 cubic kms which can serve humanity.

The ill effects of withdrawal of more water than the total annual input may be drastic. In United States, some states namely Colorado, Kansas, Nebraska, New Mexico and Oklahoma, relied heavily on the underground fresh water aquifer called Ogallala for the supply of fresh water. Its depletion due to huge over-drafts in these states caused the total agricultural area to decline by more than 15%.

3.3 Human's Water Requirement

Water is required virtually every sphere of human life. It is needed for direct consumption or indirectly for washing, cleaning, cooling, transportation or even for waste disposal, important sectors of human activity which require water can be grouped as follows:

- Irrigation
- Industries
- Livestock
- Thermal power generation
- Domestic requirements
- Hydro-electric generation, fishes, navigation and recreational activities.

About 3, 500 cubic kms of water are drawn for human use every year. Agricultural sector is the biggest consumer of fresh water. Almost 76% of the total water used by humankind has to be diverted to grow food. To produce 20 tons of organic matter in terms of fresh weight, 2000 tons of water has to be provided to the roots. Most of it is lost in transpiration. Water fixed is actually 3 tons for every 5 tons of dry organic matter produced. Following agriculture, power generation (6.2%) and industries (5.7%) are the biggest consumers of fresh water. Domestic requirement and livestock management taken together consume only 4.3 % of the total water drawn. Navigation, fisheries, hydro-electric power generation, recreational activities etc. also require a huge quality of water, much of which flows down to the sea.

The amount of water drawn for human use is never used up completely. A large fraction is returned to the surface deposits or stream flown often in a polluted state which can be used again as such or after treatment to remove impurities. Out of the total quantity of water drawn (3, 500 cubic kms) the amount of water irrecoverably consumed is estimated to be about 2, 200 cubic kms.

3.4 Causes of Fresh Water Wastages

Okebukola & Akpan (2000) outline the following issues likable to watages and degeneration of fresh water.

- **Reckless Over-Consumption and Misuse**

  Water is often misused recklessly. Taps are kept running while people do other things. Everywhere we tend to use more water than is actually necessary, often because it is available in plenty or because we can afford the wastage. Such an attitude causes over consumption and wastage.

- **Pollution of Natural Waters**
  These aquatic systems have also been used as a convenient means of disposal of waste waters. Both running and stagnant waters are capable of degrading the discarded materials into simple and harmless constituents. However, in stagnant waters the products of decay and decomposition persist in the system whereas in running waters they are carried away with water currents. With a sudden rise in human population the volume of wastes are no longer capable f decomposing these impurities. Most of our bodies streams can rivers have become polluted and unfit for human use.

- **Eutrophication of Natural Waters**
  Eutrophication is a natural phenomenon which involves gradual enrichment of nutrient ad development of plant and animal life in a lifeless water body. Natural eutrophication is, however, a very slow. This process is accelerated by addition of wastes and waste waters which contain plenty of nitrates, phosphates and organic matter. While phosphates and nitrates are essential plant nutrients, decay and decomposition of organic matter yield plenty of plant nutrients. Addition of wastes an sewage causes the water body to become exceedingly rich in plant nutrients. Blooms of algae and other organisms appear and make the water useless.

- **Pollution of Underground Water table**
  Underground water deposits receive their waters from surface waters which percolate down the upper strata of soil and rocks. Though soils possess efficient biological machinery which effectively degrades impurities present in the water, a number of materials resistant to degradation as well as non-degradable matter may pass through the upper layers of the soil and pollute the underground waters. Salts of chromium, cadmium, mercury, lead etc may be present in underground waters in concentrations sufficient to cause harmful effects on a living system.

- **Depletion of Underground Water Table**
  Pressure of demand on underground water resources has gone up considerably. Every year and more water is drawn up from sub-surface layers whereas recharging of underground water has been slowed down. Massive deforestation has caused disappearance of plant cover over a large area of land surface. In the absence of plant cover, most of the rain water flows out and down quickly in streams and rivers. Little of it percolates down to sub-surface layers to recharge the ground water stock.

3.5 Management of Fresh Water

The follow management techniques we discussed by Okebukola and Akpan (2000) for effective fresh water conservation.

- **Water Economy, Re-Use and Recycling**

  Much of the surplus water is returned to surface flow in an impure state. A little care can reduce the over- consumption. We waste because of its easy availability. If a water meter were installed and money charged for every bucket of water we use, water consumption in domestic establishments, livestock management and industries would drastically decline.

  Power generation is another sphere of human activity where in a large amount of water is needed. Most of it, however, is used as coolant (about 90-95%). Irrecoverable consumption is only 5-10%. Water used once may be used again for another purpose. All processes do not require good-quality water. Agricultural runoffs from fields can likewise be used to irrigate cropland down the stream while an efficient use of water with conditions of proper drainage can significantly reduce the agricultural runoffs.

- **Development of an efficient distribution system**

  Water resources are not distributed evenly. Therefore, transport of water from one place to another becomes an essential part of water conservation efforts. Many river basins have plenty of water which flows down unused to the sea. This surplus can be diverted to drier regions through a system of canals and pipes. Water drawn out from underground water can not be transported to zones where underground water can not be tapped.

- **Reduction of Pollution and Recycling of Water**

  Pollution spoils huge quantities of our surface water. All possible efforts should be undertaken to divert waste waters to some treatment plant instead of releasing them into our surface waters. While treated water can be safely discharged in our aquatic systems, it may also be recycled where there is more pressing need.

- **Enhancement of Surface Storage Capacity**

  About 27, 000 cubic kms of fresh water which rush down to the oceans through streams and rivers of the world as flood flow are of no use to humankind. We can store this water in tanks and reservoirs for use during drier seasons. This can be done by erecting embankments and dams which check the flood-flows and detain water for longer duration on land surface. Through a system of pipes and canals the water can be supplied wherever needed. The potential energy, the energy of water flow as it moves from a higher place to lower may be used in hydroelectric power generation, while the reserviors which develop behind the dam may be used for fisheries and other recreational activities.

- **Improvement of Underground Storage Capacity**

  An enormous amount of fresh water is stored in underground deposits. It represents accumulation over a long period of time. Every year, about 10-15% of total precipitations enter the ground water table. These deposits regularly feed streams and rivers during drier periods.

Groundwater deposits are cheap and easily obtainable source if freshwater- except for the cost involved in its withdrawal. We can improve the ground water storage capacity of earth crust by providing an effective plant cover over the soil surface. Plants obtain most of their water from soil moisture and keep the surrounding cool and humid, thereby, preventing excessive loss of water through evaporation.

- **Augmentation of Existing supplies of fresh water**
  Many regions of the world with scanty rainfall have no other choice but to augment their water supplies buy other means. This can be done by:

(i) Desalination of sea water: A huge store of water exists in our ocean. Only if the salt content of sea is removed we can use the water for consumptive purpose. This can be done by desalination plants, which are essentially huge distillation sets operated on solar energy. Desalinization plants are already under operation in many countries. However, these plants are very expensive.

(ii) Artificial rain making: in general only 20-30% of the moisture content of atmosphere over a locality precipates as snow or rains. It has been observed that clouds with temperatures ranging between 5^0-20^0C nearly always lack condensation nuclei over which moisture condenses to form droplets of water. Small particles of substances like silver iodide, sodium chloride, dry ice (solid $C0_2$) etc, are injected into a thick layer of clouds (cumulus clouds), around which moisture condenses and droplets of water form which sink down as rains. In a number of countries active experiments are being carried out in this direction. However, the process of artificial rain making is still in an experiment stage.

4.0 CONCLUSION

95% of world's water is in the ocean. The rest is in snow, ice, bodies; of fresh water and ground water comprise the rest. Fresh water sustains the value of life.

Jus as we take the air we breathe for granted, we hardly think of our dependence on fresh water. We worry for too regularly about its pollution and effects perhaps since water comes to some of us so cheaply and easily. Yet many rural dwellers spend up to six hours a day retrieving water from distant, and often polluted streams, so far, no "dead" ocean has been found, rendered lifeless from human waste. But several lakes, river, around the world have been read their last rites in just the past 40 years. The challenge now to you and I is to resurrect them and keep others from similar experience.

5.0 SUMMARY

Much of the water on earth's surface and underground water represents deposits which have accumulated over a long period of time. An important source of fresh water terrestrial life is precipitation. Like all other natural resources, global fresh water resources, also, have their own limitation.

Irrigation, industries, livestock, management thermal power generation, domestic requirement, and hydro-electric generation are some sectors of human activity which require water. The future estimates of water consumption provide a grim picture. Reckless over consumption and misuse as well as pollution of natural waters are some of the causes of wastage and degeration of fresh water resources.

6.0 TUTOR MARKED ASSIGNMENT

1. Outline and discuss five causes of fresh water wastage and degeneration
2. Mention and Explain four Management Methods of fresh water conservation.

7.0 REFERENCE AND OTHER RESOURCES

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