MODULE 1

UNIT 1 INTRODUCTION TO ENVIRONMENTAL HARZARDS AND DISASTERS

CONTENTS

1.0 INTRODUCTION

Welcome to yet another exiting and interactive learning on the environment. You need to know that you belong to the privileged few that have theopportunity to acquire knowledge and skills that can reshape our best out of thisclass that is devoted to Environmental Hazards.

Environmental hazards may be considered as a special type of environmentalproblem that demands special attention that is why environmentalist at theNational Open University of Nigeria has devoted an entire course to this globalenvironmental problem that is threatening the existence of humanity.

This first chapter is the first of a series of ten designed to stimulate yourintellectual appetite; hence it will introduce you to environmental hazards.

2.0 OBJECTIVES

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

- explain the concept of environmental hazards;
- list four types of environmental hazards;
- state two effects of natural hazards on the development of a building facility in a site prone to any named environmental hazards; and
- State and discuss two preventive measures for reducing environmental hazard.

2.1 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

3.1 Concept of Environmental Harzards

Environmental hazards may be likened to Environmental resources as both evolvefrom the Earth's natural systems howeverenvironmental hazards are more of a negative resource. So it is a clear fact that inevery sense that environmental hazards are an element of the environmentalproblems currently capturing so much public attention. They cause the alterationof natural ecosystems; heighten the effects of those ecosystems degradation,thus reflecting the human induce d damage done to the environments, and manytimes affecting a large human population.

Traditionally almost every environmentally related book on natural hazards paintsthe picture of a chronicle of death and destruction, a similar accounting ofdamage avoided is almost never included. But the effects of the disaster causedby natural hazards can be greatly reduced by action taken in advance to reducevulnerability to them. Industrialized countries have made progress at reducing theimpacts of hurricanes, floods, earthquakes, volcanic eruptions and landslides(OAS, 1990).

For instance, Hurricane Gilbert, recorded as being the most powerful hurricaneever recorded in the Western Hemisphere, was said to be responsible for 316fatalities, though less forceful hurricane killed thousands of people earlier in thecentury. A combination of zoning restrictions and improved structures togetherwith new prediction, monitoring, warning, and evacuation systems made thedifference. Latin America n and Caribbean countries have reduced loss of life fromsome hazards, principally through disaster preparedness and response; they nowhave the opportunity to reduce economic losses through mitigation in the context of development to a greater extent than they have to date.

The disasters caused by environmental hazards generate a demand for enormousamounts of capital to replace what is destroyed and damaged. The developmentcommunity should address this issue because it affords, among all environmentalissues, the most manageable of situations: the risks are readily identified, mitigation measures are available, and the benefits that accrue from vulnerabilityreduction actions are high in relation to costs.

3.2 The Toll of Environmental Hazards

Today the depressing regularity of environmental disasters is making headline News of National and International print and electronic media. Each year one or more hurricane strikes the Caribbean region.

REFLECTION
If this is the experience in your city or town, what would be yourreaction? Share your thoughts with at least two of your course mate.

The destructive ones noted in history include hurricane Gilbert in 1988 and Hugo in 1989, and Katrina in 2005 caused billions of dollars of damage. Flooding, too, occurs annually, but no reliable estimates are available of the cost in human live and property. Earthquakes and volcanic eruptions Ruiz in unpredictable with disastrous effects: the mudslide precipitated by the eruption of Volcanic Ruiz in Colombia in 1985 killed 21, 800 people, and earthquakes in Mexico (1985) and ElSalvador (1986) together killed more than 10,000 (OAS, 1990).

Landslides are limited in area. But occur so frequently that they account for hundreds of millions of dollars in damage every year. While not as spectacular, drought can be more harmful to agricultural production than hurricanes. After the1971 drought, for example, banana production in Saint Lucia did not recover fullyuntil 1976. Disaster aid, however, is scarce in the region for these types of pervasive, slow-onset hazard.

Over the past 30 years average annual costs of natural disasters to Latin America and the Caribbean were 6,000 lives, adverse effects on 3 million people, and US$1.8 billion in physical damage. Moreover, the impacts are

increasing: during 1960s approximately 10 million people were killed, injured, displaced, or otherwise affected; the number for the 1970s was six times larger, and for the 1980s, three time larger.

In addition to the direct social and economic impact, natural disasters can affect employment, the balance of trade, and foreign indebtedness for years after theiroccurrence. After Hurricane Fifistruck Honduras in 1974, for example, employment in agriculture decreased by 70 percent. Funds intended for development are diverted into costly relief efforts. These indirect but profound economic effects and their drain on the limited funds now available for new investment compound the tragedy of a disaster in a developing country. Furthermore, international relief and rehabilitation assistance has beeninsufficient to compensate countries for their losses; during the period 1983 1988, reconstruction assistance amounted to only 13 percent of the estimated value of losses (OAS, 1990).

3.3 Environmental Hazards and Development

The losses are a concern not only for the countries in which they occur but also for international lending agencies and the private sector which are interested in protecting their loans and investments. The investments are often at risk of both environmental hazards and the side effects of development projects thatexacerbate these hazards. For example, excessive erosion and siltation reduces the useful life of large multipurpose dams.

Many smaller dams in the region also experience these types of damage: accelerated erosion caused by a hurricane filled half the storage capacity of a reservoir in the Dominican Republic virtually overnight. As a result of these concerns, one important lender, the Inter-American Development Bank, is studying the process of evaluating dam projects on the grounds that more realistic methods of estimating life expectancy and cost-benefit ratios will have to be introduced if the problem of erosion and estimating life expectancy and cost-benefit ratios will have to be introduced if the problem of erosion and siltation cannot be resolved satisfactorily for any project.

While the development efforts of the past have brought economic advancement to many parts of the world, they have also brought unwise or unsustainable uses of the natural resources base. Indeed, in recent years, the United Nations specialized conferences on the human environment, desertification, water management, deforestation, and human settlements all point to environmental degradation brought about by development, and the corresponding reduction inthe capacity of an ecosystem to mitigate natural hazards.

Nevertheless, development agencies often continue to operate as though their activities and natural disasters were separate issues.

REFLECTION
As Gunnar Haman points out in Prevention is Better than Cure:When a disaster has occurred, development agencies have regarded it as a nuisance and tried to avoid becoming involved; or even worse, the risk of existing or new potential hazards has been over-looked in the planning and implementation of some development activities, it is now being observed that intensive development may be the cause of many new disasters in poor countries.

Until quite recently, in fact, many practitioners believed that development efforts themselves would spontaneously provide solutions to problems posed by natural hazard.

Environmental deficiencies generated by the conditions of underdevelopment and natural disasters pose grave problems and can best be remedied by accelerated development through the transfer of financial and technologicalassistance as a supplement to the domestic effort of the development countries (OAS, (1990).

In the intervening eighteen years enormous amounts of financial aid and sustained technical assistance have been provided, but far from reducing the effects of natural disasters, development has contributed to disaster vulnerability in areas where the presence of hazards was not properly assessed.

While the link between natural disasters and development has been demonstrated repeatedly, governments and lending agencies do not yet systematically integrate the consideration of natural hazards into project preparation. Past losses and the vulnerability of infrastructure have reached such levels that in some areas development assistance consists almost entirely of disaster relief and rehabilitation.

When loan proceeds are routinely programmed for reconstruction, little remains for reconstruction needs have brought about a reassessment of economic development programs in Bolivia, Colombia, Ecuador, El Salvador, Guatemala, Nicaragua, Peru, the Paraguay River Basin, and several Caribbean island countries. There is a growing awareness that natural hazard management is a pivotal issue of development theory and practice. The United Nations declare d the 1990s as the International Decade for Natural Disaster Reduction (IDNDR) and called on developing countries to participate actively in reducing disaster vulnerability. The Organization of American States (OAS) has endorsed the IDNDR and made natural hazard management a priority technical assistance area.

3.4 Perspectives on Prevention and Reconstruction of Natural Hazards

A key element to be addressed in this decade is the distribution of resourcesbetween disaster prevention and post-disaster efforts. Prevention, which includesstructural measures (e.g., making structures more hazard-resistant) and non-structural measures (e.g., land-use restrictions), is a cost-effective means ofreducing the toll on life and property.

Post-disaster relief and reconstruction measures are important for humanitarianreasons, and may include improvements that are designed to prevent or mitigatefuture disasters. This is increasingly the case in projects funded by developmentfinancing organizations. Nevertheless, post-disaster measures aredisproportionately costly for each life save d and each building reconstructed costsof jobs and production associated with disasters. It is useful in this regard todistinguish between hazard management and disaster management. Both includethe complete array of pre-event and post-event measures, but they differ in theirfocus. Disaster management is concerned with specific events that destroy lives and property to such an extent that international assistance is often needed (Hogan &Marandola, 2007).

Hazard management addresses the potentially detrimental effects of all natural hazardous events, whether or not they result in a disaster; it is the more inclusive of the two terms, seeking to incorporate consideration of natural hazards in all development actions, regardless of the severity of the impact. It thus concentrates more on the analysis of hazards, the assessment of the risk they present, and the prevention and mitigation of their impact, while disaster management tends to concentration more on preparedness, alert, rescue, relief, rehabilitation, and reconstruction.

Despite the clear economic and humanitarian advantages of prevention, it is relief and reconstruction measures that typically enjoy political and financial support. Donor nations quickly offer sophisticated equipment and highly trained personnel for search and rescue missions. Politicians of a stricken nation gain more support from consoling disaster victims than from requesting taxes for the un-dramatic measures that would have avoided the disaster.

Short-term efforts to address immediate needs usually take precedence over longterm disaster recovery and prevention activities, particularly given the visibility attached to the relied phase of disaster by the mass media. It is not surprising. Therefore, to find that of all funds spent on natural hazard management in the region, more than 90 percent goes to saving lives during disasters and replacing lost investment; less than 10 percent goes to prevention before disasters.

The situation is similar with respect to science and technology as opposed to basic information on the location, severity, and probability of events-the data

that provide the basis for prevention measures. A sound balance must be sought between obtaining additional scientific information and applying existing information to institute mitigation measures resting chiefly on economic and political organization and process.

3.5 Reducing the Impact of Natural Hazards

There are information and techniques designed to minimize the effects of eve n the most sudden and forceful of hazardous events and prevent than causing a disaster. But in some instances the situation itself cannot be avoided,construction measures and location decisions can help save lives and avoid damage. In some instances, such as flooding, the integration of hazard mitigationmeasures into development planning and investment projects may make itpossible to avoid the hazards entirely.

Mitigation measure is better seen as a fundamental investment, essential to alldevelopment projects in high-risk areas, and not as a luxury that may not beaffordable. The vulnerability of many places around the world to hurricanes,earthquakes, volcanic eruptions, flooding, or drought is widely recognized.
Environmental planners should not ask the question whether these events willhappen, but what may occur when they do.

The normal single-sector planning technique can no longer maximize the benefitsof mitigation methods and may, in fact, increase the risk exposure of people andtheir property. Since the orthodox development project often represents anisolated intervention into complex and long- standing natural and socioeconomicprocesses, an advance in one area may not be accompanied by needed change inanother. When natural events subsequently exert pressure, the fruits of theproject may be lost to a disaster cause d by the deterioration of the natural andhuman environment related, in turn, to the project itself (Hogan &Marandola,2007).

Environmentally Integrated development planning, relatively implies, amulticultural approach. It accounts both for a change in associated sectors thatshare a defined physical space and for the changing relationships between sectorsas the result of an intervention. Underlying the integrated approach is theassumption that change is organic and that an initiative in one sector affects theregion as a whole.

Exercise 1.1

State two reasons, why Natural hazard considerations should be introduced at theearliest possible stage in a facility development process.

If a location designed for a housing estate is in an earthquake zone, this should be considered before it is planned for urban development. If a piece of

land is considered for agricultural project is subject to flooding, that should be taken into consideration in the formulation of the project. If environmental hazard risk is notice d on time in any planning process, lesser unnecessary projects will be carried forward simple on their own momentum.

Mitigation measures must be applied early, and non-structural mitigation, the most cost-effective mechanism, requires particularly early recognition of the need for land-use restrictions. As in environmental impact audit conducted on a projectalready formulated, an after-the-fact natural hazard assessment has much lessvalue than an evaluation conducted in time to impact the original formulation ofthe project.

4.0 CONCLUSION

You must have discovered by now that it a clear fact and in e very sense thatenvironmental hazards are an element of the environmental problems currentlycapturing so much public attention. They cause the alteration of naturalecosystems; heighten the effects of those ecosystems degradation, thusreflecting the human induced damage done to the environments, and many timesaffecting a large human population.

This call for the attention of all and sundry to take urgent steps that will educate and equip citizenry on how to handle environmental hazards.

5.0 SUMMARY

Environmental hazards may be likened to Environmental resources as both evolve from the Earth s natural systems but I want you to understand thatenvironmental hazards are more of a negative resource. But the effects of the disaster caused by natural hazards can be greatly reduced by action taken in advance to reduce vulnerability to them. Industrialized countries have made progress at reducing the impacts of hurricanes, floods, earthquakes, volcanic eruptions and landslides.

6.0 TUTOR – MARKED ASSIGNMENT

1. What are environmental hazards?
2. List four types of environmental hazards
3. State two effects of environmental hazard on the development of a building facility in a hazard prone site
4. State and discuss 2 preventive measures for reducing environmental hazards.

7.0 REFERENCES/FURTHER READING

Hogan, D.J. &Marandola, E. (2007).Vulnerability of Natural Hazards in population-Environment Studies. Background Paper to the Population-Environment research network (PERN) Cyberseminar on Population and Natural Hazards, 5-19 November.

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Other Resources

Lauwerys, J. A (1970). Man's Impact on Nature. New York. The American Museum ofNatural History.

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UNIT 2 EARTHQUAKE

CONTENTS

1.0 INTRODUCTION

In your last lecture we discussed environmental hazard, there is another environmental hazard it is calledearthquake. Earthquakes are one of the commonest environmental hazards thatare still challenging the survival instinct, capacity for survival and adaptivetechniques of humans to subdue the environment for comfort.

The occurrence of friction between rocks on either side of a fault prevents therocks from slipping easily or when the rock under stress is not already fractured,some elastic deformation will occur before failure. When the stress at lastexceeds the rupture strength of the rock a sudden movement occurs to releasethe stress. This experience may be simply described as earthquake or seismic slip.

2.0 OBJECTIVES

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

- explain what an earthquake is;
- state the form of earthquakes ; and
- differentiate between ground failure and earthquake

2.1 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.

3.1 Seismic Waves

Earthquakes simply demonstrate that the earth is consistently a changing system.They general depict a built up stress in the lithosphere which occurs along its, planar breaks in rock where there is displacement of the side relative to the other.

Often, the stress results into faults or breaks, at other times, it causes slipping along old, sting faults. When movement along faults occurs gradually relatively smoothly, it is called creep. Creep- is termed as seismic slip, meaning fault displacement without significant earthquake activity-can be inconvenient rarely causes serious damage.

When friction between rocks on either side of a fault presents the rocks from slipping easily or when the rock under stress is not already fractured, some elasticdeformation will occur before failure. When the stress at last exceeds the rupturestrength of the rock (or the friction along a pre-existing fault), a sudden movement occurs to release the stress. This is earthquake, or seismic slip. With the sudden displacement and associate d stress release, the rocks snap back elastically to their previous dimensions; the behaviour is called elastic rebound.

Faults come in all sizes, from microscopically small to thousands of kilometres long. Likewise, earthquakes come in all sizes, from tremors so small that even sensitive instruments can rarely detect them, to massive shocks that can level cities. Indeed, the seismic movement of creep is actually characterized by many micro-earthquakes, so small that they are typically not felt at all. The amount of damage associated with earthquake is partly a function of the amount of accumulated energy release d as the earthquake occurs.

The point on a fault at which the first movement or break occurs during an earthquake is called the earthquake, or hypocenter. In the case of a large earthquake s focus, for example, a section of fault may be kilometres long and may slip, but there is always a point at which the first movement occurred, and this point is the focus (Montgomery, 2006).

Deep- focus earthquakes are those with focal depths over 100 km, which distinguishes them from shallow-focus earthquakes. The point on the earth's

surface directly above the focus is called the epicentre. When news accounts tellwhere an earthquake occurred, they're port the location of the epicentre.

When an earthquake occurs, it releases the store d-up energy in seismic waves that travel away from the focus. There are several types of seismic waves. Body waves (P waves and S waves) travel through the interior of the earth. P waves arecompression waves. As P waves travel through matter, the matter is alternatelycompressed and expanded. P waves travel through the earth, much as soundwaves travel through air. S waves are shear waves, involving a side-to side motionof molecules.

Seismic surface waves are somewhat similar to surface waves on water. This means that they cause rocks and soil to be displaced in such a way that the ground surface ripples or undulate. Surface waves also come in two types: Somecause vertical ground motion, like ripples on a pond; other cause horizontal sharing motions. The surface waves are, large in amplitude-amount of ground displacement-than the body waves from the same earthquake. Therefore, most of the shaking and resultant structural damage from earthquakes is caused by the surface waves.

3.1 Magnitude and Intensity

All of the seismic waves represent energy release and transmission; they causeground shaking among people associated with earthquakes. The amount ofground motion is related to the magnitude of the earthquake. Magnitude is most commonly reported in countries using the Richter magnitude scale, named aftergeophysicist Charles F. Richter, who developed it.

Montgomery (2006) says that a magnitude number is assigned to an earthquake on the basis of the amount of ground displacement or shaking that it produces near the epicenter. The amount of ground motion is measures by aseismograph, and the size of the largest (highest-amplitude) seismic waves on the seismogram is determined.

The value is adjusted for the particular type of instrument and the distance of thestation from the earthquake epicentre (because ground motion naturallydecreases with increasing distance from the site of the earthquake) so thatdifferent measuring stations in different places will arrive at approximately thesame estimate of the ground displacement as it would have been measured closeto theepicentre value is assigned.

The Richter scale is logarithmic, which means that an earthquake of magnitude 4causes ten times much ground movement as one of magnitude 3, one hundredtimes as much as one of magnitude 2.

3.2 Occurrence and Severity of Earthquakes

Table 2.1

Descriptor	Magnitude Number	per Year	Approximate Energy Release (ergs)
Great	8 and over	1 to 2	Over 5.8x102 3
Major	7-7.9	18	2-42 x 102 2
Strong	6-6.9	120	8-150 x 1020
Moderate	5-5.9	800	3-55 x 101 9
Light	4-4.9	6200	1-20 x 101 8
Minor	3-3.9	49.000	4-72 x 101 6
Very mirror <3	(mag. 2-3 about	1000/day) (mag. 1-2 about 8000/day)	Below 4 x 1016

Source: *Frequency data and descriptors from National Earthquake Information Centre.*

Different observers in the same spot may assign different intensity values to a single earthquake. Nevertheless, intensity is a more direct indication of theimpact of a particular seismic event one vent on humans in a given place than is magnitude. The extent of damage at each intensity levels is, in turn, related to the maximum ground velocity and acceleration experienced. Thus, even in uninhabited areas, intensities can be estimate if the latter data have beenmeasured (Montgomery, 2006).

Several dozen intensity scales are in use worldwide. The most widely applied intensity scale in the United States is the Modified Mercalli Scale.

3.3 Ground Motion

Ground shaking and movement along the fault are obvious hazards. The offsetbetween rocks on opposite sides of the fault can break power lines, pipelines,building, roads, bridges, and other structures that actually cross the fault. In the1906 San Francisco earthquake, maximum relative horizontal displacement acrossthe San Andress fault was more than 6 meters. Fault displacement aside, theshaking produced as accumulate energy is release through seismic wave causesdamage to and sometimes complete failed of buildings, with the surface wavesespecially shear surface waves- responsible for most of this damage. Shifts ofeven a few tens of centimetres can be devastating, especially to structures made of weak materials or inadequately reinforced concrete.

When shaking continues, damage may become progressively worse. Such effects,of course, are most severe on or very close to the fault, so the simplest strategywould be not to build near fault zones. However, many cities have already developed near major faults. Sometimes, cities are rebuilt many times in suchplace. The ancient city of Constantinople- now Istanbul-has been leveled byearthquakes repeatedly throughout history. Yet there it sits.

Short of moving whole towns, what else can be done in these cases? Power linesand pipelines can be built with extra slack where they cross a fault zone, or theycan be designed with other features to allow some give as the fault slips andstretches them. Such considerations had to be taken into account when the Trans-Alaska Pipeline was built, for it crosses several known, major faults along itsroute(Montgomery,2006).

Designing earthquake resistant buildings is a developed challenge and is arelatively new idea that has developed mainly in the last few decades. Engineershave studied how well different types of building have withstood realearthquakes. Scientists can conduct laboratory experiments on scale models ofskyscrapers and other building, subjecting them to small-scale shaking designedto simulate the kinds of ground movement to be expected during an earthquake.

On the basis of their findings, special building codes for earthquake-prone regionscan be developed.

This approach, however, presents many challenges. There are a limited number ofrecords just on how the ground does move in a severe earthquake. To obtain thebest of such records, sensitive instruments must be placed near the fault zone.

*Earthquakes are generally followed by many aftershocks earthquakes that are*weaker than the principal tremor. The main shock usually causes the mostdamage, but when aftershocks are many and are nearly as strong as the mainshock, they may also cause serious destruction.

The duration of an earthquake also affect how well a building survival is. Inreinforced concrete, ground shaking leads to the formation of hairline cracks, which then widen and develop further as long as the shaking continues. Aconcrete building that can withstand a one-minute main shock might collapse inan earthquake in which the main shock lasts three minutes. Many of theCalifornia building codes, used as models around the world, are designed for a25-second main shock, but earthquake main shock can last ten times that long.

A final point to keep in mind is that even the best building codes are typicallyapplied only to new construction. When a major city is located near a fault

zone,thousands of vulnerable older buildings may already have been built in high-riskareas. The cost to redesign, rebuild, or even modify all these, buildings would bestaggering. Most legislative bodies are reluctant to require such efforts; indeed,many do nothing even about municipal buildings built in fault zones.

3.4 Ground Failure

Landslide can be a serious secondary earthquake hazard in hilly areas. Earthquakes are one of the major events that trigger slides on unstable slopes.The best solution is not to build in such areas. Even if a whole region is hilly,detailed engineering studies of rock and soil properties and slope stability maymake it possible to avoid the most dangerous sites.

Ground shaking may cause a further problem in areas where the ground is verywet in filled land near the coast or in places with a high water table.Thisproblem is infestation. When wet soil is shaking by an earthquake, the soilparticles may be jarred apart, allowing water to seep in between them, greatlyreducing the friction between soil particles that gives the soil strength, andcausing the ground to become somewhat like quicksand. Whenthis happensbuildings can just topple over or partially sink into the liquefied soil; the soil hasno strength to support them. The effects of liquefaction were dramaticallyillustrated in Niigata, Japan, in 1964. One multi-storey apartment building tippedover to settle at an angle of 30 degrees to the ground while the structureremained intact! (Montgomery, 2006).

Liquefaction was likewise a major cause of damage from the Loma Pietaearthquake and the Kobe earthquake. Telltale signs of liquefaction include sandboils, formed as liquefied soil bubbles to the surface during the quake. In someareas prone to liquefaction, improved underground drainage systems may beinstalled to try to keep the soil drier, but little else can be done about this hazard,beyond avoiding the areas at risk. Not all areas with wet soils are subject toliquefaction; the soil or fill plays a large role in the extent of the danger.

3.5 Tsunamis and Coastal Effects

Coastal areas, especially around the Pacific Ocean basin where so many largeearthquakes occur, may also be vulnerable to tsunamis. There are seismic seawaves, sometimes improperly called tidal waves, although they have nothing todo with tides. When an undersea or near- shore earthquake occurs, suddenmovement of the sea floor may set up waves travelling away from that spot, likeripples in a pond caused by a dropped pebble.

Contrary to modern movie fiction, tsunamis are not seen as huge breakers in theopen ocean that topple ocean liners in one sweep. In the open sea, tsunamis areonly unusually broad swells on the water surface. As tsunamis approach land,they develop into large breakers waves, just as Ordinary Ocean waves becomebreakers as the undulation waters touch bottom near shore.

The breakers of tsunamis, however, can easily be over 15 meters high in the caseof large earthquake. Several such breakers may crash over the coast insuccession; between waves, the water may be pulling swiftly seaward, emptying aharbor or bay, and very quickly speeds of 1000 kilometres/ hour (600 miles/hour) are not uncommon speeds and tsunamis set off on one side of the Pacificmay still cause noticeable effects on the other side of the ocean.

A tsunamis set off by a 1960 earthquake in Chile was still vigorous enough tocause noticeable effects on the other side of about 7-meter-high breakers whenit reached Hawaii some fifteen hour later, and twenty five hours after the earthquake, the tsunami was detected in Japan (Montgomery,2006).

Given the speeds at which tsunamis travel, little can be done to warn those near the earthquake epicentre, but people living some distance away can be warned in time to evacuate, saving lives, whenever a major earthquake occurs in the Pacific region, sea- level data are collected from a series of monitoring stations around the Pacific. If a tsunami is detected, data on its source, speed, and estimated time of arrival can be determined.

3.6 Fire

A secondary hazard of earthquakes in cities is fire, which may be more devastating than ground movement. In the 1906 San Francisco earthquake, 70% of the damage was due to fire, not simple building failure. As it was, the flames were confined to a 10-square-kilometer area only by dynamiting rows of building around the burning section. Fires occur because fuel lines and tanks and power lines are broken, touching off flames and fuelling them. At the same time, water lines also are broken, leaving no way to fight the fires effectively (Montgomery,2006).

4.0 CONCLUSION

Earthquake is one of the commonest environmental hazards that humans are yet to subdue. Thus earthquakes are still challenging the survival instinct, capacity for survival and adaptive techniques of humans to subdue the environment forcomfort.

5.0 SUMMARY

Earthquakes simply demonstrate that the earth is consistently a changing system. They general depict a built up stress in the lithosphere which occurs along its, planar breaks in rock where there is displacement of the side relative to theother. When the stress at

last exceeds the rupture strength of the rock a sudden movement occurs to release the stress. This experience may be simply described as earthquake or seismic slip.

The amount of ground motion is related to the magnitude of the earthquake. A magnitude number is assigned to an earthquake on the basis of the amount of ground displacement or shaking that it produces near the epicentre. Allearthquakes may be categorised as;

- Major
- Strong
- Moderate
- Light
- Minor
- Very mirror

Landslide can be a serious secondary earthquake hazard in hilly areas.Earthquakes are one of the major events that trigger slides on unstable slopes. The best solution is not to build in such areas.

6.0 TUTOR MARKED ASSIGNMENTS

1. Categorize and describe each of these earthquakes based on table 2.1?
2. Explain the meaning of earthquake
3. Differentiate between ground failure and earthquake

7.0 REFERENCES/FURTHER READING

Montgomery, C. W (2006).Environmental Geology.7th Edition. New York. McGraw Hill.

Other Resources

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UNIT 3 FLOODS

CONTENTS

1.0 INTRODUCTION

In your last lecture we discussed about the earthquake. In the present lecture, we will discuss another environmental hazard called ***flood***. The problem of flood is real and the consequences of this hazard have beencontinually felt in most of our communities. Among these four major NaturalHazards in Nigeria, flooding stands out as the most disastrous in Nigeria in term of life and properties loss in view of studies reported by Nest (1991), Ojo (1991),Ologunorisa&Adeyemo (2005) and Ojo (2007).

The outcomes from these studies are an indication that flooding should be givenadequate attention in terms of awareness, perception, experience, coping andmanagement strategies. This is what this unit strives to focus on.

2.0 OBJECTIVES

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

- define the term flood;
- list two types of flood you have studied;
- discuss on the causes of flooding;
- list the benefits of flooding; and
- explainthe effects of flooding.

2.1 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 daily usage and in common environmental literature, a flood may be referredto as a comparatively high flow of water that over-tops the natural or artificialbanks in any reach of stream. It is also regarded as an over flow or inundationthat comes from a river or other body of water and causes or threatens damageor simple as a deluge or inundation (see Ojo, 2007).

Flood can also be defined as the highest values of the stage or discharge of astream during the water year. This common view implies the distinction betweenfloods of the same magnitude, but there might have been in existence alsoseveral different inundations or none at all. If there are several inundations in ayear, the greatest one will be a flood but a flood need not be an inundation, evena dry year has a flood.

It is necessary to state here that these definitions do not contradict themselves.The latter is necessary only because of the technical exigency of including at leastone flood for every year in the computation of flood magnitudes and theirprobable frequencies of occurrence. A year for while a rare flood is recorded forinstance, will transform logarithmically to affinity which induces computationalproblem.

EXERCISE 3.1

1. In your own words describe what you understand as flood.
2. Find out from 4 of your classmate their perception of what constitutes as flood.
3. Find out from 3 people in your community their perception of what constitutes as flood.
4. Compare your perceptive and that of others with the definition and explanation of flood give n in section 3.0 above.

3.1 Types of Flood

Ologunorisa (2006) mentioned that flood have been divided into: River Floods andCoastal Floods.

3.1.1 River Floods

They are caused by precipitation acting either directly by rainfall, or indirectly bysnow or ice melt, and those resulting from dam collapse and earth slides. Floodsresulting from melting of snow and ice, with or without an additional incrementfrom rainfall, are a major component of hydrological region in the high latitudeareas a Canada, the United States and Russia, and parts of Europe and at highattitudes in the major mountain areas of Europe and Asia. Such floods normallyoccur only once a year.

In view of the markedly varying flood response to different rainfall conditions, many attempts have been made to classify rainfall floods on the basis of the storm event itself. Thus, Ward recognized two types, of river floods related to different causal factors:

(1) Flash floods, and
(2) Long rain floods.

Flash floods are often the results of convection storms; while long rain floods areassociated with several day convention or even weeks of low intensity rainfall andare the most common cause of major flooding.

The characteristics of long rainfall floods can be classified into four types.
These are:

- Flash floods of few hours duration;
- Single e vent floods of longer duration;
- Multiple even floods and
- Multiple event floods.

It should be noted that apart from the four discussed above, another type calledflood poundage occur on surface depression on urban and other surfaces.

3.1.2 Coastal Floods

They are of three kinds:

(i) Those caused by meteorological disturbances such as hurricanes and other disturbances at sea (Typhoons, cyclones, tsunamis, etc).
(ii) Those caused by seismic disturbance such as submarine earthquakes, landsides and other disturbances of the sea.
(iii) Lakeshore floods. The combination of the different types of floodsaccounts for 40 percent of the world's natural disasters. Earthquakes are butover-estimated while droughts are under-estimated probably because it is a non-event hazard. Apart from the high frequency of flood occurrence, most of theoverflow of river or seas. For example, flood- prone lands comprise about 5percent of the area of the Unite d States, more than 10 percent of the Hwang Hobasin in

China, almost all of the Netherlands and nearly all of the Southern part ofVietnam.

There is therefore an imperative need for a proper and comprehensiveunderstanding of floods, if the safety of flood plain occupancy and coastal areasare to be guaranteed Ologunorisa (2006).

3.2 Causes of Floods

Climatologists have discussed seventeen factors which may influence runoff andhence floods in any stream. These they divided under three broad categories vies:

- Climatic factors such as precipitation,
- Interception and physical factors; and
- Channel characteristics, including types and efficiency.

(1) Climatic factors, these are:
   (a) Precipitation form: such as rain (rainstorm floods), snow (snow melt floodsdue to ice jams, floods due to glaciers, floods due to earth-slide; types of precipitation, intensity, duration, time distribution, area distribution, frequency ofoccurrence, direction of storm movement, antecedent precipitation and soil moisture.
   (b) Interception vegetation species, composition, age and density of stands, season of the year, size of storm.
   Evaporation and
   (d) Transpiration.

(2) Physiographic Factors which include:
   (a) Basin characteristics such as size, shape slope, orientation, elevation, stream density.
   (b) Physical factors such as land use and land cover surface infiltration condition, soil type, geological conditions such as the permeability and capacity of ground water formation.
   (c) Topography factors such as the presence of lakes and swamps.
   (d) Artificial drainage.

(3) Channel characteristics including:
   (a) Carrying capacity such as size and shape of cross sections, shape roughness, length, tributaries, types and efficiency.
   (b) Storage capacity such as breakwater.

The effects of all these factors are fairly accurately known except for the effect ofland use. Among many physiographic factors that affect the runoff of any area,one of the important is land use and land management. Some environmentalistshave agree d that it is largely the human that apparently increased severity of allthese factors and in them alone insufficient.

Ologunorisa (2006) says that few scholars have discussed the causes of the mostdangerous floods of all. That is coastal floods. A hurricane for

instance causesdamage by the direct action of wind on property, by the accompanying heavyrainfall that causes river to flood. Hence the damage is from three sources, eachpotentially destructive in its own right, collectively, they are catastrophic.

Floods may also be caused by the encroachment of hydraulic structures and cities on floodplains and coastal lands and by blocking of river channels. The Ogunpariver flood in Ibadan on August 30 1980 for instance was wholly due to the blocking of the river channel with waste deposited by the residents of Ibadan (Ojo, 2007). Eventually, it was as if the river decided that it had created the channel and should therefore have the right of way. The entire channel was cleared in one swift flood along with over 200 residential building, over 200 livers and inestimable property.

3.3 Beneficent Effects of Floods

Of all the extreme events, none is more paradoxical than floods. That is because itis the most frequently occurring natural hazard that causes the greatest damageas well as the most beneficial effect. It is probably safe to attribute the rise andgrowth of the early loosely refers to the period when man settled and embarkedon cultivations of agriculture. Naturally, these early settlements (later to the Nile,Tigris, Euhrates, Indus and Hwange Ho.

All these rivers have over the years build expensive and fertile instrumentspossessed ideally suited to tilling with the crude instruments possessed by theearly man. Since the beginning of recorded time, humans have always had anaffinity for floodplains and riversides. This is because there is lack of road and railnetworks, and hence greeter affinity for floodplains and riversides.

Perhaps, the best example of the benefits of floods and floodplains is presentedby the river Nile and its valley. It covers and fertilizes large area of land. Thisresulted in the early occupancy and subsequent rise of civilization, in the Nilevalley. The Nile valley indeed has been a human anthill since very ancient time.

Today, the Nile valley with about 900 persons per square kilometres is one of themost densely settled, parts in the African continent. Farming is so completelyreliant on flooding to ensure that the River floods, the rive r channel is artificiallynarrowed in some stretches by the construction of levees. These hold back theexcess flood-water after the flood has receded. This dependence has given riseto such popular saying like Egypt is the Nile and the Nile is Egypt, No Nile, noEgypt, and the Nile gives life to the Egyptian desert.

Also some farmers along the lower zones of floodplains have adopted their croppattern, to annual overflow and they would be disappointed if flooding

were tofail. Here than are examples where floods are not only beneficial, but alsodesirably necessary for the substance of life. Other examples of floodplains givingrise to civilization are the early West African Empires of Ghana, Mali and Songhai who are most value possessions were the Region of present day Bamako. The Nokcultures also developed on the floodplains of the Niger.

Today, the Ganges delta and the Hwang Ho floodplains are some of the mostdensely settled parts of the world while valuable forest resources continue to beharvested on the Amazon floodplains.

A list of other advantages of the floodplains are:the fact that floodplains soils are normally more fertile and easier to till
than those of uplands,the flat lands characteristics of floodplains are less costly to build on,the moderate gradients are favourable for highways and railroadsconstruction and the abundance of water for various purposes attract humanoccupancy of the floodplains.

It is important to note that sites on riverbanks have always been attractivelocations for towns because they act as a focus for routes at bridging points.

Towns tended to develop first on bluffs or terraces close to the river. Consequentexpansion forces them to spread out on the floodplains, e.g London, Paris andWashington D. C. In Nigeria, examples of such towns include Makurdi, Jebba,Lokoja and Onisha (Ologunorisa, 2006).

Floods may also have other beneficial uses if they can be properly controlled andmanaged. The excess floodwater, for instance, may be held in reservoirs and usedto provide water for homes and industry in the dry season and generate hydro-electric power. For example, the Naser Dam in Egypt and the Hydro- Electricpower works at the Kainji Dam in Nigeria rely on high floodwater to be efficient.

The floodwater may also be used to r educe stream pollution and provideopportunity for fishing and recreation, and agricultural expansion schemes.

3.4 The Negative Effects of Flood

Flood has been known to cause damage to lives, landed property, household property, business, traffic, drains, surface and underground water. For an in-depth comprehension of flood effects, it is preferable to review a few catastrophic floods. The causes of floods are essentially the same differentiate d only in magnitude and the diversity of the victims (especially in their nature and response capability).

On August 31st, 1980, the Ogunpa River flowing through the city of Ibadan overflow its banks and all features encroach on its floodplains. Over 2000 persons perished in that flood (see Oyo State Year Book, 1981, P.2). The series of flood which hit the city of Kano between August 6 and 13, 1986 culminating in thecollapse of the Baguda dam and is estimated to have claimed at total of over 100lives.

No discussion of the loss of lives will be complete without mention of the HwangHo River (Translated from Chinese to mean Yellow River). This amazing river isresponsible for more human deaths than any other individual feature of theworld's surface. In 1887, a massive flood on this river killed over 2 million people(by drowning or starvation). In 1931, the worst flood ever claimed a total deathtoll of 3,700,000 people. Hence within a time span of only 44 years, the yellowRiver had depleted the Chinese population of by million people or more, which isabout the population of the entire Niger Delta. No wonder then that the river ismore popularly referred to as Chinese sorrow.

In 1970, a cyclone initiated a flood in the coastal areas surrounding the Bengal inBangladesh which killed about 225,000 people, crops worth about 63 milliondollars were destroyed and 280,00 herds of cattle were washed away (Burton, etal, 1978). These weather events range d from hurricane in the Americas to heavyrains resulting in flash floods and avalanches in the other parts of the globe. Indiahad the worst disasters with 3,320 dead resulting from cyclones, tornadoes, rainfloods, snow, rain and typhoons and snows. Nigeria (14) and republic of Benin (7)the way African countries listed ranked low not necessarily due to the mild natureof rainstorms which reliable records can be complied. WMO (1997) hasconfirmed that the 1995 figures were very close to 8,300 The number of countries which reported weather-related deaths was also similar 44 in 1996 and 42 in 1995. It is important to note that the largest fatalities are associate d with floods resulting from rain.

The most striking feature of these severe rain events is the amount per day which in India was about 12,00mml-1 for 12 consecutive days in August 1996 while in China falls totalled 70,000mmd-1 (also in August, 1996). In the case of China, live lost within demolished houses have not been full accounted for but about 2 million houses collapsed and 2,000 boats sank (Adefolalu, 2000).

Adefolalu (2000) further observes that the story in other parts of the world was not different, as most fatalities had to do with flooding arising from heavy rains. The case of United States of America deserves special mention if only to highlight that the low number of deaths (292) was not as a result of mild storms, snowstorms, or weak hurricanes and tornadoes but to the efficiency and high level of sophistication of early warning system (EWS) and the accuracy of the NEW-CASTING Techniques which connect over 1,000 Radar network to the GlobalTelecommunication System (GTS) from which India houses derive their 30-minuteforecasts of the weather.

Further, the underground shelter system allows for immediate evacuation ofpeople rather than transporting them over long distances at great danger. It isnoteworthy that only, 24 fatalities accompanied 1,200 tornadoes in 1996-a figurethat was 5 less than in 1995 and less than 30% of the average annual deaths, (82).

These go to prove that in terms of averting death, the United State of America isfar ahead of the whole world in their EWS and public enlightenment/sensitizationcampaigns on extreme weather events.

Despite their ranking as numbers 1 and 2 world population, China and India tendto lead in rating catastrophic losses of life in weather-related event. Nigeria has afair rating of 1 out of every 7.7 million at risk of dying in any major weatherdisaster. This, of course, does not represent the total picture, as reports cannot
be said to be complete due to lack of reliable (reporting) network. For instance,air disaster and multiple road accidents occurring in bad weather in 1996 wouldhave changed the total figure if properly accounted for. However, the rate offatalities in normally occurring severe weather events in Africa is amplified by theother rating for Egypt, Ethiopia and Malagasy.

4.0 CONCLUSION

The reality of the terrible effects of flood hazards have clearly been shown in thisunit and that the benefits are nothing to compare with relative to the negativeconsequences.

5.0 SUMMARY

Flood is referred to as a relatively high flow that over-tops the natural or artificial boundary of a water body. It is also regarded as an over flow or inundation that comes from a river or other body of water and causes or threatens damage or simple as a deluge or inundation. Flood can also be defined as the highest values of the stage or discharge of a stream during the water year.

Floods have been divided into: River Floods and Coastal Floods and we have two types of river floods related to different causal factors:
(1) Flash floods, and
(2) Long rain floods.

Flash floods are often the results of convection storms; while long rain floods are associated with several day convention or even weeks of low intensity rainfall and are the most common cause of major flooding.

There are four characteristics of long rainfall floods, these are:
- Flash floods of few hours duration;

- Single e vent floods of longer duration;
- Multiple even floods and
- Multiple event floods.

Coastal Floods are of three kinds:

1. Those caused by meteorological disturbances such as hurricanes and other disturbances at sea (Typhoons, cyclones, tsunamis, etc).
2. Those caused by seismic disturbance such as submarine earthquakes, landsides and other disturbances of the sea.
3. Lakeshore floods

There are seventeen factors which may influence runoff and hence floods in anystream. These are divided under three broad categories:

- Climatic factors such as precipitation,
- Interception and physical factors; and
- Channel characteristics, including types and efficiency.

Of all environmental hazards, none is more paradoxical than floods. Simply because it is the most frequently occurring natural hazard that causes the greatest damage as well as the most beneficial effect. Perhaps, the best example of the benefits of floods and floodplains is presented by the river Nile and its valley. History tells us that it covers and fertilizes large area of land. This resulted in the early occupancy and subsequent rise of civilization, in the Nile valley.

6.0 Tutor – Marked Assignments

1. Define flood
2. List two type of flood which you have studied
3. Discuss the causes of flood
4. What are the benefits of flood

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UNIT 4 DROUGHT& DESERTIFICATION: CONCEPTS AND CAUSES

CONTENTS

1.0 INTRODUCTION

Drought and desertification are becoming popular environmental problems in Nigeria today. This emerging popularity has made these twin environmental hazards essential for us to study in Nigeria and especially at the Open University. In this unit we shall study with clarity the concepts of drought and desertification. The causes of these environmental hazards will be analyzed systematically and the root cases will also be traced in details.

2.0 OBJECTIVES

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

- describe what is drought;
- list the three major types of global drought;
- state seven features of drought;
- describe what desertification is;
- state five indicators of desertification; and
- discusson two basic causes of desertification.

2.1 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

Drought has been described as an extended and continuous duration of very dryweather (Jones, Robertson, Forbes, &Hollier, 1990). I want you to understandclearly that this definition varies from country to country, since weather varies. Inthe UK, three types of drought are recognized:

(a) total drought is a period of 15 or more consecutive days with a rainfallbelow 0.2mm;
(b) partial drought has a duration of 29 successive days with an a mean rainfall of 0.2 mm or less per day;
(c) a dry spell has a duration of 15 or more successive days, during which therainfall does not exceed 1 mm per day.

But in the United States, a dry spell is a period;

1. Of 14 days without measurable rainfall.
2. A period with an experience of insufficient water supply to meet usual domestic,agricultural and industrial demands. Drought takes place under many climatic regimes and may vary in severity from the minor and short-lived summer restrictions on washing cars and watering gardens in southern and eastern England to catastrophic events such as the development of the Dustbowl in the American Midwest during the 1930s and the large-scale crop failures during the Ethiopian famine of 1985.

Drumlin, an elongated hummock of uncertified glacial all deposited and molded below an incensed. Drumlins may be up to 36 mm length 60 m in height and theparallel to the direction of the former ice flow with their steeper blunt end facingupstream. Drumlins usually occur in clusters or swarms, giving rise to a basket-of eggs topography. The sands and gravels in drumlins are often extracted for construction and industrial purposes.

There is no generally accepted definition of drought, but understand that it is generally accepted that the menace is characterized by moisture deficiency, when the demand for water for particular water use system exceeds the supply available from various sources.
Droughts have been recorded as recurrent phenomena in Nigeria in general and more specifically in the Sudano-Sahelain regions, which are the areas of West Africa characterized by droughts and desertification.
As in most parts of the world, precipitation is the most significant avenue of water supply-demand component of most of the water use systems. Therefore, are closely associated with droughts and with many definitions of droughts.

Globally, there are three basic types of drought;

- meteorological drought,
- agricultural drought and
- hydrological drought.

The metrological drought is usually said to take place when there is a prolonged absence or deficiency or inadequate distribution of precipitation.

REFLECTION
Have you ever had this experience of metrological drought in your community? Ifyes, what was your survival strategy? If no was your answer make inquiry frompeople or individual from your community who you hope to have had such anexperience at one time or the other.

It is often defined as a percentage of the long-term average rainfall in a given location. There are many variations of this definition and this makes meteorological drought apparently difficult to identify with any degree of accuracy.

Compared to meteorological droughts, agricultural droughts have been observedto take place when there is insufficient moisture available at the appropriate time to meet evaporative demand by crops, vegetation, pastures and other agricultural systems; as a result, yield and/or absolute production decline (Ojo, 2007).

Crops requires varying moisture needs through their growth and development periods, and therefore, the timing of rain is essential in rain-fed agricultural regions in determining whether there will be a good harvest or a poor one. Hydrological drought takes place when the water needs of plants cannot be met by available precipitation.

Some of the features of drought were articulate d by Ojo (2007) are:

(a) Low rainfall and high rainfall variability.
(b) High evaporation and potential evapotranspiration rates
(c) Generally persistent negative rainfall anomalies
(d) Occasional torrential rains resulting in floods
(e) Rapidly high erosive runoff especially on steep terrains
(f) Sparse vegetation cover
(g) Too little moisture for rain fed cultivation throughout the year

Drought is no doubt an inevitable and often devastating phenomenon. In general,droughts have occurred throughout the available historical record of climate inWest Africa. Severe droughts that have affected parts of West Africa in the Sahelregion where highlighted by Ojo (2007) spanning from1445-1452, 1538, 1557-1588, 1681-1687, 1738-1756 and 1828-1839.

The droughts of the 1730s to the 1750s were recorded to have killed 50% of thepopulation of Timbuktu and other parts of the Niger bend and resulted to faminein places like Senegal, Gambia, Mali, Mauritania, Burkina Faso, Benin, Chad andparts of northern Nigeria especially Bornu and Kano regions.

The droughts between 1972 and1973 were also severe, although they werecomparatively less than the 1983-84 in scope. In 1984, the Food and Agricultural Organization (FAO) mentioned that about 250 million inhabitants in 22 countriesin Africa, including northern Nigeria, were affected by food crisis as a result of thepersistent droughts of 1972-73.

So it clear that drought have occurred in many parts of West Africa and thatcertainly includes our country Nigeria. This experience have occurred in varyingdegrees of severity and duration throughout human history, and many regions ofthe African continent have experienced considerable distress arising from droughtoccurrences, mass migration, famine and cessation of economic activity in manycountries.

3.1 Desertification: A Conceptual Review

Desertification, just like drought, is not simple to define; however, most definitions have generally reflected some degree of land degradation processes. Globally the term desertification, since its adoption by the United Nations Conferences on Desertification (UNEP, 1977), has swallowed up a number of related terms such as desert encroachment, the advancing Sahara, desiccation, desertization. The term has also been use d to describe the dogmatization due toburning, clearing and erosion of forest and savannah zones of West Africa.

The United Nations Environment Programme (UNEP, 1977) described desertification as land degradation in arid, semi-arid and dry humid areas as a basic consequence of human activities. Another version of his definition was developed at the UN Conference on Environment and Desertification (UNCED, Rio de Janeiro, June 1992), which says that desertification is land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors including climatic variations and human activities.

This new version definition has been internationally discussed and approved at the UNCED as the operational standard for Agenda 21. Therefore it is general accepted that desertification may take many forms but it usually refers to widespread land degradation in the dry lands, which is the reduction of biologicalproductivity of dry land ecosystems, including rangeland pastures and rain fedand irrigated croplands, as a result of the acceleration of certain natural physical,chemical and hydrological processes.

These processes usually include;

- erosion and deposition by wind or water,

- salt accumulation in soils,
- groundwater or surface runoff,
- reduction in the ability of soils to transmit and store water for plant growth.

The severity of desertification in West Africa, however, varies significantly fromone country to another, and even in the Sudano- Sahelian regions of Nigeria, thedegree of desertification varies from one state to another. In general, the mainfeatures of desertification include:

a) A reduction in the amount of the soil covered by the vegetation. Specifically, the amount of bare soil increases and vegetation may be reduced to isolated patches.
b) A consequent rise in the reflective capacity (albe do) of the surface for solarradiation, since arid and semiarid soils are lighter-coloured than most plants, even with grey foliage so usual in these climates.
c) A considerable and permanent loss of perennial plants, especially woody shrub and trees
d) Considerable soil erosion and impoverishment, because of removal of fine minerals and organic materials by wind and because of rapid oxidation ofthe remaining water and soil carbon. Gully and sheet erosion of soils byoccasional heavy rainfalls appears to accumulate the eroded materials onvalley floors or in basins.
e) Overgrazing and inadequate forage in relation to vegetative resources (Ojo, 2007).

3.2 Indicators of Desertification

Desertification is often the consequence of stress disturbance on the environmentwhich may be natural or caused by human. Ecosystems which do not alter in thepresence of stress and/or disturbances are described as stable. Alterations hereare varied from those associated with regular seasonal stresses. When ecosystemremains stable from year to year it is said to be stable. Such an ecosystem isexpected to return to its original state after a disturbance or stress or to maintainequilibrium (oduwaiye, 1999).

Stability here can be viewed from two angles;

(1) Structural stability: if the species composition remain more or less the same and
(2) Functional stability: if ecosystem characteristic biomass production andnutrient cycling rates unchanged.

The following are the indicators of desertification.

(a) The disappearance or permanent degradation of the vegetation
(b) Soil erosion by wind
(c) Dune formation or reactivation
(d) Desiccation of the soil profile and more controversially

(e) Lowering of the ground water table.

However Grumblatt in his pilot study on Evaluation of FAO/UNEP provisionalmethodology for assessment and mapping of desertification provided thefollowing scheme (partly reproduced) which can be used in collecting data.

I. Physical

(i) Climate
- (a) Rainfall
- (b) Temperature
- (c) Wind speed, Direction, Frequency
- (d) Sunlight duration
- (e) Sand storm/ dust storm frequency

(ii) Soils
- (a) Surface rockiness
- (b) Texture
- (c) Opinion water
- (d) Permeability
- (e) Alkalinity
- (f) Water erosion
- (g) Wind erosion

II Biologica

(i) Vegetation
(a) Herbaceous canopy cover
(b) Herbaceous biomass
(c) Percent bare ground
(d) Species composition
(e) Vegetation type winds

III Socio/Economic

Human population
(a) Density of permanent structures.

3.3 Causes of Desertification

The basic causes of desertification as articulated by Oduwaiye (1999) are;
- drought and
- human activities which include grazing by livestock, wood cutting, cultivation andburning.

1. Drought

Drought is commonly regarded as one of the causes of desertification. But it isknown this is the only possible when there is prolonged drought. Althoughdrought usually leads to the loss of several plant species.

Drought is known to be a periodic event even in arid and semi-arid climateswhere periods of rainfall failure are interposed with years of abundant rainfall.

Drought however only gives more force to instability created through othermanagement practices e.g. overgrazing of available fragile lands during wet years.

2. Human Activities

(a) Grazing by Livestock: This human activity may contribute in different ways to desertification. These include:

(i) The substitution of annual for perennial grasses which will perhaps reduce the plant cover available to protect the soil in the long dry season.

(ii) Damaging of soil structure in the vicinity of wells as a result of trampling by cattle.

(iii) Destruction of seedling.

(b) Wood Cutting: Humans especially in poor nations are used to wood cuttingto produce fuel wood or construction timber. This impairs natural regeneration ofwoody species and a great proportion of the soil surface nutrients content areexposure after woodcutting. This will also result in more run-off and soil surfacecompaction leading to deterioration.

(c) Cultivation: Yearly cultivation without adequate fertilization impoverishes the soil structurally in quality- wise. It also increases the possibility of remobilization by wind.

(d) Burning: Burning affects biological productivity by

(i) destroying grass and herb growth

(ii) favouring fire resistant species over fire-tender ones

(iii) stimulating fresh shoots, particularly of grass

(e) Other activities by human There activities include urban development, androad construction.

4.0 CONCLUSION

These semis twin-Drought and desertification are dry devils that are becoming popular environmental problems in Nigeria today. This emerging popularity has made these twin environmental hazards essential for study in Nigeria andespecially at the Open University.

We have studied with clarity the concepts of drought and desertification. The causes of these environmental hazards have been analyzed systematically and the root causes also traced in details.

I want to challenge you to disseminate the knowledge you have acquired in this unit to your families, friends and neighbours in order to help control these problems. I do hope you have taken the advantage this unit has provided you.

5.0 SUMMARY

Drought has been described as an extended and continuous duration of very drywealth. This definition varies from country to country, since weather varies.

In the UK, three types of drought are recognized:
(a) total drought is a period of 15 or more consecutive days with a rainfall below 0.2mm;
(b) partial drought has a duration of 29 successive days with an a mean rainfall of 0.2 mm or less per day;
(c) a dry spell has a duration of 15 or more successive days, during which therainfall does not exceed 1 mm per day.

Globally, there are three basic types of drought;
- meteorological drought,
- agricultural drought and
- hydrological drought.

Some of the features of drought were articulated as:
(a) Low rainfall and high rainfall variability.
(b) High evaporation and potential evapotranspiration rates
(c) Generally persistent negative rainfall anomalies
(d) Occasional torrential rains resulting in floods
(e) Rapidly high erosive runoff especially on steep terrains
(f) Sparse vegetation cover
(g) Too little moisture for rain fed cultivation throughout the year

Desertification was described as land degradation in arid, semi-arid and dryhumid areas as a basic consequence of human activities.

Another version of his definition was developed at the UN Conference onEnvironment and Desertification (UNCED, Rio de Janeiro, June 1992), which says that desertification is land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors including climatic variations and human activities.

The following are the indicators of desertification.
(a) The disappearance or permanent degradation of the vegetation
(b) Soil erosion by wind
(c) Dune formation or reactivation
(d) Desiccation of the soil profile and more controversially

(e) Lowering of the ground water table.

The basic causes of desertification as articulated are;

- drought and
- human activities which include grazing by livestock, wood cutting, cultivation and burning.

6.0 TUTOR MARKED ASSIGNMENTS

1. Discuss with examples four features of desertification
2. Make an outline of five evidences of desertification.
3. Explain two human activities that have contributed to desertification in Nigeria.
4. What is draught?
5. List three major type of global drought
6. State seven features of draught

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UNIT 5 IMPACTS OF DROUGHTS AND DESERTIFICATION

CONTENTS

1.0 INTRODUCTION

In this unit we shall move further to discuss on the impact that the consequencesof drought and desertification has resulted into and ways of ameliorating some ofthese impact.

2.0 OBJECTIVES

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

- statefive major impacts of drought and desertification;
- list six basic socio- economic impacts of drought and desertification in Nigeria;
- statethree ways by which human contributes to desertification; and
- explainhow grazing leads to desertification.

3.0 MAIN CONTENT

It is essential for you to first understand clearly that it is virtually impossible toseparable, perhaps almost like a Siemens twin, the impact of droughts from thatof desertification.Consequently, discussions on the two hazards will not beseparate d in this unit.

The impact of drought and desertification in the drought prone and decertifiedareas of Nigeria are serious on many sectors such as:

- the physical and ecological environment
- agriculture and livestock production and management
- water resources and water resources management
- Health
- ecosystems and
- forests and forestry.

Related to the above listed impacts of droughts and desertification are:

- Loss of biodiversity, rapid deterioration of the ecosystems,
- Loss of ecological stability, soil erosion and loss of soil fertility, silting of reservoirs and change in hydrological regimes.

REFLECTION: The Punch Newspaper, 30th January, 2006Onedisturbing manifestation of the effect of droughts and desertification isthe progressive shrinking of Lake Chad, which is one of Nigeria s important landmarks and best-known cultural heritage. The lake which is the remnant of an inland sea was estimated to have covered an area of 400,000km about6000 years ago.Newly released satellite images by the National Space Research and Development Agency of Nigeria (NASRDA) show that Lake Chad has completely withdrawn from Nigeria and is now located in Chad Republic.

As a follow up to this story, experts have predicted that the lake may dry up completely by 2010 if the current rate of retreat is not controlled. This will have serious of socio-economic, socio-cultural and socio-political implications on the communities that benefits from the lake.

The Chad Basin Development Commission is made up of four countries:

- Chad
- Cameroon
- Nigeria and
- Niger.

These nations must rise quickly and that on time to rescue the situation before itis too late to cry over spilled milk.

Do you realise that we are talking about estimated 20 million people living inthese four countries whose means of livelihood-subsistence agriculture-is totallydependent on the lake is currently at risk of severe hunger and famine?

Recent studies have also shown that farmers on the Nigerian side of the lake aremoving along with the water as it recedes. The implication of this is that we nowhave some Nigerians living in Chad Re public but still believe that they are withinNigeria (Ojo, 2007).

DISCUSSION POINT

Can the gradual migration of Nigerian farmers at the Lake Chad generateborder disputes in the next decade?

Do you foresee another Bakassion our hands in the near future because of theimpact of drought and desertification?

3.1 Socio-Economic Impacts

Basic socio- economic impacts of drought and desertification include:

(a) Unemployment

(b) Rapid drop in agricultural activities and production with its release in the rural labour force from farming activities. This labour force move to urban locations.

(c) The dynamics migration from rural areas places more pressure on jobs andfacilities in the urban centres. Such movements are characteristic of theSudano-Sahelian regions, from where migrants move southwards to urbancentre such as Lagos in search of better living conditions. The economic andsocial consequences of these movements are substantial.

(d) The feedback mechanisms in drought and desertification systems exacerbate their own effects.

(e) The consequences of drought and desertification sometimes leads to political problems (including conflicts and possibly wars) which often lead to a lot of suffering and death.

(f) Decrease in quality of living as a consequence of the decline in quality of the rural communities. This decline in rural communities is apparently due to lack of water supply, un-sustained availability of fuel energy and inadequate income generation.

(g) Famine and death.

EXERCISE 5.1

1. List six basic socio- economic impacts of drought and desertification in Nigeria.
2. Discuss your personal experience on any one or as related to you through an individual or any means.

Other socio-economic impacts of drought and desertification in Nigeria are listed below:

a. Migration: An alarming rate of rural-urban movement as a result of serious foodshortages and rural unemployment (example is the experience at the GidanKaura village in Gada Local Government Area of Sokoto state).

b. Demand on few facilities: In affected areas, only women, old men and little kids are left in a pathetic state of inadequacy of such amenities as housing, food, medicine etc.

c. **Social Vices: The urban centres are littered with loiterers and beggars with high**incidence of crime and truancy among idle immigrants from affectedcommunities.

d. Famine and Malnutrition: Reduction in food production and subsequent nutrient, intake of both human and animals result in high mortality among both populations.

e. Industrials Raw Materials: The 1972 drought in Sokoto State has been the onset of an irregular and inadequate supply of industrial raw materials such as cotton, cotton seed and tanning materials.

3.2 Control of Desertification

There are short and long-term techniques for the control of desertification. Thesetechniques as outlined by Olagunju (1999) are articulated below:

3.2.1 Short Term Techniques

These techniques give a cushion effect within a short period of establishment. Examplesinclude:

(1) Preservation of Existing Forest

The currently existing vegetation in gazetted forest reserves and other woodedareas should be adequately policed and legislations against indiscriminate fellingof tree, bush-burning and overgrazing must be wells enforced while those on theprotection of planted trees should be enacted.

There is also need to evolve systematic management practices for sustainingadequate supply of goods and services from the forests. Moreover, apart fromincreasing the number of grazing reserves, there is also need to establish andimplement grazing reserve laws and by-laws to improve the pasture.

(2) Enrichment of Soil Nutrient

Steps must be taken to encourage the use of manure and fertilizers to improvegrowth rate of the existing vegetation.

(3) Alternative Energy Sources

The utilisation of gas cookers, kerosene stoves, and solar energy appliances fordomestic use will reduce the demand on the forests. For example, the purchase of42,000 kerosene stoves by the Sokoto State Government for resale to Civilservants at subsidized rates is an example in the right direction.

3.2.2 Long-Term Techniques

There are techniques whose effects show up after a long period of establishment.

Examples include:

(1) Yearly Planting of Trees

This activity is better backed up by Government policies. This is one potentmethod for educating the populace on the dangers of an environment devoid oftrees.

Importantly, the general public should be mobilized to make forestation apersonal programme knowing full well that a restore tree-cover in theenvironment is for their personal benefit.

(2) Sand Dune Fixation

This is the planning of grasses on the dunes to reduce movement of sand particlesfollowed by the introduction of tree species.

(3) Community/ Individual Wood lots Programme

This is idea for the provision of more trees in the environment for the benefits of fuel wood, poles, fodder and shad, fruits, gums and resins, and other commercial products.

(4) Farm- Forestry Practice

The farm forestry involves the distribution of seedlings to farmers free of chargeto plant on their farms, protect and nurture to maturity. Moreover, the use of insitu conservation where existing trees are protected from destruction to protectthe soil from wind erosion (as wind breaks) and serve as fodder and shade forman and animals.

(5) Shelter belts Establishment

The Arid zone Forestation Programme, Ecological `Disaster Relief Programme, Forestry II Project, the State Forestry Services, Drought and Desertification Control and State Environmental Protection Programmes have established conventional shelterbelts. These programmes have proved to be some of the most effective way of protecting the soils. For example, the 65 gazzetted forest reserves and 200-km of shelter belts in Sokoto State still exists and is protective.

(6) Integrated Rural Development

With irrigated shelterbelts, other welfare services like the provision of water forthe rural people and their livestock (in boreholes) exist, to improve the livingstandard of affected communities.

3.3 Irreversible Desertification

Desertification ends up into irreversible loss of biological productivity when thereis destruction or alteration of soil profile which is itself the result of thousands ofyears of soil forming processes in which case, the soil will not be able to support plant growth which leads to reduced productivity.

Such soil degradation includes Lateritsation and Compaction which facilitatessheet wash by running water, sand accumulation which may develop into dunes.

These situations can be checked through the planting of grass (e.gvetiver), shrubsand trees (Oduawaiye, 1999).

3.4 The importance of Remote Sensing in Desertification Control

To monitor and solve the challenges of desertification, there is need to collectdata about the target environment. Remote Sensing has proved very useful in thisarea.

Lilles and Kiefer (1979) defined remote sensing as the science and art of obtaininginformation about an object, area or phenomenon through the analysis of dataacquired by a device that is not in contact with the object, area or phenomenon.The device is used to collect data about environment without coming in contactwith the environment under study.

4.0 CONCLUSION

The reality of desert encroachment in Nigeria is not an issue for debate but a callfor concern, awareness and concrete actions that will help reduce the negativeimpacts of droughts and desertification.

It is essential for you to first understand clearly that humans are the major causeof these environmental hazards whose effects are virtually impossible toseparate.

5.0 SUMMARY

The impact of drought and desertification in the drought prone and decertifiedareas of Nigeria are serious on many sectors such as:

- the physical and ecological environment
- agriculture and livestock production and management
- water resources and water resources management
- Health
- ecosystems and
- forests and forestry

There are short and long-term techniques for the control of desertification. Thesetechniques are:

Short Term Techniques

- Preservation of Existing Forest
- Enrichment of Soil Nutrient
- Alternative Energy Sources
- Long-Term Techniques
- Yearly Planting of Trees
- Sand Dune Fixation
- Community/ Individual Wood lots Programme
- Farm- Forestry Practice
- Shelter belts Establishment

- Integrated Rural Development

6.0 TUTOR MARKED ASSIGNMENT

1. State five major impacts of drought and desertification.
2. List three ways by which human contributes to desertification.
3. How does grazing lead to desertification?
4. Discuss how desertification becomes reversible.

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