FEDERAL UNIVERSITY OF TECHNOLOGY, OWERRI, NIGERIA
INSTITUTE OF EROSION STUDIES (IES)

PROCEEDINGS

1ST OF THE INTERNATIONAL TRAINING WORKSHOP

ON

EFFECTIVE WATERSHED MANAGEMENT FOR ENVIRONMENTAL HAZARD CONTROL/ MITIGATION IN NIGERIA

DATE: 8TH-10TH FEBRUARY, 2016

EDITORS:
PROF. C. A. Ahiarakwem
ENGR. E. U. Uja
ENGR. P. C. Nwachukwu
Dr. J. E. Umunakwe
Mr E. C. Nwaihu
Mrs Amadi Chinyere
Mr Henry Echetama
Mr J. O. Popoola

LEAD PAPER 3:

EFFECTS OF CLIMATE CHANGE ON COASTAL EROSION AND FLOODING

BY

ENGR. V. A. JOHN
B. Eng., M. Eng. (Civil)
MNSE, C. Eng.

DIRECTOR OF EROSION, FLOOD AND COASTAL ZONE MANAGEMENT DEPARTMENT

FEDERAL MINISTRY OF ENVIRONMENT

1.0 INTRODUCTION

Climate change has become a source of co[illegible]n in recent times especially because of its implications for ozone layer depletion a[illegible]ustainable development.

Climate is usually defined as the average weather in a place. It includes patterns of temperature, precipitation (rain or snow), humidity, wind and seasons. Climate patterns play a fundamental role in shaping natural ecosystems, and the human economies and cultures that depend on them.

1.1 What is climate change?

Climate change occurs when the average long-term weather patterns of a region are altered for a prolonged period of time, typically decades or longer. Examples include shifts in wind patterns, the average temperature or the amount of precipitation. These changes can affect one region, many regions or the whole planet.

Climate changes are caused by changes in the total amount of energy that is kept within the earth's atmosphere. The change in energy is then spread out around the globe mainly by ocean currents as well as wind and weather patterns to affect the climates of different regions.

1.2 What are causes of climate change?

It is caused by natural processes such as volcanic eruptions, variations in Earth's orbit and changes in the sun's intensity. However, human activities can also cause changes in climate. For instance, by creating greenhouse gases emissions or cutting down of forests (deforestation).

1.3 Global warming and climate change.

Global warming and climate changes seen today are being caused by the increase of carbon dioxide (CO_2) and other greenhouse gas emissions by humans such as methane (CH_4), Ozone (O_3). Nitrous Oxide (N_2O), etc.

Human activities like the burning of fossils, industrial production, etc. increase greenhouse gas levels. This traps more heat in our atmosphere, which drives global warming and climate change.

So while CO_2 concentrations and other greenhouse gases are naturally present in the atmosphere, emissions from human activities have greatly amplified the natural greenhouse effect. CO_2 concentration in the Earth's atmosphere has increased significantly since the beginning of industrial revolution, and most especially in the past 50 years.

Human activities have caused the Earth's average temperature to increase by more than 0.75°C over the past 100 years. Scientists have tracked not only the changes in temperature of the air but other indicators such as the melting of the polar ice caps and the increase of world-wide sea levels.

2.0 EFFECTS OF CLIMATE CHANGE ON COASTAL EROSION AND FLOODING.

As global temperatures rise, the oceans warm slightly and expand, ice caps and glaciers melt, and more precipitation falls as rain instead of snow. This causes sea levels to rise. Most climate change models forecast a global sea-level rise of half a meter by 2100.Coastal communities are particularly vulnerable to the effects of climate change, which puts the affected communities at risk - homes, infrastructure, livelihoods, and even lives.

Effects of climate change on coastal erosion and flooding include:

i. Storm flooding
ii. Coastal erosion
iii. Landslides
iv. Salt water intrusion, and
v. Loss of wetlands.

2.1 STORM FLOODING

Melting glaciers, ice fields and polar ice caps, plus warming ocean waters all contribute to rising sea levels. The Nigerian bar beach presents a typical case of storm flooding. Climate change is predicted to bring stronger storms with heavier precipitation and higher wave conditions. This will increase the frequency and extent of flooding in many Nigerian coastlines.

Flooding is a common occurrence in many parts of Nigeria. It occurs in in low–lying areas of Southern Nigeria where annual rainfall is quite heavy such as Lagos, Calabar, Warri and Port-Harcourt.

Flooding is observed in floodplains of the major rivers such as the Niger, Benue, Gongola, Sokoto, etc.

2.2 COASTAL EROSION

Coastlines are continually changing as sand is shifted by waves, tides, and currents. Sea-level rise and land subsidence contribute to coastal erosion and narrowing or movement of barrier islands. With climate change, rates of coastal erosion would increase.

Climate models project an increase in storms, which would further contribute to coastal erosion

Climate change is predicted to increase storm intensities and wave height in seas and oceans. More frequent, intense storms combined with higher overall sea levels will result in higher coastal erosion rates and more storm damage.

As waves approach the shore, they slow down and hence become shorter in length and steeper in height. This increase in steepness reaches a limit of stability after

which the waves break. Waves arriving at the coast are refracted as they enter the shallow waters. The long- shore compon[illegible] of the surge (which is formed as the waves break) induces littoral currents. Th[illegible] littoral currents move large quantities of sediments offshore. Sediment movem[illegible] offshore and onshore has caused a recession of the 800km Nigerian Coastline.

2.2.1 Problems of coastal erosion

Problems of coastal erosion vary from place to place and may either be short term or long term. These problems have adverse consequences on the living conditions of the people in the affected eras.

Some of these coastal erosion problems are:

i. Loss of arable land which could be used for agriculture and settlement.
ii. Loss of lives and valued property such as roads and water treatment systems.
iii. Huge monetary loss due to frequent storm surge.
iv. Huge capital outlay is involved in the protection of coastal coastlines against flood and erosion.
v. Navigation activities are often hindered.
vi. Some of the measures used in solving coastal erosion may lead to legal problems due to their hazardous nature.

For instance, rip currents associated with groynes may be dangerous to beach users.

2.3 LANDSLIDES

Landslides have always existed on our planets. Generally, they are classified as mass movement of rock, debris, and soil down a slope of land.

While landslides are naturally occurring environmental hazards, they have recently increased in frequency in certain areas as a result of climate change and human activity. Although there are many different causes of landslides, they all have two things in common- they are all the results of the failure of the soil and rock materials that make up the hill-slope and they are driven by gravity.

Natural causes of landslide include:

i. **Earthquakes** – Seismic activities have always been a main cause of landslides throughout the world. Any time plate tectonics move, the soil that covers them moves with them. When earthquake occurs on areas with steep slopes, the soil slips causing landslides.
ii. **Heavy rainfall**- When sloped areas become completely saturated by heavy rainfall, landslides can occur. Without the aid of mechanical root support, the soil simply runs off when it contains too much water.

Human causes of landslide include:

i. **Clear cutting-** This is amethod of timber harvesting which completely

energy.

ii. Scouring at toe of the shorewall ma[illegible]ecur.

iii. Heavy equipment are required durin[illegible]onstruction; and

iv. Huge capital outlay is required for it[illegible]onstruction.

3.3 GROYNES

Groynes are shore protective structures usually built perpendicular to the shoreline to trap longshore littoral drift and could be classified as direct or indirect measure. They extend from the backshore into the littoral zone and are effectively used in groups i.e. groyne field. These cause wave to break before reaching the shore resulting in the realignment of the shoreline as the groynes accumulate sand on the shore. Groynes may be used to reduce sand losses too.

Groynes could be constructed with wooden piles, concrete or rubble mounds either as permeable (permitting the flow of water) or impermeable structure. The layout of a groyne system is governed by their length, spacing, height and orientation to the coastline. Currently, the inter-relationship of these parameters is largely based on empirical rules and observations.

Advantages of groynes:

i. They are good energy dissipating structure; and

ii. They can cause rapid accumulation of sediments on beaches.

Disadvantages of groynes

i. They cause considerable erosion on downdrifts area.

ii. Longshore littoral drift can bypass a groyne.

iii. Rip currents generated by groyne systems are hazardous to beach users; and

iv. Heavy equipment is required during construction.

3.4 BREAKWATERS

Breakwaters refer to structures built some distance into the sea.

They dampen waves by reducing their access to the shore and thus protect the shore immediately behind them. Breakwater in dampening waves create quiet water behind them and deposition of sand occurs in this region, building the shoreline seaward. The rate of sediment accumulation depends on the height, length, distance offshore and the permeability of the breakwater as well as longshore transport rate.

Materials like piles (wooden, steel and reinforced concrete sheets), armourstones or stone rubbles and concrete-filled fabrics bags could be used for breakwater construction.

Advantages of breakwater

i. They dissipate wave energy considerably.

ii. They prevent sediment loss into the sea during storms; and

iii. Beaches may be reclaimed for recreational purposes.

Disadvantages of breakwaters

i. They cause down- drift erosion.
ii. Strong rip currents which are dangerous to swimmers and beach users may develop.
iii. Heavy equipment is required.
iv. They pose hazards to navigators; and
v. They are expensive when compared to other measures.

3.5 BEACH NOURISHMENT

Beach nourishment is the movement of sand to a beach to maintain it. It protects the adjacent upland by dissipating energy without adverse effects.

Advantages of beach nourishment

i. It provides dredging inlets for navigation.
ii. The borrow material can be placed exactly at the desired locations; and
iii. Cost of beach nourishment may be relatively low compared to other protective measures.

Disadvantages of beach nourishment

i. This measure cannot be executed during high currents and severe wave conditions.
ii. For short segments of shore, the option is considered expensive; and
iii. The borrow material composition can sometimes cause environmental problems.

3.6 EARTH DYKES.

Dykes are protective measures particularly useful in the protection of river floodplains and flooded coasts. A dyke is built up to a crest level exceeding the annual flood level, while the land behind may be filled up. The seaward slope of the dyke could be protected either with gabions or stone rip-rap.

The technical requirements for effective performance of a dyke are:

i. It should not overstress its foundation.
ii. It must remain stable for all water levels below the design crest level.
iii. It should not be overtopped; and
iv. It must be safe against internal erosion, water forces and pressures.

Advantages of dykes over other forms of protection devices include:

i. The dykes crest could be used as an access road by pedestrians.
ii. The use of naturally occurring materials implies low cost of compacted fill over the years despite the global economic recession.
iii. Simplicity of construction and adaptability to a wide range of circumstances; and

iv. Reliable analytical methods have evolved from an improved understanding of the structural behaviour of large fills.

Disadvantages of dykes

i. Heavy equipment are required during construction.
ii. The borrow material composition can sometimes pose environmental problems; and
iii. The toe of the seaward slope of the dyke may be undermined if not well protected.

4. CONCLUSION

The Federal Government of Nigeria has joined the rest of the world in continuous fight against the climate and its associated impacts. To this end, the Federal Ministry of Environment has created a climate change department saddled with the responsibility for climate change control and other related matters.

For effective climate change control and monitoring, the following recommendations are imperative:

i. Establishment of climate change control and monitoring department in each State Ministry of Environment in the Country.
ii. Enactment of legislation on burning of fossils and other forms of carbon generation activities such as firewood, use of bad generators and use of old vehicles with high carbon emissions.
iii. The use of clean and renewable energy should be encouraged by all tiers on government in the Country.
iv. Adequate budgetary allocation for controlling and combating climate change and its resultant ecological problems in the Country is strongly solicited.

REFERENCES

GORNITZ. V. (2001). Sea-level rise and coasts. An assessment of the Metropolitan East Coast Region. (pp.21-46) Columbia Earth Institute, New York.

ROSENZWEIG .C. AND W.D SOLECKI (2001). Climate change and a global City. the potential consequences of climate variability and change, Metro East Coast. report for the U. S Global change research program.

IBE A. C AND QUELENNEC R. E (1989). Methodology for Assessment and control of Coastal Erosion in West and Central Africa. UNEP Regional Seas Reports and studies No.107

PER BRUUN (1989). Port Engineering Vol. I and II, Fourth Edition, Gulf Publishing Company.

NEDECO (1985). Coastal Erosion in West and Central Africa. UNEP Regional Seas Report and Studies No.67

U. S ARMY CORPS OF ENGINEERS (1984). Shoreline Protection Manual. Vol. I and II, Fourth Edition, U. S Coastal Engineering Research Centre.

PIANC (1980). Final Report of the 3rd International Commission for the study of waves. supplement of bulletin No. 36 Vol. 1.