EMT 511: ECOLOGICAL DISASTERS AND CONTROL (3 UNITS)

LECTURE NOTE

PREPARED BY

A.M. GBADEBO AND B. S. BADA

EROSION

Soil erosion is the detachment and transportation of soil particles by the forces of water and or wind. It is a process that transform soil to sediment. Erosion can be natural or accelerated/anthropogenic in nature. Base on size, erosion can be classified as rill (smell), sheet (big) and gully (very big).

Erosion is one of the most critical environmental problems affecting all part of the world including Nigeria.

CAUSES OF EROSION

1. Rain- is one of the most important causes of erosion. Rain drops helps in loosening the soil particle and later carries/transport the soil as it slows down the slope and finally deposits it as sediment in low-lying or flat areas where the speed of the flowing rain water dropped sharply. In some cases, the soil material carried by rain water are deposited in the river which finally deposits it in the ocean.
2. Winds- is another very important causes of erosion. Strong wind erodes the soil where there is no or small vegetative cover. The first thing that happens in wind erosion is the loosening of the soil particles, then the soil particle are blown away and finally dropped in a farther or neighbouring area, there by forming what is called sand dunes.
3. Human activities
    a. Deforestation- is regarded as another cause of erosion, especially where vegetation is deliberately removed. Vegetation in this case may be trees, shrubs or grasses which are generally supposed to protect the soil from being washed by falling rain or being blown away by wind.

b. Bush- burning- the habit of burning bush especially for the purpose of farming or hunting not only destroys the vegetation but also exposes the soil to erosion. The more the soil is exposed to bush burning, the faster it is eroded rain water and wind

c. Overgrazing- is an act in which the eroded by available vegetation is eaten up by cows, cattles and sheeps. This also is also expose the soil to agents of erosion.

d. Wrong farming method- has been indentified as one of the causes of erosion and this includes.

i. Clearing or clean weeding that involves total scraping of the weeds on the farm land and leaving the bare soil between the farm and crops.

ii. Mono cropping- which in an habit of planting only one crop on the farm e.g. maize for several year or season after season.

iii. Marking farm ridges- such a way that they are down the slope instead of across the slope

iv. Use of heavy tractors for cultivation will leave the soil bare and expose it to agents of erosion.

e. Mining or quarry activities- soil digging and scarping for the purpose of extracting solid mineral deposits obtaining building materials like laterites, gravels especially on a hilly slope will result in soil erosion.

f. Lack of drainage- or erosion channel even in the form of gutter that is meant to allow free drain of run off will result in erosion.

g. Road construction- either small roads or large express way without great-care being taken to make sure that the sides are well protected by directing the run off into a safe place will eventually lead to erosion.

h. Footpaths – that leads to stream, farms, schools, neighbouring villages (even on the lawn here in UNAAB) are constantly been eroded since they lack vegetation cover.

4. Soil composition and strength soil that are made up of sand, silt that are naturally weak or not bonded together by organic matter lacks cohesive force and are much likely to be eroded than soil comprising of clays materials that has more cohesive force and are naturally strong.

EFFECTS OF EROSOIN

1. Rill erosion- helps to make harvest poor since it cause the removal of top soil
    - It prepares the soil ready for higher degree of erosion such as sheet erosion
    - Must be fill up in order is make effecter use of it
2. (i) Sheet erosion- whether caused by water or wind or both, it results in loss of soil.

   (ii) Loss of soil minerals that would have been useful for plant nutrients. This will in turn affect plant growth, hence crop yield.

   It also result in reduction in the depth of soil (i.e. soil profile) that is supposed to be available for plant root.

   Also, since the rich top soil is constantly removed, the soil becomes poorer and poorer.
3. Gully erosion- although the land coverage by gully erosion in not as much as in sheet erosion, however gully erosion still do more havoc than the rill and sheet erosion. The damages include
    a. It has claimed lives of many people in Nigeria.
    b. Many house have been swallowed by gullies

c. Numerous roads and footpaths are eaten up by gullies

d. It has destroyed water supply taps, electricity and telephone poles

e. Gully erosion has resulted in the loss of farmlands and other useful lands.

f. It has resulted in the relocation of many families.

4. Generally effect of rill, sheet and gully erosion

- Erosion types all together cause siltation of stream, rivers and lakes thereby leading to Eutrophication of water bodies. Eutrophication will result in loss of oxygen, death of aquatic animals like snails, fish and final the water bodies. Besides, siltation (i.e. dumping of eroded sediments into water bodies) is a very serious problem because it blocks the free flow of streams and rivers thereby making them to be shallow and narrow. Siltation will lead to severe water pollution thereby causing water borne disease. Siltation where it result in the dry up of water, will therefore result in the acute shortage of water supply
- Erosion by wind can cause serious problems for human health during harmattan such as catarrh.

EROSION CONTROL

There are various way of controlling erosion. These include viz.

a. Biological measure/methods

1. Right method of agricultural practices

- Mixed cropping
- Agro forestry

- Use of cover crops
- Mulching
- Proper weeding practices

2. Tree planting method

b. Engineering method- i.e. building of engineering structure like

- Dams
- Dykes
- Drainage channel
- Spill ways
- Retaining walls
- Contour bunds
- Bench terraces

c. Mechanical method

- Erosion bund
- Farm contour bund
- Regional contour bund
- Top side gully drain
- Hill side drain
- Sand bagging

d. Administrative method

- Role of government
  - LG
  - SG
  - FG
- Role of communities
- Role of individuals

ECOLOGICAL CONSEQUENCES OF NATURAL RESOURCES MISMANAGEMENT

A resource is any substance or factor that satisfies human needs. A resource may be natural or made. It can also be renewable or non renewable.

A renewable resource is one that is capable of regeneration sometime in-exhaustible. They are mostly biological in nature. Example include fish, forest products etc.

A non- renewable resource is one that is not capable of regenerator somewhat exhaustible in nature. They are mostly non-biological. Examples include metallic minerals, crude oil, and water.

Resources are of vital importance to a nation. They serve as the basis of national economy they are directly or indirectly the source of individual wealth. They are nationals potential for development if properly managed.

The consequences of resources grievous. It could lead to irreversible disequilibrium of our ecosystem and environment. It can retard our economic development and also effects man's survivals on earth. Ecological consequence of N.R.M can be fully understood under the followings.

A) Faming Activities

i) Generally, faming involved clearly of vegetation for agricultural purpose. This normally leads to loss of important flora and ever total extinction of some endanger species. As a result of faming activities, some wildlife habitats have been altered or changed thereby resulting in the migration of some animals. Death of animals during hunting, bush burning or migration is capable of leading to total extinction of some animal species. Exposure of soil resource to harsh weather/climatic condition like erosion and flooding due to excessive deforestation can lead to

loss in soil nutrient and fertility and hence reduction in crop yield. This will result in shortage of food supply or famine and even death in the case of acute famine.

Mechanized farming has subjected most of the agricultural land resource to pollution. Increased in soil metal loads can be traced to the practice of mechanized farming. Also, mechanized farming has rendered most of the surface water in the vicinity unsafe for drinking purpose. The underground water resources even suffer greater fate due to leaching effects of metals.

Lumbering – cutting down of forest products for commercial purpose has constantly resulted in reduction in both plant population and species. Some have even gone into extinction.

Hunting and fishing for commercial purposes involving the use of organic chemicals can result in reduction in animal and fish population and ever extinction of certain species.

B) Mining Activities

This is removal of non- renewable resources from the lithospheric and hydrospheric part of the planet earths. Mining could be open cast method or underground mining method. Generally, mining involves exraction, processing and transportation. All these leave their effects on the landscape e.g.

ii) Pollution and contamination of the ecosystem.

iii) Make the ground to be sterile

iv) Surface and groundwater pollution

v) Disuse land on closure of operation

C) Oil Exploration and Exploitation Activities

Every stage of petroleum activities has its own impact on the environment. Traverse cutting during oil exploration is capable of deforestation and erosion problem. Seismic activities can result in land, soil, water and air pollution through the use of explosive. The gases can be harmful to human, animals and can ever hinder the productivity of plants.

Most of the initially productive agricultural lands have been acquired and designated oil explored zone. The abandoned oil producing areas are full of relics of equipment, metal scraps and ditches and gullies, collapsed structures. This way, neither one time beautiful environment is now an eye sore. A good example is the Oloibiri area of the Niger Delta.

The produced oil has to be refined before use. Hence the use of networking, of pipeline to transfer oil to various parts of the country and even neighbouring countries. Vessel are even used for the conveyance of the crude oil through the water waves while Tankers are popular means of crude oil transportation and land. On several occasions, crude oil has been observed to seep or spill into the environments naturally or anthropogenically. And spill the effect of the seeped or spilled oil in the environment can be devastating. In other to comprehend what oil seepage or spillage is one need his define the word oil/crude oil is one of the non-renewable natural resources mostly of organic origin, made up of several carbon and hydrogen atoms. Component of crude oil are thousands of different organic molecules. The majority of their hydrocarbons in between 4 and 25 atoms per molecule sulphur and nitrogen compound as well as nickel vanadium metals etc. crude oil may contain toxic substances such as hydrocarbon (PHHS), polychlorinated siphons (PCBS) and metals especially lead (Pb). Oil spillage (or seepage) a toxic form of pollution which posses a great ecological disaster to man, animal, plants and the environment at large. It is difficult to predict the potential effect of oil because of its complex.

However, ecological disaster aspect of oil seepage needs to be assessed in order to determine coastal or offshore. It may occur as a result of errors or accident from the operational facilities of the oil industries. Its implication on life and properties of the environment. Oil spillage is the out flow of crude oil into the environments of dry land, it is common in the oil shipping lines, oceans and every rivers and around the oil drilling zones.

Oil seepage on the other hand is the natural outflow of crude oil into the environment. Oil spillage may be minor (i.e. spill 250 barrels) medium (i.e. spill blur 250-2,500 barrels) or major (i.e. spill 2,500 barrels).

ECOLOGICAL DISASTER OF OIL SIILL AGE

1. **On Land:-** Oil spilled on land is capable of destructing soil fertilities of its aesthetic and landscape values. It will also cause death of all microbial and animals present on such lands. Since it will result in migration of residents, there will be competition for little available resources present on the newly inhabited land. Besides, lands that suffers oil spillage can be regarded as useless to agricultural practices or declared a danger zone to human
2. **On Wildlife:-** Wild life component (i.e. flora and farms) in particular animal may undergo changes in habitat due to the effects of oil spillage. Fire that results from oil spillage (e.g. Jerne case/incidence) not only capable of destroying the habitat but can also destroy the animals and their food chain thus there is bound to be reduction in animal and plant population due to death. Also many of the animals will migrate away from the spilled zone to avoid disturbance. Also the touristic value, medicinal value, aesthetic value and monetary value of the wildlife are hampered by the oil spillage problem.
3. **On Vegetation:-** Oil spillage is capable of resulting in a fire outbreak. This fire outbreak consumer vegetation of the affected areas leading to the loss of flora components of the

environment. Thus the ability of the tree to help in the natural environmental mehorstion is reduced by oil fire incidence. Hydrologic cycle, timber production for domestic and construction purposes and wildlife juvenile plant habitats even for juvenile animals are destroyed. This also result in loss of organic matter and soil nutricants, reduction in the rate of infiltration, destruction in bird nests and eggs leading to reduction in their population there is also an accumulation of carbon IV oxide into the atmosphere. Effect of fire outbreak from oil spillage on vegetation also include blockage of stomas pores of leaves thereby camp reduction in the photosynthesis and transpiration reactions in plants. This environment stream in plants may result in plant destruction and reduction in agricultural practices.

4. **On Water Bodies:-** Oil spillage in water bodies is capable of increased microbial activities which will rapidly deoxygenates the affected water body down stream from the point of oil discharge hence resulting in an oxygen sag curve. The extent of deoxygenation depends on a number of factors including the dilution of the crude oil or effluent on entering the water body and the amount of biologically oxidized materials present in the crude oil or the effluent. This process of depletion in the water body nutricants and reduction of lives due to microbial activities is called water entrophication. Entrophication is expenditure in an area where oil spillage occurs. And eutrophilication is capable of resulting in decrease in species diversity of water plant of animal shortening of life span of water bodies and increased turbidity. Eutrophication makes boating and fishing unattractive. The adverse effects of the spillage of oil into surface water include damage to aquatic lives. However, this effect varies with type and quantity of oil, wind velocity, ambient temperature, rate of stream flow and duration of spill and ever the techniques employed in the clean-up operation. Ingestion of oil by fish may lead to their mortality due to clogging of gills, or digestive, tract, disablement of

appendages erosion etc. The sea birds and other sensitive marine animals stand the risk of death or total extinction due to the effect of oil spillage water bodies. Also, swimmers eye irritation.

5. **On Man:-** Man, being one of the components of the ecosystem suffer indirectly from any damage that happens to other ecological components. It may be through eating of contaminated food or pollution of the environment. The death effect of ecological disaster aspect of oil spillage on man will lead to gradual population reduction.

3.3 EROSION MANAGEMENT AND CONTROL

High surface runoff and accelerated soil erosion are major degradative problem on newly cleared land. Immediately implementing appropriate erosion management technique is therefore essential. Accelerated erosion can be most severe in the very first season after land clearing (Lah 1981). Soil is caused by raindrop impact surface sealing and crust formation leading to high runoff rate and amount, high runoff velocity on long and undulating slopes, and low soil strength of structurally weak soil with high moisture content due frequent rains.

Effective erosion management has in;

(a) Preventing or minimizing the rain drop impact, through mulching and canopy cover.

(b) Maintain favourable soil structure for reducing crusting.

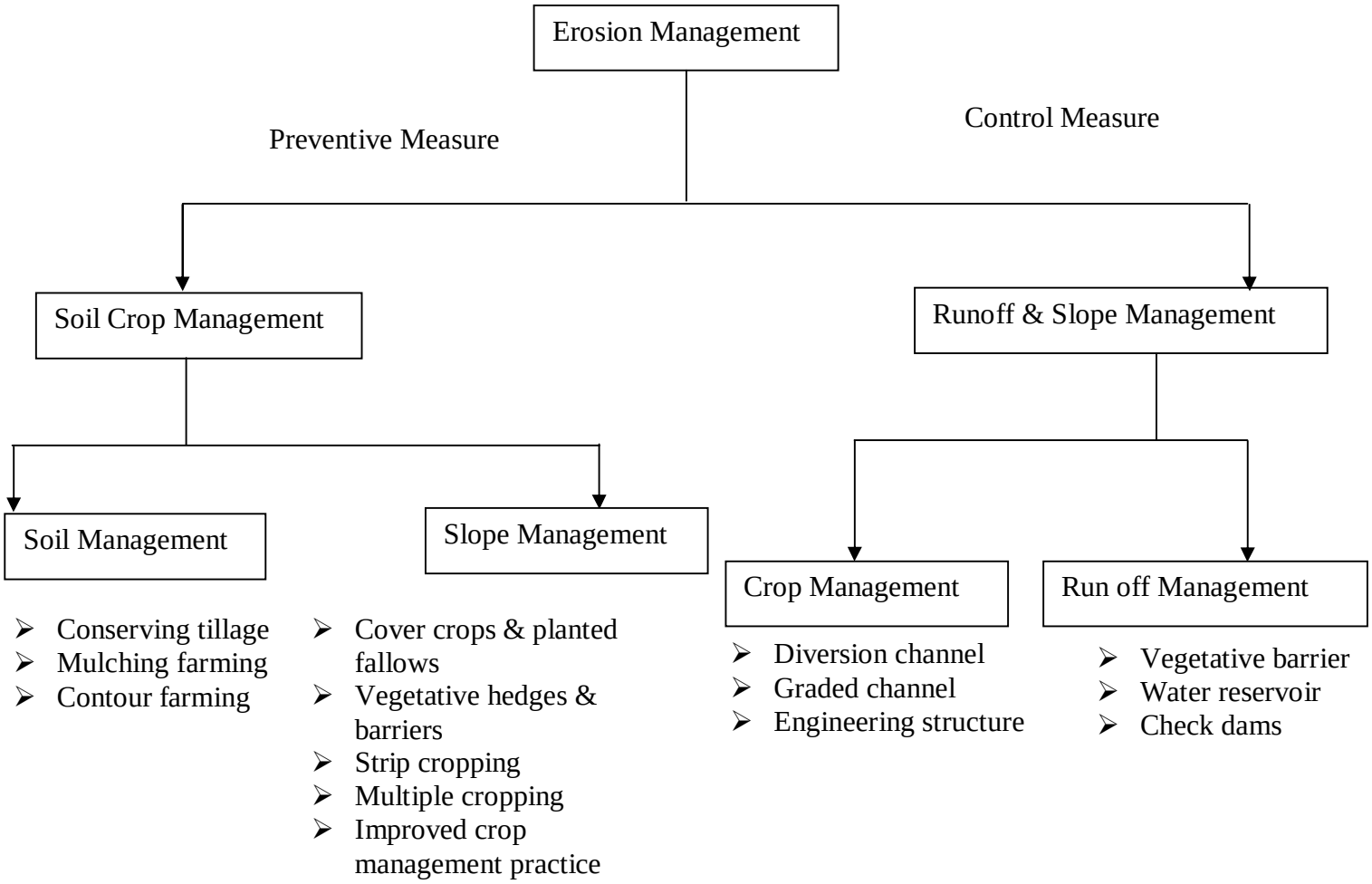
(c) Managing soil surface to enhance infiltration rate.

(d) Reducing slope length to minimize runoff build-up.

(e) Disposing excess runoff safety through protected waterways graded channel.

Based on these prinaple, erosion control measures are grouped into two broad

categories? Erosion preventive technique and erosion control measures.


Erosion Management
Preventive Measure
Control Measure
Soil Crop Management
Runoff & Slope Management
Soil Management
Slope Management
Crop Management
Run off Management
Conserving tillage
Mulching farming
Contour farming
Cover crops & planted fallows
Vegetative hedges & barriers
Strip cropping
Multiple cropping
Improved crop management practice
Diversion channel
Graded channel
Engineering structure
Vegetative barrier
Water reservoir
Check dams

3.3.1 CROP AND VEGETATION MANAGEMENT

Agronome measure for soil conservation are based on the role of the plant cover in reducing erosion. Because of differences in their density and morphology plant differ in their effectiveness in protecting the soil from erosion.

CROP ROTATION

The simplest way to combine different crops is to grow them consecutively in rotation. The frequency with which row crops are grown depend upon the severity of erosion where erosion rates are low, they may be grown every other year, but in very erodible area, they may be permissible only once in five or even seven years. A high rate of soil loss under the row crop is acceptable because it is counteracted by low rates under the other crops so that averaged over a six-or seven years period, the annual erosion rate remain low.

Suitable crop for the use in rotation are legumes and .grasses. These provide good ground cover; help to maintain or even improve the organic status of the soil thereby contributing to soil fertility and enable a more stable aggregate structure develop in the soil. These effects are often sufficient long lasting as to reduce erosion and increase yield during the first year of row crop cultivation, but they rarely extend into the second year for this reason, two continuous years of planting with a row crop should be avoided.

3.3.2 SHIFTING CULTIVATION

Shifting cultivation is a traditional method of reducing soil erosion in the reopic by rotating the location of the field. An area of forest is cleared by slash and burn, the soil loosened by hand hoeing and a crop planted where two crop a year can be obtained, a second crop is grown after

the harvest of the first, otherwise the land is left as a weed fallow. The same area may be cropped for a second year before being allowed to revert to scrub and secondary forest. The typical crops grown are cassava, maize, upland, rice and yam. The residual effect of the forest on the organic content and aggregate stability of the soil generally lasts for the first year of farming so that the soil loss remains low.

3.3.3 GRAZING LAND MANAGEMENT.

Rotation is commonly practiced on grazing land, moving the stock from one posture to another in turn, to give time for the grass to recover. Generally grassland should not be explained to more than 40 to 50 percent of their annual production (Fournier 1992) and should be allowed to regenerate sufficiently to provide a 70 percent ground cover at the time of erosion risk. Grazing land has to be very carefully managed, while overgrazing can lead to deterioration of the rangeland and the consent of erosion, under grazing can result in the loss of nutrition's grasses, many of which regenerate rapidly when grazed.

3.3.4 FOREST MANAGEMENT

The private of rotation can be applied to other forms of land use. The timber resources of forest are often exploited commercially by patch cutting also termed clear felling, on a rotational basis. Erosion rates are highest in the years immediately following logging operation but decline in subsequent years either with natural vegetation regrowth or replanting so that averaged over twelve years or more they may be little different from those of undisturbed land.

3.3.5 MULCHING

Mulching is the covering of the soil with crop residues such as straw, maize stalks, palm fond or standing stubble. The cover protects the soil from raindrop impact and reduces the velocity of runoff and wind from the conservation view pot a mulch simulates the effect of a plant cover. It is most useful as an alternative to cover crops in dry areas where insufficient rain prevents the establishment of a ground cover before the onset of heavy rain or strong wind or where a cover crop compete for moisture with the main crop.

In semi-humid tropical areas, the effect of mulch in the forms of lower soil temperature and increased soil moisture are beneficial and may increase the yields of coffee, banana and cocoa.

3.3.6 AGROFOREST

Tree can be incorporated within a farming system by planting them on land which is not suitable for crop production, along river banks, on terraces and contour bunds, on area being renegotiate to control erosion, as wind breaks and shade trees and as ornamentals around the homestead (Wene 1991, Lundgren and Nai, 1985). Trees help to preserve the fertility and structure of the soil and prevent erosion.

They are attractive to the farmer where they provide additional needs especially fuel, folder and fruits.

Soil Management

The aims of sound soil management are to maintain the fertility and structure of the soil. Highly fertile soils result in high crop yield, good plant cover and therefore, in condition which minimize the erosive effect of raindrops, runoff and wind, These soils have a stable, usually

granular structure, which does not break down under cultivation, and a infiltration capacity. Soil fertility can thus be seen as the key to soil conservation.

3.4 ORGANIC CONTENT

One way of achieving and maintaining of fertile soil is to applyorganic matter. Thus improves the cohesiveness of the soil, increase its water retention capacity and promotes a stable aggregate structure.

Organic material may be added as green manure straw or as manure, which has already undergone a high degree of fermentation. The effectiveness of these three kinds of material varies with the isohumic factor, which is the quantity of humus produced per unit of organic matter. (Kolenbrauder 1994). Green manures, which are normally leguminous fermentation and yield a rapid increase in soil stability!

3.4.1 TILLAGE PRACTICES

When manage so as to maintain their fertility most soils retain their stability and are not adversely affected by standard tillage operations. Indeed, tillage is an essential management technique. It provides a suitable seed bed for plant growth and help to control weeds. The effect of wheeled traffic and tillage implement on a soil depends upon its shear strength, the nature of the confirming stresses and the direction in which the force is applied. The main effect of driving a tractor across a field is to apply force from above and compact the soil

This may result in an increase in shear strength through an increase in bulk density and in the number of clods larger than 30mm in diameter, but these effects are often more than offset by

decreased infiltration and increased runoff so that wheeling are frequently zones of concentrated erosion.

The pattern of compaction depends upon tyre pressure, the width of the wheels and the speed of the tractor, the later controlling the contact time betwecn the wheel and the soil

3.4.2 SOIL STABILIZER

Improvement in soil structure can be achieved by applying so condition, which may consist of organic by product, polyvalent salts and various synthetic polymers. Polyvalent salt such as gypsum bring about flocculation of the clay particle while organic by products and synthetic polymers band the soil pa into aggregates.

Gypsum has been used successfully to improve the structure of sodic soil in southeast Australia (Davidson and Quirk 1991; Rosewell ‘970). Sodic soils are highly erodible because the excess of sodium results in the dispersal of the minerals on contact with water with consequent structural deterioration Such soils appear to be particularly susceptible to tunnel erosion The most effective treatments is therefore to apply gypsum as this applies a cation to replace the sodium.

3.5 MECHANICAL METHODS OF EROSION CONTROL

Mechanical field practices are used to control the movement of water and wind over the soil surface. A range of technique is available and decision on which to adopt depend on whether the objectives is to reduce the velocity of runoff and wind increase surface water storage capacity or safety dispose of excess water. Mechanical methods are normally employed in conjunction with agronomic measures.

3.5.1 CONTOURING

Car out plugging, planting and cultivation on the contour can reduce soil loss from slopping land by us to 50 percent compared with cultivation up and down the slopes.

The effectiveness of contour farming varies with slope steepness and slope length, for it is inadequate as the sole conservation measure for lengths greater than 1 80m at 10 steepness. The allocable lengths decline with increasing steepness to 30m at 5 • and 20mt 8.50. Moreover, the technique is only effective during storms of low rainfall intensity. Protection against more extreme storms is improved by supplementing contour farming with strip cropping. (Tregobol 1981).

3.5.2 CONTOURBUNDS

Contour bunds are earth banks 1 5 to 2m wide thrown across the slope to act as a barrier to runoff, to form a water storage area on their upslope side and to break up a slope into segment shorter in length then is required to generate overland flow They are suitable for slopes of 10 to 70 and are frequently used on small holdings in the tropics where they form permanent buffer in a strip cropping system, being planted with grasses of tree (Roose 19996). The banks, spaced at 10 to 20m intervals, are generally land-constructed. There are no precise specifications for their design and deviations in their alignment of up to 10 percent from the contour are permissive (Hurni 1984)

3.5.3 TERRACES

Terraces are earth embarrassments constructed across the slope to intercept surface runoff and convey it to a stable outlet at a non erosive velocity, and to shorten slope length They thus

perform similar functions to contour bunds They differ from them by being larger and designed to more stringent specification. Decisions are required on the spacing and length of the terraces, the location of terrace outlet, the gradient and dimensions of the terraces channel and the layout of the terrace system.

3.5.4 STABILIZATION STRUCTURES

Stabilization structures play an important role in gully reclamation and gully erosion control small dams, usually 0 4 to 20m in height, made from locally available materials such as earth, wooden planks, brushwood or loose rock, are built across gullies to troop sediment and thereby reduce channel dept and slope. These structures have a high risk of failure but provide temporary stability and are therefore used in association with agronomic treatment of the surrounding land where grasses, trees and shrubs are planted. If the agronomic measure successfully hold the soil and reduce runoff, the dams can be allowed to fall into disrepair. Even though they are temporary, the dams have to be carefully designed. They must be provided with a spillway to deal with overtopping during high flows and installed at spacing. appropriate to the slope of the channel.

3.5.5 WINDBREAKS

Shelterbelts are placed at right angles to erosion winds to reduce wind velocity and, by spacing them at regular intervals, break up the length of open wind blow.

Shelterbelts are strictly living windbreaks. In art structure such as stonewalls, slat and brush fances and cloth screams can be used to perform similar function on a smaller scale.

A shelterbelt is designed so that it rises sharply on the windward side and provides both a barrier and lilter to wind movement. A complete belt consist of two tree rows and up to three shrub rows, one of which is placed on the windward side. The density of the belt should not be so great as to form on impermeable barrier nor so sparse that the belt is transparent. A belt of the correct density is best described as translucent.

3.5.6 GEOTEXTILES

Several types of netting woven from natural fibre such as jute or made from artificial fibre such as nylon are now manufactured commercially for use in erosion control. They are supplied in rolls, unrolled over the hillslope from the top and anchored with large pins or stapled. They are designed to give temporary stability on roadsides and on sleep slopes not used for agriculture until such time as the vegetation cover grows. The thinner net, comprising one layer of mesh, are generally unsafisfactory on their own and need to be combined with much

4.7 PREVENTING GULLY EROSION IN NIGERIA

Southeastern Nigeria is a densely-forested region with a kind of a rolling, hilly terrain. But this lush, green land could soon become an arid badland that's [for cultivation, dangerous for human habitation, and well on the way to becoming a parcel of useless land, warns Frank Simpson, a sedimentologist at the University of Windsor.

The culprit is a phenomenon called 'gully erosion'. Mainly a product of human activities such as deforestation, unsustainable farming practices, path and road construction, and poorly constructed drainage systems, gully erosion takes place when wear-and-tear on the surface land causes rainwater to accumulate in one area, causing loss of vegetation cover, localized erosion,

and the formation of gullies. According to Dr Simpson, the problem grows as interconnecting systems of gullies spread across the land surface. The resulting run-off from the hillsides often pollutes the water supply, while landslides threaten villages and highway travellers.

Better engineering

But the phenomenon can be prevented through a combination of better engineering and changes in human behaviour, says Dr Simpson, one of the members of a Nigerianl Canadian research team funded by the International Development Research Centre (IDRC). For almost a decade, the team has been searching for solutions to gully erosion.

The origins of this research project date back to 1990, when Enuvie Akpokodje, a Professor of Geology at Nigeria's University of Port Harcourt, proposed a joint research effort to specialists at the University of Windsor in Canada, where Dr Akpokodje was on sabbatical leave. He and geological engineer Peter Iludec (who has since retired and turned over leadership of the Canadian team to Dr Simpson) submitted a proposal for funding to ID.RC. Meanwhile, a similar proposal had been prepared by the late Professor Meshach Umenweke (who died earlier this year) of Nigeria's Nnamdi Azikiwe University, at Awka.

Multi-Disciplinary Approach

According to Dr Simpson, IDRC was keen to involve both Nigerian institutions in a single venture, believing that a more multi-disciplinary approach would be most effective, and that Dr Akpokodje's perspective as a geological engineer would complement that of Dr Umenweke, who had mapped the geology of much of the

threatened region. The scope of the project was further broadened to include botanists, an anthropologist, a sociologist, and an agricultural specialist.

A number of gullies in southeastern Nigeria are caused by the overflow of concrete rainwater gutters at the side of highways, leading to erosion — particularly at the point where the gutter and the road meet — that destabilizes hillsides and undermines roadbeds, says Dr Simpson. The solution to this is largely a matter of engineering: there is a need for better roadside drains that can corral greater volumes of rain.

Outreach Campaigns

But other causes of gully erosion are social in nature — and are best addressed through public outreach campaigns that actively involve rural villages, farmers, and herdsmen in the remedy, he adds.

Foot traffic that creates pathways down slopes, for instance, can have disastrous effects. What starts out as a simple pathway through the forest quickly sets the scene for localized erosion by run-off, Dr Simpson explains. In only a matter of weeks, or a few months, where there was previously no gully, there might now be a gully tens of metres or more wide, tens of metresdeep, and hundreds of metres long.

Other Causes

Driving animals to market or between villages can also have destructive consequences. And cultivating crops can create gullies if the small mounds of soil typically used to trap rainwater for infiltration around the crops are not adequate for the volume of rain.

Dr Simpson views a mixture of innovation and the revival of traditional knowledge as the solution to these problems. Building terraced plots will help ensure that agriculture does not degrade the slope, while the use of soil ridges and spiliways can channel rainfall downslope fromone terrace to the next in a controlled manner. Footpaths built alongside these terraces can also improve the situation, if they follow the natural contours of the landscape, descending at regular intervals through the use of steps, and possibly employing boardwalks to protect the soil. In addition, erosion can be slowed or halted by harvesting rainwater from the roofs of houses, and restoring the traditional mud and, tree-branch barriers, which villagers once constructed to contain rail3fall in the forest.

Public Education

These measures will not be enacted, however, without a concerted effort to educate the public something that has already begun. A workshop, which occurred in Imo State in September 1999, when the IDRC-funding was winding down, enjoyed the participation of state politicians, heads of public works, private industry, local erosion committees, and a strong contingent of graduate students and undergraduates who may keep the work alive within academia. Dr Simpson also reports strong media interest in gully erosion, ‘which coincides with the broad public realization — in the aftermath of military rule — that environmental rehabilitation is a key prerequisite for economic growth in Nigeria.

Still, more remains to be done. The researchers have proposed a second-phase project focusing on a specific watershed that will serve as a series of demonstration sites, which others may wish to follow. Dr Simpson expresses cautious optimism about the situation, stressing that follow up action must be timely, and the right time is now.

DROUGHT

Drought is one of the major weather phenomena that constitute hazards to agriculture. It is a serious hazard to agriculture in both temperate and tropical regions of the world. There are various definitions of drought depending on the disciplinary background or interest of the researcher.

(1) **In Meteorology**

Absolute drought: - is a period of at least 15 consecutive days to none of which is credited 0.2mm or more of rainfall.

Partial drought: - is a period of at least 29 consecutive days the mean daily rainfall of which does not exceed 0.2mm.

(2) **In Agriculture**

Drought is rainfall deficiency extending over months or years drying up water supplies and affecting crops.

Drought is condition in which there is insufficient moisture in the soil to maintain plant life.

(3) **In Hydrology**

A drought is a period during which river discharge falls below a prescribed minimum threshold.

(4) **In Climatology**

A drought is said to occur when the rainfall received in a given year is more than 10% below the normal.

(5) **In Economics**

Drought is said to prevail whenever precipitation is insufficient to meet the needs of established human activities.

❖ What is of interest to us here is agricultural drought. From the point of view of crop production, a drought can be said to occur whenever the supply of moisture from precipitate or stored in the soil is insufficient to fulfill the optimum water needs of crops.

Types of drought

(1) **Permanent drought: -** This type of drought occurs in arid areas where in no season is precipitation enough to satisfy the water needs of crops. In such areas agriculture is impossible without irrigation.

(2) **Seasonal drought: -** This type of drought occurs in areas with well defined wet and dry season as in most parts of the tropics. Drought occurs every year owing to seasonal change in atmospheric circulation pattern. Agriculture is possible during the rainy season or with the use of irrigation during the dry season.

(3) **Contingent drought: -** This drought is a characteristic of sub-humid and humid areas and occurs when over a period of time the expected rain fails to fall. Contingent drought is unpredictable and therefore constitutes serious hazards to agriculture.

(4) **Invisible drought: -** Invisible drought cannot easily be recognized like the other types of drought which is quite evident by the wilting of crops and lack of vegetative growth. In invisible drought the crops do not wilt but fail to grow at their optimum rates because the daily supply of moisture from the soil or through falling precipitate does not match the daily requirements of crops.

Only contingent and invisible drought constitute hazard to agriculture. Permanent is synonymous with aridity and so it is an attribute of arid areas.

Seasonal drought occurs every year and it is expected in areas characterized by well defined wet and dry seasons. In contrast contingent and invisible drought are unexpected difficult to predict and occur because of variability in rainfall incidence within the year and / or from one year to another. Contingent and invisible drought therefore constitute the scientific and popular notions of drought.

The causes of drought are primarily meteorological since drought results from failure of rains expected as a result of changes in atmospheric circulation system, the failure of expected rainfall can be inform of reduction in the total amount of rainfall received or abnormal distribution of rainfall in time or both. The failure of rain is a direct result of lack of formation of rain producing cloud. Hence, period of drought is also characterized by lack of clouds and high rate of evapo-transpiration. In other words, there is increase in crop water requirement as well as short fall in rainfall receipts. Some have argued that some drought situation could be partly man induced or man made. This can happen if the economic development of an area, man creates a demand for more water than it is normally available in that area or through the disruption of the ecological system and by over grazing, over cultivation and deforestation among others. This man induced drought is often termed economic drought.

The effects of drought on agriculture are wide-ranging but the most fundamental is that: -

(1) Drought causes poor crop yield or total crop failure.

(2) Drought also has adverse effect on animal husbandry

(3) Persistent occurrences of drought in semi-arid areas often lead to soil erosion and desertification which may diminish the capacity of the soil to support crops when the rains return.

Since drought is a condition in which crop water needs are in excess of available moisture the hazard of drought can be managed in two ways:

(1) By decreasing the water needs of crops

(2) By increasing the supply of water available for crop use

- Crops with low water demands can be planted in drought prone areas as a means of combating the effect of drought. Similarly, drought resistant crops and quick-maturing or short season crops should be planted in drought-prone areas. Also, cultivation methods that conserve soil moisture should be employed. For instance, legumes, grasses, organic matter and lime fertilizers help to improve the water retention capacity of soils. There is also need to control weeds which accelerate water loss by transpiration at the expense of crops. Dry farming technique is commonly practiced in subhumid and semi-arid environments which are drought prone. This involves the use of two or three years rainfall to raise one year's crop.

  The most effective method of combating drought is however through provision of water by irrigation or cloud seeding. Cloud seeding is at present an insignificant method of combating drought because it is costly and not very effective. Suitable clouds for seeding are non-existent during period of drought. Besides, there are legal problems involved in cloud seeding while some have questioned the efficacy of cloud seeding in producing additional rainfall, some have argued that cloud seeding merely redistributes rainfall over an area rather than create 'new' rainfall. In other words, when a cloud is forced to give up

its moisture through seeding over an area, it is the area downwind of the target area that will be robbed of the rain that would have fallen on it if the cloud had remained unseeded.

In contrast, irrigation is a more common and effective method of combating the problem of drought world wide. In arid areas, agriculture is made possible by means of irrigation. In semi-arid and subhumid areas, the application of irrigation water helps to increase crop yield and avert crop failure as well as make possible the cultivation of a greater variety of crops.

DESERTIFICATION

Desertification is the degradation of land in arid and semi-arid and dry sub-humid areas resulting from various climatic variations, but primarily from human activities. Current desertification is taking place much faster worldwide than historically and usually arises from the demands of increased populations that settle on the land in order to grow crops and graze animals. A major impact of desertification is biodiversity loss and loss of productive capacity.

Deserts-like properties include high air temperatures, low humidity, high evapotranspiration, low soil moisture content, low cloudiness or persistent clear sky conditions e.t.c.

The observable indicators of desertification are

- The disappearance or permanent degradation of the vegetation;
- soil erosion by wind;
- dune formation or reactivation;
- desiccation of the soil profile;
- lowering of the ground water table.

CAUSES OF DESERTIFICATION

Desertification is induced by several factors, primarily anthropogenic. The primary reason for desertification is drought but can be helped by overgrazing, overcultivation, incorrect irrigation methods. It is a common misconception that drought by themselves causes desertification while drought is a contributing factor the root causes are all related to man's exploitation of the environment. Droughts are common in arid and semi-arid lands. Well managed lands can recover from drought when the rain returns, continued land abuse during drought however increases land degradation.

(1) Natural causes of desertification: - The natural causes of desertification include poor physical condition of soil, vegetation, topography and as well as inherent extreme climatic variability as evidence in periodic drought. Climate variation is perhaps the most important cause of desertification and drought in the dry land of Nigeria. Some arid and semi-arid land can support crops but additional pressure from greater populations or decrease in rainfall can lead to the few plant present disappearing the soil becomes exposed to wind causing soil particles to be deposited else where. The top layer becomes eroded with the removal of shade, rate of evaporation increasing and salt becomes drawn up to the surface this increases soil salinity which inhibit plant growth, the loss of plant causes less moisture to be retained in the area which may change the climate pattern leading to lower rainfall.

(2) Wood extraction for fuel and consumption (deforestation): - Without alternative sources of energy, the demand for fuel wood has been on steady increase by the increasing population and rapid organization; despite the existing felling of trees policy in

the various states. In addition, wood is also exploited for building, art and craft in this environment. Forest depletion is the major agent of desertification in Nigeria.

(3) Bush Burning: - It is an agent in the process of deforestation. Owing to the low relative humidity of the semi-arid zone coupled with dry harmattan wind, there is always a high incidence of bush fires every dry season. The occurrence of fire, within the zone can be attributed to: -

(i) Bush Burning by villagers during land clearing for agriculture.

(ii) Hunters in search of game, set fire unto the vegetation.

(iii) Cattle herdsmen who set fire to dry grass to stimulate growth of dominant grass.

(4) Grazing: - Increased population and livestock pressure on marginal lands has accelerated desertification. In some areas, nomads moving to less arid areas disrupt the local ecosystem and increase the rate of erosion on the land. Nomads typically try to escape the desert, but because of their land use practices, they are bringing the desert with them.

(5) Cultivation of marginal land: - Cultivation of marginal areas is one of the causes of desertification. In periods of higher than normal rainfall, people tend to extend farming activities into the marginal area. When the years of plenty are followed by dry years, exposed land with very little vegetal cover is at the mercy of the winds. The fine clays and silts are carried away as dust, and the sand drifts into dunes. The effect of this could be irreversible except through carefully planned rehabilitation programme.

(6) Poverty: - Perhaps the most important and often neglected cause of desertification is poverty. Although, statistical data are hard to come-by, evidence seems to suggest that the vast majority of the inhabitants of the dry lands of Nigeria live below the poverty level. To a large extent, they depend heavily on the natural resources of Nigeria. The dry

land of Nigeria is the least developed in terms of the ability to meet basic needs. Per capital income is not only low, but the population on growth rate is high, morbidity and mortality rates are high, medical services are lacking and food security is not guaranteed. Therefore over stocking, over-grazing, cultivation of marginal land are seen as possible responses to a harsh and inhospitable environment and poverty. For any conservation measure to be successful in this environment, it must address the issue of poverty squarely.

MITIGATION MEASURES TO COMBAT DESERTIFICATION IN NIGERIA

The Federal Government of Nigeria within the overall frame work of protecting the Nigeria environment has given attention to the twin environmental problems of drought and desertification. Some of the measures are: -

(1) National policy on the environment: - This includes: -

(i) Development of a national programme to combat desertification and mitigate the effects drought towards the implementation of the Convention to Combat Desertification (CCD) in Nigeria.

(ii) Integrating public awareness and education on causes and dangers associated with drought and desertification, as well as the constraints of the CCD.

(iii) Strengthening of national and state institutions involved in drought and desertification control programme.

(iv) Promoting sustainable agricultural practices and management of water resources including water harvesting and inter-basin transfers.

(v) Encouraging individual and community participation in viable afforestation and reforestation programmes.

(vi) Establishing drought early warning systems.

(2) Institutional and legislative frame work: - The establishment of FEPA by Decree number 58 of 1988 was probably the most far reaching initiative undertaken by the Federal Government of Nigeria for the purpose of addressing environmental problems (drought and desertification inclusive) and protecting the Nigerian Environment.

(3) Management of water resources: - Towards promoting sustainable utilization of water resources in the dry lands, Nigeria established River Basin Development Authorities under the supervision of the Federal Ministry of Water Resources. They are actively involved in the development of water resources particularly for irrigation. The effort includes damming and diversion of rivers and in some areas exploiting under ground water. They are also involved in the improvement of community water supply and provision of watering point in range land.

(4) Forestry programme: - An Arid zone afforestation project was instituted by the Federal Government in 1976 to tackle the problems of desertification over 10 million seedlings were raised annually between 1978 and 1984. Other forestry programme embarked upon by the Federal Government include: - Land use policy, mass tree planting campaign, prevention of bush fire e.t.c.

(5) Agricultural Development Programme (ADP): - The Federal Government of Nigeria with World Bank assistance has expanded resources to establish Agricultural Development Programme in all the 36 states of the federation and the federal capital territory. The ADPs operate the training and visit system of unified extension system

covering the areas of crop production and protection, livestock production and animal health, fisheries, agro-forestry and gender related issues in agriculture popularly referred to as women in agriculture.

(6) Integrated programme targeted at poverty alleviation: - The Federal Government of Nigeria realized that poverty alleviation is a major weapon for combating desertification. Consequently, a number of poverty alleviation programmes have been put in place. Notable amongst these are the North-East Arid Zone Development Programme (NEAZDP), Katasina State Agricultural and Community Development Project (KSACDP). The NEAZDP funded by the Federal Government of Nigeria with Europe Union (EU) assistance commenced in February 1990 with the main objective of motivating and assisting the rural population to improve their standard of living through proper resource use and management. The programme covers an area of about 25,000 km^2 in the extreme Northern part of Yobe State. Rainfall in the area, which occurs between July and Sept. is extremely unreliable in amount and distribution (less than 300 mm).

EFFECT OF DROUGHT AND DESERTIFICATION

(A) Effect of Drought on Natural Resources

In a predominantly agricultural country such as Nigeria, the most important natural resources are the land (soil and climate), tree vegetation, animals (wildlife and domestic livestock) and water.

(I) Effect on food production (land)

Droughts have effects on the available natural resources of the affected region in Nigeria. Drought occurred between 1972 – 1974 and 1982 – 1984 in Nigeria. The most important

and long lasting effects is the progressive deterioration of land quality. The extensive disintegration of the soil, expansive erosion by short rainstorms, leaching of the meagre nutrients are aggravated by the steady build up of sand dunes which reduce productivity of the land to a barest minimum. The very high wind velocities, extreme temperatures (exceeding 30^0c) and humidity induce the onset of desiccation which progressively reduces the vigour of plant and animal life. The low and variable rainfall 500 – 650 mm annually and the deep and shallow water table drastically reduce the length of the growing season. This invariably results in poor agricultural yields and widespread crop failures.

(II) Effects on livestock resources

The droughts in Nigeria have had severe adverse effect on the livestock resources. Drought invariably eliminates food and water sources for livestock. Indeed the competition between humans and livestock becomes intensified and the latter is frequently the looser. Under the nomadic pastoral system of the traditional livestock economy, starving animals must travel great distances on the hoof in search of food and water. Mass deaths of livestock are, therefore, not uncommon.

(III) Effects on tree vegetation

The effect of drought on tree vegetation depends on the severity and on the structure of existing vegetation. Generally the tree vegetation in the Sahel is sparse and highly vulnerable to human action either by wood cutting for fuel or grazing of livestock. During drought, desiccation causes severe depletion of the conventional food and water sources for man and animals alike. There is thus a widespread resort to natural woodland vegetation in search of food and water for man and fodder for livestock. These

interventions which remove the tree vegetation, eliminate soil cover and with subsequent (post drought) rains, initiate extensive sheet and wind erosion. Sand dunes may build up where tree vegetation has been removed. This severely reduces the ability of the site to revegetate, creating desert-like condition.

(IV) Effects on water supplies

Drought is normally characterized by very short and few rains. There is thus minimal recharge of the ground water reservoirs artesian wells. Absence of tree vegetation accelerates surface runoff of precipitation and reduces the proportion eventually percolating to reach underground water reserves. Given the increasing demand for water by man and animals, long periods of drought severely deplete water reserves and may reduce supplies to dangerous low levels that may preclude their access to animals. It is also observed that accelerated surface run-off induced by drought affected soils, reduces water quality and increases the cost of water use.

(B) Socio-economic aspects

Acute food and water deficits have accompanied every drought in Nigeria. The deficits contributed in large measure to the large spread of famine, hunger, malnutrition and undernutrition of large sections of the local populations as well as those of neighbouring states. These effects are also at the root of the generally poor health and the low productivity of the local people.

Food deficits also cause spiraling of prices in the economy. The consumer price index for food in Nigeria rose by approximately 74% in four years. In all the states affected by drought in 1972 – 1974 prices of basic food stuffs such as guinea corn, millet and rice, soared to unprecedented levels and persisted for longer periods especially along the

extreme northern boundary. The effects of the scarcity of grains in these states also led to high prices further south.

The income losses due to drought are considerable. The losses derived from both food production deficit and mass deaths of cattle and other livestock.

Massive movement of people (migration) south-wards from the drought areas in search of food, water and comfort. Frequently the host communities are not economically or physiologically prepared for the mass influx of strangers.

Social disequilibrium often follow as immigrants experience severe difficulties with adjustment. In the short term, transit camps may be built by government and managed by famine relief organizations to receive spillovers of refugees. In the long term transit refugee camps may develop into permanent settlements of communities which are in permanent conflict with the original inhabitants of the area especially as competition for few available jobs intensifies.

Drought also causes disintegration of prevailing socio-cultural system of affected communities. Many people must change their occupations and move to new areas following the crop harvest and livestock losses in order to earn their livelihood. Head of families are forcibly separated from their dependants and many never return. In the communities that host migrants from drought affected areas there is increased pressure on local infrastructure and social amenities such as housing, schools, hospitals and recreational facilities. Incidence of crime and truancy among idle immigrants from areas affected by drought may also be on the increase.