

# DESERTIFICATION: CLIMATE AND WATER RESOURCES PERSPECTIVES

*BY*

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# 1.0 INTRODUCTION

- Among the many environmental issues facing our planet, desertification and drought may have caused more humans suffering than any other problem.
- In 1977, the United Nations Conference on Desertification (UNCOD) defined desertification as the diminution or destruction of biological potential of the land, which could lead ultimately to the formation of desert-like conditions (UNCOD, 1977).

# INTRODUCTION CONT'D

- The United Nations Environment Programme (UNEP) revised this definition in 1991 as land degradation in arid, semi-arid, and dry sub-humid areas resulting mainly from adverse human impact.
- Dregne and Chou (1992), viewed desertification as a human induced process of land degradation that can range in severity from slight to very severe, and is caused from erosion to Salinisation to toxic chemical accumulation to vegetation degradation, irrespective of climate

# INTRODUCTION CONT'D

- Robins (1997) described desertification as a menace in the semi-arid zones and its causes are complex, but it is generally the result of the combined effects of climatic variability, demographic, human and animal factors.
- In the International Convention to Combat Desertification, the term "desertification" means land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors, including climatic variations and human activities (CCD, 1994).

# INTRODUCTION CONT'D

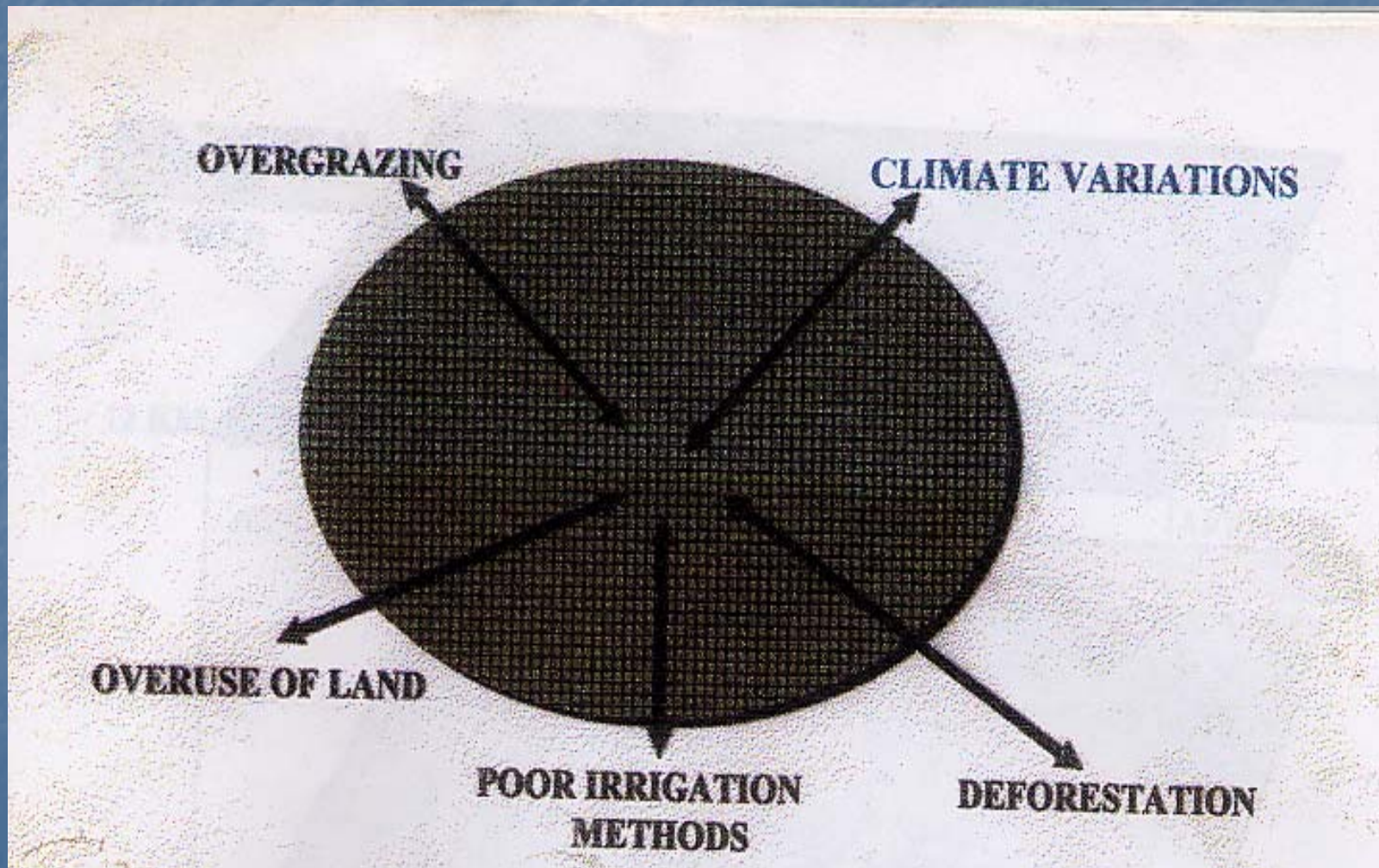
- The principal desertification processes are degradation of the vegetative cover (rangeland desertification)
- Accelerated water and wind erosion ( rain fed cropland desertification), and
- Salinisation and water logging (irrigated land desertification).
- Other important desertification processes include soil compaction and accumulation of toxic substances such as heavy metals and persistent pesticides.

## 2.0 CAUSES OF DESERTIFICATION

- In recent years, deserts seemed to have spread due to two main causes :-
  - Human induced factors
  - climate and water resources factors

This paper is concerned with the second cause

# Major Factors that cause Desertification





# 2.1 CLIMATIC FACTORS

## ■ DROUGHT

- Drought is a complex phenomenon, which is governed by a complex system.
- It is a major disruptive force capable of exacerbating existing social, economic, political and cultural factors of development.
- The definition of drought is dependent on the sector being considered

# Definition of Drought

- Agrometeorologist view drought in the context of insufficient soil moisture to support crop growth and development;
- Meteorologists are concerned with drought as a period of below normal precipitation;
- Hydrologist view drought as a period with below normal stream-flow and depleted reservoir storage;
- Economists are concerned with drought as it affects society's productivity and consumptive activities (Dracup et al 1980).
- Politicians are also concerned with the impacts of drought as it is the period that the electorates lose confidence in them, as they are incapable of meeting the demands from the society.

# Impact of Drought

- Impacts of drought can be categorised under the economic, environmental and social categories.
- Economic impacts include losses from crop production, fishery production, and timber production (Oladipo, 1995).
- Major environmental impacts include damage to animal and plant species, wind and water erosion, and deterioration in air and water quality.
- Social consequences of drought include increased poverty, reduced quality of life, population migration and social unrest and conflicts.

## 2.1.1 PHENOMENA ASSOCIATED WITH THE AFRICAN DROUGHT

- GENERAL CIRCULATION PATTERNS
- OCEAN – ATMOSPHERE INTERACTION
- CLIMATE VARIABILITY AND CHANGE

# GENERAL CIRCULATION PATTERNS

## A) THE INTER-TROPICAL CONVERGENCE ZONE AND ASSOCIATED WEATHER ZONE

- During the rainy season, the atmosphere is dominated by the warm, moist and convectively unstable South Westerly winds, which penetrate, to 20-22°N Latitude in August under normal rainy season.
- Dry and dusty North Easterly winds are dominant during the dry season and extend south as far as 6°N in January/February.
- The imaginary line or boundary that separates the moist South-westerly and dry north-easterly winds at any location and time of the year is known, globally, as the Inter-Tropical Convergence Zone (ITCZ), but locally, in West Africa, as the Inter-Tropical Discontinuity (ITD).
- The rate of movement and position of the ITD determines the rainfall pattern over the region.
- If the northward excursion of the ITD is delayed or the southward retreat is earlier than normal, drought over the Sahel and The Gambia is likely.

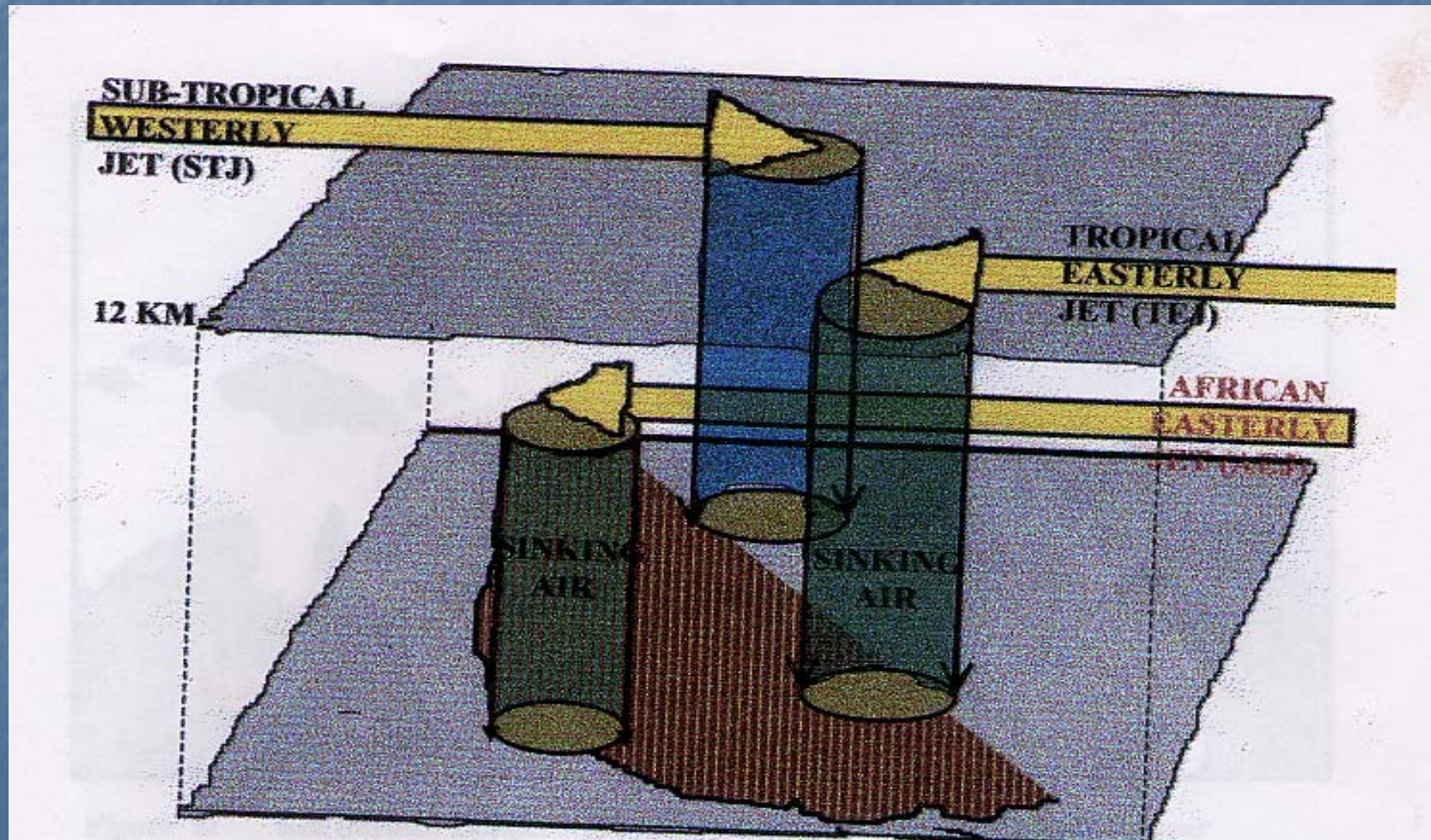
# THE WIND FLOW THAT DETERMINES THE SEASONS OVER THE GAMBIA AND WEST AFRICA



## B) The Tropical Easterly Jet, the African Easterly Jet and Squall Lines

- Superimposed on this general pattern are the African Easterly jet (AEJ) at about 3km, and the Tropical Easterly Jet (TEJ) and the Sub-Tropical westerly Jet (STJ) at about 12km above mean sea level.
- These jets have their right exists over North Africa, north of about 10°N.
- The left exists of AEJ and TEJ are over central and coastal West Africa.
- Right exists of jets are associated with subsidence of air and drying of the surface of the area of sinking motion.
- Left exists are associated with rising motion, convective activity and wet conditions.
- Weak TEJ and AEJ will results in less convective activity and drought.

# The Jet Streams over North and West Africa: The Drying of Africa

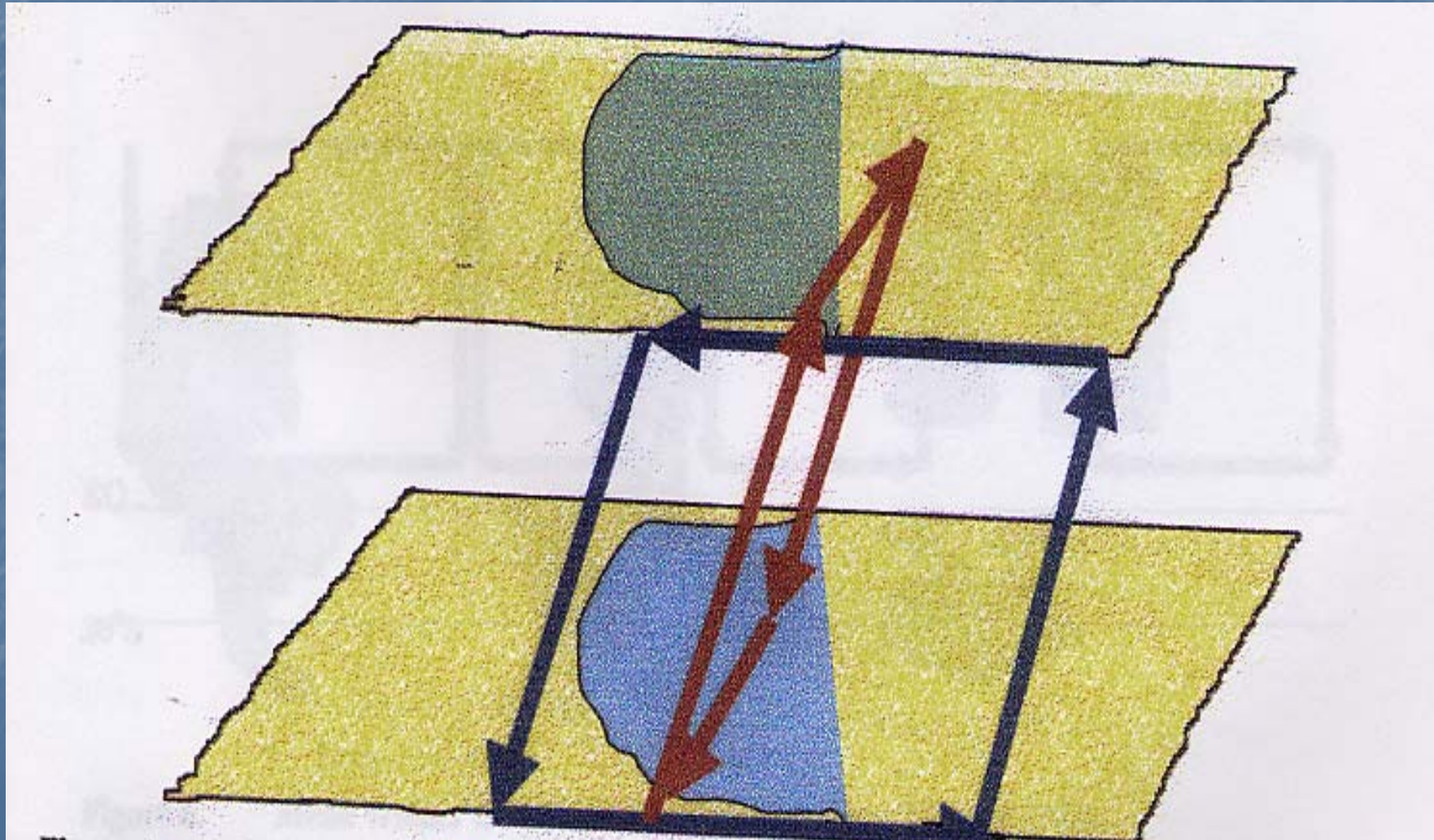




## C) SUB-TROPICAL ANTICYCLONES, HADLEY AND WALKER CIRCULATION PATTERNS

- Subtropical Anticyclones are areas of sinking air mass at about latitude  $30^{\circ}$  -  $45^{\circ}$  north and South.
- Hadley circulation is the north-south overturning of air mass with rising motion over the equatorial region and sinking at  $25^{\circ}$  -  $30^{\circ}$ N (Northern cell) and  $25^{\circ}$  -  $30^{\circ}$ S (Southern cell).
- The Walker circulation, on the other hand, is the east-west overturning of air mass with rising motion over equatorial central Africa and sinking motion over Northwest coast of Africa and the Cape Verde Island.
- Three sub-tropical Anticyclones control the movement of wind systems of Western Africa:- The St. Helena; The Azores and Libyan anticyclones.

# Illustrations of Hadley (red) and Walker (blue) Circulation over West Africa



# OCEAN - ATMOSPHERE INTERACTION

- Certain aspects of the African drought, particularly the inter-annual rainfall variability, are related to and strongly influenced by large - scale atmosphere - ocean fluctuations occurring around the world
  - EL-NINO PHENOMENON
  - EL-NINO SOUTHERN OSCILLATION AND SEA SURFACE TEMPERATURES (SSTs)

# CLIMATE VARIABILITY AND CHANGE

- INCREASE IN CARBON DIOXIDE (CO<sub>2</sub>) CONCENTRATION
  - An increase in the carbon dioxide level leads to less of the temperature - dependent infrared radiation emitted by the earth escaping through the atmosphere to space but the amount of solar radiation absorbed by the earth remains almost unchanged
  - An increase in temperature results in higher evaporation and losses of soil moisture
  - A longer time is needed for saturation of the air and cloud formation.
  - Thus, the frequency of storms will be reduced.
  - Clouds will develop in a deeper atmosphere and hence, storms will be more severe, resulting in violent flash floods.

## 2.2 WATER RESOURCES FACTORS

- Most of the water resources factors related to desertification are feedback mechanisms that contribute to sustaining the desertification process

## 2.2.1 SOIL MOISTURE AND SURFACE ALBEDO

- The occurrence and persistence of the Sahel drought appears to be due to strong positive feedback mechanisms operating which are driven by changes in soil moisture and surface Albedo.
- Both affect the radiation balance at the surface,
- The first directly, the second indirectly through its influence on the latent heat flux.

# SILTATION OF SWAMPS AND WATER BODIES

- Erosion transports a lot of sand into swamps, "bolongs" and the main river.
- The sand deposited in the swamps is infertile and overlays the fertile soil. This reduces the productivity of cultivated swamps.
- Most of the sand that finds its way to the "bolongs" is deposited at the mouth of the "bolongs" and this causes the Siltation of the channel.
- This results in the reduction of the flow from the main river into the "bolongs".
- Swamps upstream of the "bolongs" are dry and productivity is reduced

# SALINIZATION

- Almost as destructive, but spatially less extensive, is the process of Salinization, whereby mineral salts become concentrated in the surface soil by the evaporation of saline soil solution.
- This process, though on a small scale, can be observed in the Jeshwang/Bakau swamps around "Sitting Corner", in the Darsilami swamps of Jokadu and the Bambatenda/Yellitenda swamps of Jarra/Badibou districts of The Gambia.
- It has resulted to the scaling down and, in some cases to the total halt in the cultivation of the "Banta Faros" in some parts of The Gambia.



# 3.0 IMPACTS OF DROUGHT AND DESERTIFICATION

- PHYSICAL IMPACTS
- SOCIAL IMPACTS
- ECONOMIC IMPACTS
- FEEDBACK MECHANISMS

## 3.1 PHYSICAL IMPACTS

- Lack of water in the soil results in the situation that less water is absorbed by the roots of the plants while more are transpired by the leaves.
- Therefore drought impact is firstly induced by low water content of the soil, plant roots are hindered from absorbing moisture, and the moisture balance in the soil - plant -atmosphere system is broken.
- This leads to disaster on agriculture, specifically on crops, trees, vegetation and rangelands.
- In addition to having impacts on agricultural output, drought and desertification influence water quantity and quality.

## 3.2 SOCIAL IMPACTS

- Shortage of food and herbage due to reduction in soil moisture availability often results in famine, pestilence and social suffering and unrest.
- Cumulative impacts on agriculture and social amenities of communities have led to rural - urban migration
- The demands of a rapidly expanding population in the urban areas and the growth centres of the country are placing increasing burden on those regions and their resources.
- This means that the potential for adverse effects of disasters in human life is also growing, since population pressures will lead more people to live and work where risks are highest.

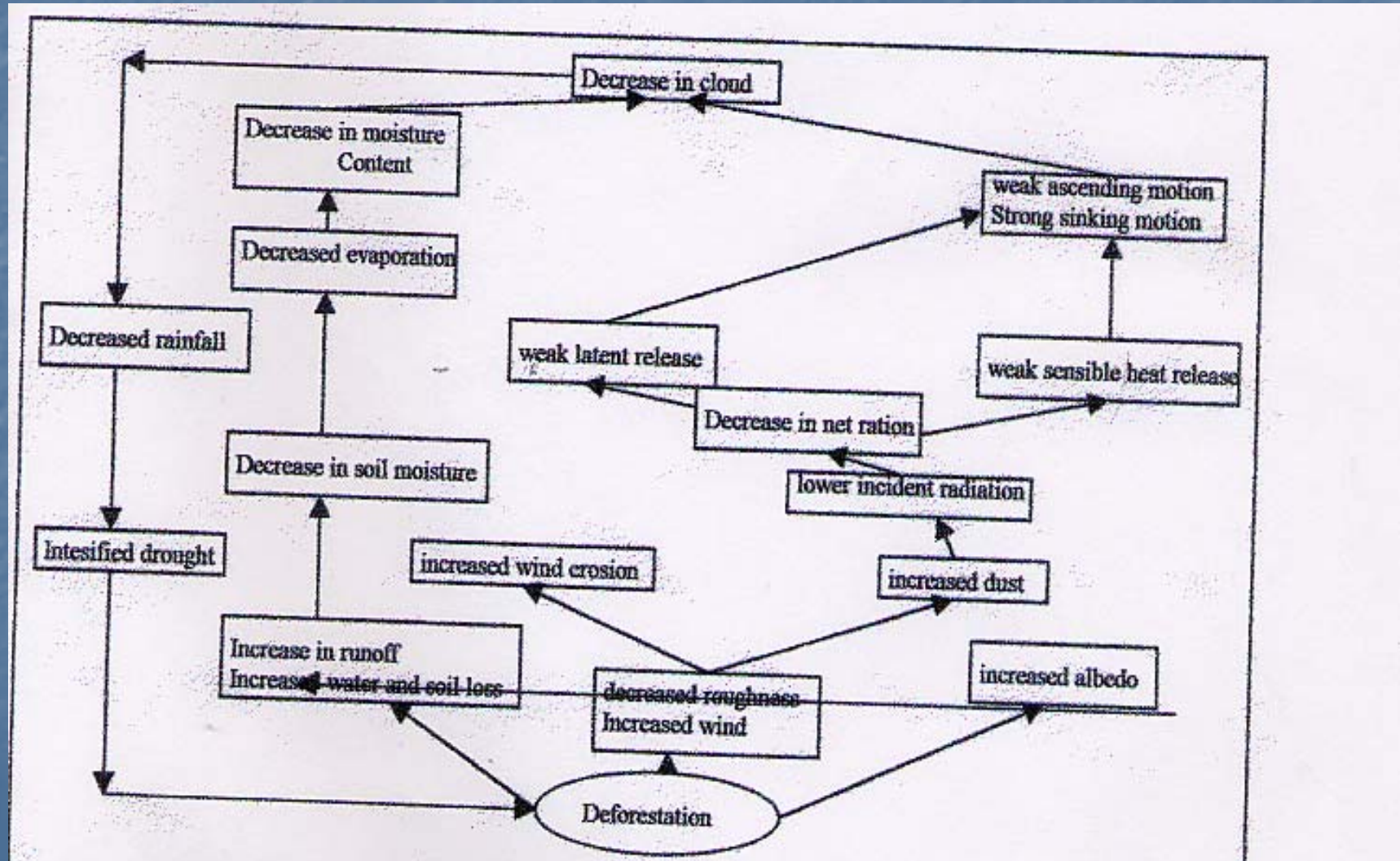
## 3.3 ECONOMIC IMPACTS

- Severe water shortage and expansion of decertified land become shackles on economic development in the world. In The Gambia, this has meant that Government and donor partners have to concentrate most development efforts and resources in relief functions especially in years following drought episodes.

## 3.4 FEEDBACK MECHANISMS

- Impacts of desertification on climate and water resources in The Gambia are better referred to as feedback mechanisms.
- They start with a change in one or more of the parameters of the energy and water balance parameters of the climate system, which leads to changes in other parameters and results in a lasting change of the energy or water balance at the surface.
- A good example is deforestation, which is a non-climate factor but leads to disruption in the water and energy balance in the climate system and water resources

# DEFORESTATION AND FEEDBACK PROCESSES AND VEGETATION AND CLIMATE



# 4.0 MITIGATING DROUGHT AND DESERTIFICATION

- MONITORING OF DROUGHT AND DESERTIFICATION
- ASSESSMENT OF DROUGHT AND DESERTIFICATION
  - DROUGHT INDICES e.g percent of normal
  - SATELLITE TECHNIQUES e.g NDVI
- DROUGHT PREDICTION (ENSO - Rainfall)
- DROUGHT MANAGEMENT (National policy of drought management and planning)

# 5.0 ADAPTING TO THE ADVERSE EFFECTS OF DESERTIFICATION

- Adaptation to desertification goes beyond mitigation and the measures are adopted after the desertification process has actually set in and it has become too late to use relief functions.
- Some of the measures to be included, as and when desertification is established in The Gambia include:
  - Setting up of the institutional framework including,
    - Establishment of a cabinet committee on desertification;
    - Establishment of Divisional, District and Village committees.
  - Create awareness; and
  - Develop contingency plans at National, Divisional, District and Village levels.



# 6.0 RECOMMENDATIONS

- Develop a well-equipped and representative hydrological and meteorological station network for monitoring of drought and desertification.
- This will enhance the national capacity in the acquisition, processing and dissemination of data and information required meeting the needs for
  1. Climate, drought and desertification monitoring.
  2. Application of the knowledge of climate in the detection, monitoring and control of drought and desertification for national economic development

# RECOMMENDATION 2

- Develop capacity in assessment and prediction of drought and desertification. This will entail the acquisition of knowledge in the use of drought indices, climate and biophysical models, and appropriate technologies. Ground techniques that are being developed to monitor drought should be integrated with space technology for better results. Technological advances in space studies allow improved drought monitoring using satellites with high resolution in a cost-effective manner.

# RECOMMENDATION 3

- Develop a drought management plan. If better monitoring must be undertaken, the development of a management plan is essential. This will require considerable political courage and foresight. The co-ordination of drought monitoring data and information among government and international organisation is essential for better drought management in The Gambia. This strongly suggests the need for a suitable mechanism or independent agency that co-ordinates and facilitates the availability of information to all kinds of users. It may also help reduce duplication of efforts among the various groups involved in drought management

# RECOMMENDATIONS 4

- Assess and regulate abstraction rate from surface and ground water sources and monitor salinity status of the River Gambia catchments. This will involve:
  - the determination of the present rate of abstraction of fresh water from the River Gambia and its tributaries, and from the ground water resources; and
  - develop a practical model for the prediction of salinity movement in the River Gambia and its tributaries; and

# RECOMMENDATIONS 5

- Introduced water harvesting on experimental bases and adopt, if found feasible. It is expected to introduce and assess the potential of water harvesting techniques as means of water supply to remote rural communities.

# CONCLUSIONS

- Drought is a normal part of climate
- Planning for drought represents prudent action by Government
- A national drought policy is strongly needed to coordinate national response to the possibility of increased frequency of future droughts
- Even if the governments can not stop drought from occurring, there are ways either to protect more vulnerable people or to prepare them to better able to cope when such situations occur.
- These people need drought preparedness training, drought technology and coping mechanisms.

THANK YOU !!!