

# Trees, Agroforestry and Climate Change in Dryland Africa (TACCDA)

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Adaptation of dryland vegetation to climate change

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## Gum arabic: Western Sudan



# DRYLAND DEVELOPMENT IN AFRICA

1. Dryland (definition), UNESCO: P/PET (moisture index): 0.03-0.65

## 2. Characteristics

- Diverse in terms of climate, soils, vegetation, animals, people's activities
- Water is the major limitation
  - ☞ - insufficient and erratic rainfall
  - ☞ - high rate of evaporation
- Strong winds, high temperature and high solar radiation
- Soils are:
  - ☞ - often erodible, poorly structured, low in organic content
  - ☞ - salts deposit and salinization is common
- Low population density
- Pastoralism is the main source of livelihood
- Rainfed agriculture is found in semi-arid highly populated zones combined with agroforestry
- irrigated agriculture, horticulture and (some) forestry are practiced where
  - - water is permanent (rivers), or
  - - groundwater sources are available
- wildlife often significant, but exploited resource.
- Resilience

## Principal means of livelihood in drylands

- Nomadic: pastoral groups that rely on livestock for subsistence, follow irregular rains, migration in search for pasture.
- Seminomadic: pastoral groups depending largely on livestock and practice agriculture at a base camp.
- Transhumance: combine farming and livestock, seasonally migrate.
- Sedentary farming: practice Rainfed (irrigated ?) agriculture. Land use often combination of crops, animals and trees.

# Importance of trees and forests

- Trees and forests products include, timber, building material, fuelwood, fodder, food, medicine, and fodder, and many other NTFPs. Important services include shade, shelter, erosion control, watershed protection, soil enrichment, conservation of biological diversity and wildlife, etc.
- - Forest ecosystems are inherent sustainable systems
- - maintain vegetative cover as an effective soil and water conserving measure
- - provide regular supply of organic matter and enhance nutrient recycling
- - promote pest regulation (biological control, conserving natural enemies)
- - Trees: efficient root system
- - rapid start of growth
- - secure favourable soil conditions through build-up of organic matter
- - deep rootedness (survival, water & nutrient recycling)
- - extensive root system
- - improve microclimate, water harvesting and soil management
- - enhancing soil biotic activity and nitrogen fixing

# Main causes of dryland degradation

***The vulnerability to degradation of land is determined by current climate, relief, and the state of the soil and natural vegetation.***

Climate: Drought, rainfall (variability in time and place), solar radiation and wind

Negative human activities: some of the human activities that can cause desertification are:

- 📖 cultivation of soil that are fragile and vulnerable to wind and water erosion
- 📖 reduction in the fallow period
- 📖 overgrazing
- 📖 overexploitation of woody vegetation or deforestation: Tropical deforestation worldwide is estimated at 12.6 mill ha per year, or 0.7% of the total forested area (FAO, 1997). The depletion and degradation of the existing tropical forests and woodlands is a major concern because deforestation and forest degradation result in a dramatic loss of present and future options for utilization. Deforestation could be for conversion of the land to agriculture or clearing for fuelwood and charcoal.
- 📖 uncontrolled use of fire for different purposes, e.g.. Hunting, regeneration of pasture, honey, clearing for agriculture, etc.
- 📖 agricultural practices that destroy soil structure and loss of soil fertility.
- 📖 mismanagement of irrigation (salinization, alkalinization, increasing water table).

# Underlying root causes of land degradation

- \* Policy: policy factors strengthened man-made factors
- \* Economic factors: poor agric. economy,
- \* Settlements (sedentarization)
- \* Population pressure (?)
- \* Lack of land use planning
- \* Mismanagement of resources (bad exploitation of soil & vegetation “robbing the environment”
  - Natural disasters
  - Poverty and underdevelopment
  - Colonial legacies
  - Inappropriate technology and advice
  - Ignorance
  - Attitude & behaviour
  - War and civil unrest

# Major visible forms and consequences of degradation in tropical drylands

- ❖ Vegetation degradation
  - Reduction of vegetation cover
  - Change towards a less productive type (species composition, less palatable)
- ❖ Soil degradation
  - Water erosion (sheet, gully, and landslides)
  - Wind erosion
  - Water logging, salinisation, and alkalinisation
  - Chemical degradation (base leaching, acidification, toxicity)
  - Physical degradation (structure loss, crusting, silting, decreased aeration)
  - Biological degradation (loss of organic matter, decreased biological activity)

## **&Poverty**

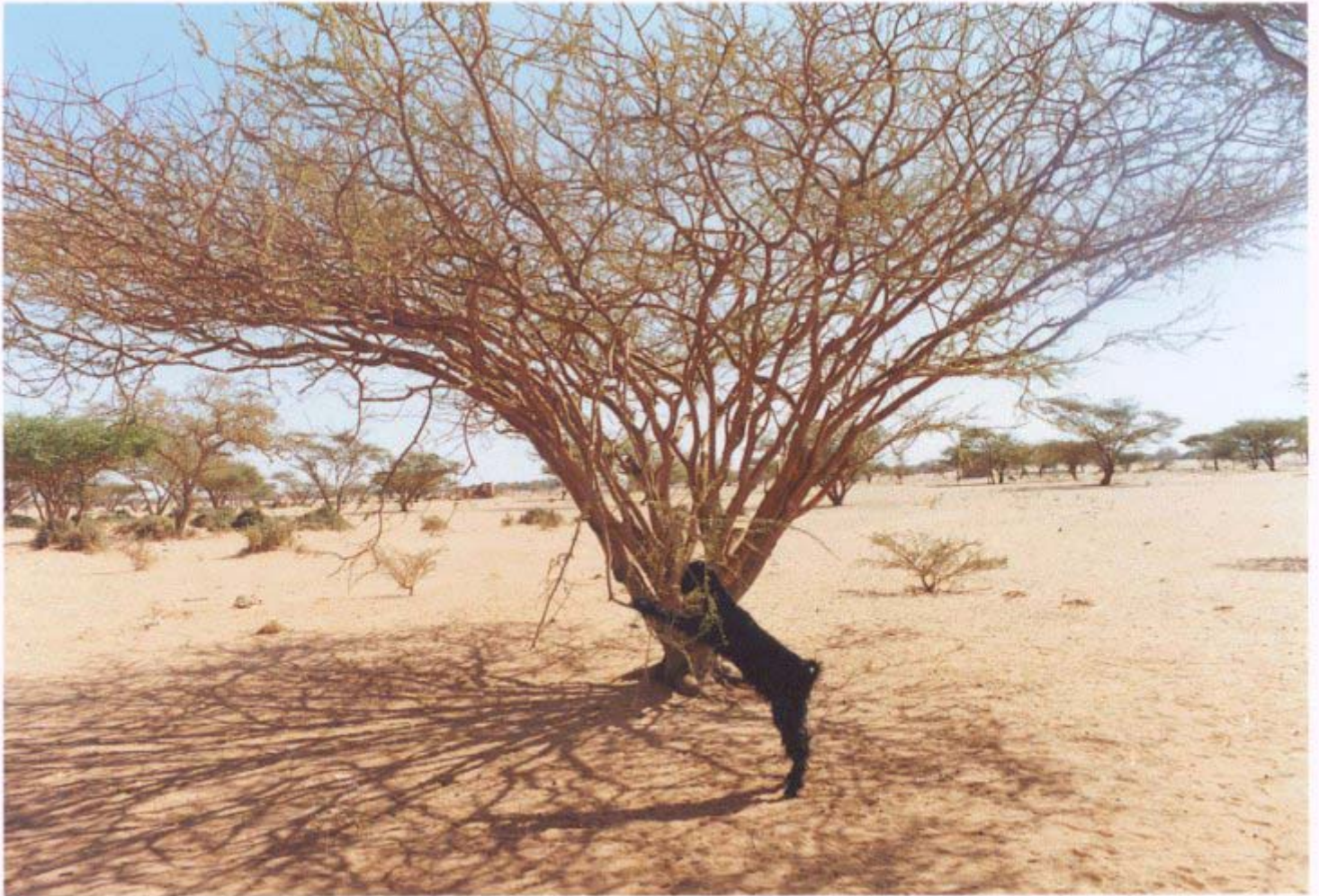
- Reduces production
- Undernourishment and malnutrition
- A search for short survival strategies that results in intensification of overexploitation of the most readily available natural resources.
- No access to credit or market.
- Limited access to basic schooling and health services.
- Lack of basic security (selling of properties, migration).
- Political instability and social breakdown

# I belong to here: I was borne in this house

(Fitna village, northern Sudan)



## Combined stress: drought and browsing



# Vegetation adaptation

- **Processes of the vegetation**
- Regeneration
- Growth
- Mortality

# Adaptive Traits

## 1. Reproductive traits

- Seed size/mass
- propagule persistence/seedbank
- Germination type
- dispersal distance
- flammability of residues
- Specialised pollination/dispersal
- maturity age/size
- Seed production
- Reproductive phenology

## 2. Leaf traits

- Leaf size
- Leaf palatability
- leaf thickness
- SLA
- Leaf lifespan
- Leaf water content and osmotic adjustment
- Leaf quality (decomposability)
- Photosynthetic response ( $A_{max}$ )
- Stomatal regulation
- C:N ratio
- N content

### 3. Structural traits

- Wood density
- LAI or crown depth
- Bark thickness
- Rooting depth
- Tree/root architecture
- Tree lifespan
- Plant architecture (DBH to height curve)
- Max size/height
- Allocation

# Plant response to climate

- Drought tolerance
- Mycorrhizae
- Rooting depth
- Leaf water content
- Stomatal regulation
- $\delta^{13}\text{C}$
- Bark thickness
- Response to nutrients and  $\text{CO}_2$  availability
- Abiotic stress
- Leaf size
- Decreased SLA

# Morphological adaptation

- Reduced leaf size and total leaf area
- leaf shedding
- Increased cuticle thickness
- Reduced trunk growth
- Increased allocation to roots & increased R:Shoot ratio

# Physiological adaptation

- Water-use efficiency (WUE)
- Water potential and relative water content
- Osmotic adjustment
- Carbon isotope discrimination

# The importance of correct diagnosis

- Drought (food aid)
  - Climate change (permanent withdrawal)
  - Complete devegetation (reseeding, replanting)
  - Active desert expansion (holding-line)
  - Falling productivity because of over- and misuse of- (more appropriate land-use and management practices).
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- The term spreading desert is very common (Dregne and Tucker 1988); for example: On 11.3.1986, Vice-President Bush was being urged to give food aid to the Sudan because of “desertification was advancing at 9 km per annum”.
  - On 11.9.1986, in a debate in the European parliament on the subject of aid to Africa, Winifred Ewing declared that aid must go to the Sahel, because the desert was advancing at 8 km a year.
  - This misapprehension of desert expansion had caused many to avoid tackling the social and economic problems and rather they go for afforestation/reforestation of sand dunes.

## Interlinkages between agroforestry and climate change

- Agroforestry is one land use method that has shown promising results in the rehabilitation of degraded lands.



## Water harvesting: to increase the productivity of dryland



**Plate 2.** Water concentrated in contour furrows with cross ties. *Courtesy FAO.*

## In SSA water harvesting is still far below its potential



**Plate 3.** Stone wall terraces for irrigation of sugar cane (Cape Verde). *Courtesy IFAD.*

# Can Africa produce enough food? Shall we keep the local adapted varieties or shall we go for GMCs?



**Plate 1.** Water and nutrients concentrated in planting pits (Burkina Faso). *Courtesy IFAD*

## Some useful terms and definitions

- Resilience: the capacity of a system to absorb disturbance (change) without qualitatively changing its behaviour.
- Afforestation: occurs on bare land where there has been no forest (>50 years), including afforestation of grasslands and sand-dune fixation.
- Reforestation: occurs on land which has carried forest before (<50 years), the previous crop being either replaced or renewed.
- Water harvesting: collection and concentration of rainwater and runoff and its productive use; with a main goal is to secure water supply in drylands where other water resources are not available or uneconomical to develop.
- Drought: naturally occurring phenomenon that exist when precipitation has been significantly less than the normal recorded levels, causing serious hydrological imbalances that adversely affect production systems (departure from average).
- Aridity: average conditions of limited rainfall and water supplies.

## Dryland Agroforestry:

mitigation of climate change, a means for livelihood, and the way out from land degradation and desertification

Thank you!



**Plate 4.** Terracing in Rwanda. *Courtesy IFAD.*