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Lessons from Mauritania

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Cover photo:
Mechanical dune stabilization: installing plant matter
M. Ould Mohamed

Foreword

Mauritania is one of the Sahelian countries most severely affected by the repeated periods of drought that have been occurring since the end of the 1960s. Desertification control has always been a national priority and a central concern of successive governments, taking the practical form of various development plans and programmes over the past four decades.

After ratification of the United Nations Convention to Combat Desertification (UNCCD), in June 2001 Mauritania formulated a National Action Plan to Combat Desertification (PAN-LCD), adopting an integrated, participatory approach. As in other countries in the Sahelian region, constantly increasing desertification is due to various natural, human, juridical and socio-economic factors, which combine to cause degradation of soil, forest resources and biodiversity.

Implementation of the PAN-LCD is based on various fundamental principals, including:

- adoption of an integrated approach covering physical, biological, institutional and socio-economic aspects;
- integration of poverty reduction into desertification control programmes;
- coordination of activities to be carried out under the PAN-LCD with those of other United Nations framework conventions, such as the Convention on Climate Change and the Convention on Biological Diversity;
- more closely targeted international assistance in order to respond better to local needs in the framework of partnership agreements;
- the participatory approach, with close collaboration of grassroots communities, especially local government and non-governmental organizations;
- encouragement of scientific research and the use of its results in the rehabilitation of degraded land and the improvement of agrosilvopastoral production.

The present publication has been produced within the framework of FAO support for the Mauritanian Government's efforts to combat desertification, and reflects results and lessons learned during implementation of the Support for the Rehabilitation and Extension of the Nouakchott Green Belt Project with financing from the Walloon Region and the support of Prince Laurent of Belgium.

J.A. Prado
Director, Forest Assessment, Management and Conservation Division
FAO Forestry Department

A prologue from Prince Laurent of Belgium

What picture can we give our children today of our relationships between north and south, which are so often tarnished by a spirit of imperialism and a poor knowledge and understanding of other cultures that too often are foreign to us? The spectacular progress of science and knowledge in recent decades should have allowed us to know each other better, thus enabling us to join together to envisage a more sustainable outlook for the future. The foundations of our western civilization and knowledge come from other continents, including of course Africa.

Today, we sometimes have to realize that when we withdraw into ourselves this gives rise to relationships based on force and thus to immense frustration. However, if we take the time to reflect on nature, it teaches us that the party we believe to be the strongest is not always the one that wins out over the weakest.

I was deeply imbued with the knowledge, love and passion for forests of my spiritual father, Raymond Antoine, Professor Emeritus of Forest Engineering at the Catholic University of Louvain, who is always present in my thoughts. I also love to stroll through the works of my friend Jean-Marie Pelt, Professor Emeritus of Plant Biology and Pharmacology at the University of Metz, for whom I have great admiration.

Professor Pelt is particularly interested in the relationships of attraction and repulsion among plants and animals in a single ecosystem. Based on his observations, he teaches us about the relations between the Douglas fir and the birch. These two trees exchange carbonaceous sugars through almost invisible mycelial filaments. As the Douglas fir has needle-shaped leaves throughout the year, which ensure its photosynthetic activity, it is able to pass on carbonaceous sugars to a leafless fellow tree of another species. During its vegetative period, the birch provides the same service to the Douglas fir. What a splendid symbiosis we see in the plant world with the fragile-looking fungus, which brings the tree the water and mineral salts it needs, and the tree, which in return offers the organic nutrients the fungus needs for its survival. And of course there is the orchid species with no chlorophyll whose development and survival is vitally linked to the beech tree through similar mycelia.

All this shows us how much more attention we should pay to ecology and the environment. I am convinced that many of our societies' problems could find solutions in the mechanisms underpinning nature.

The relationship between trees, development and the maintenance of a sustainable agriculture is not yet sufficiently well established in our consciousness. It has been shown in Europe that forest and agricultural monocropping systems produce much less timber and food than does a harmonious combination of these two elements, as found in agroforestry. It is still too little known that trees generate soil and thus allow the development of sustainable agriculture, and also that they prevent erosion and conserve water.

However, in the greater Maghreb region, where pastoralism is the predominant system, silviculture provides the guarantee of sustainable agriculture. If we are to attain this ambitious objective, we have to establish an agrosilvopastoral centre within the region to facilitate scientific exchanges between north and south and among the countries of the region.

This undeniably leads us to realize that the very concept of the environment is the source of a better understanding of our various cultures, and will hence generate peace.

Without a doubt, the two main challenges facing our planet will be, on the one hand, the development of renewable energies that are accessible to one and all and, on the other, the reforestation of forest land.

I was delighted that the project I had presented to His Excellency Maaouiya Ould Sid'Agmed Taya, then President of Mauritania, was given major priority both by him and his country, and that he entrusted me with seeing it through to completion.

The present President, His Excellency Mohamed Ould Abdel Aziz, has assured me of his support and complete collaboration in maintaining the work carried out.

I would thank the partners who have enabled me to achieve my objectives: FAO and the Walloon Region of Belgium, together with the Mauritanian Ministry of the Environment and Sustainable Development.

His Royal Highness,
Prince Laurent of Belgium

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Abbreviations, acronyms and terminology

AFESD	Arab Fund for Economic and Social Development
CILSS	Permanent Inter-State Committee for Drought Control in the Sahel
DANIDA	Danish International Development Agency
FAO	Food and Agriculture Organization of the United Nations
GTZ	German Agency for Technical Cooperation
IFAD	International Fund for Agricultural Development
LWF	Lutheran World Federation
moughataa	prefecture
NGO	non-governmental organization
PANE	National Action Plan for the Environment
PAN-LCD	National Action Plan to Combat Desertification, Mauritania
PDLCD	Desertification Control Master Plan
PLEMVASP	Sand Encroachment Control and Agrosilvopastoral Development Project
PMLCD	Multisectoral Desertification Control Programme
UM	ouguiya (Mauritanian currency)
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNSO	United Nations Sudano-Sahelian Office
US$	United States dollar
WBI	Wallonie-Bruxelles International
WFP	World Food Programme
wilaya	administrative district

Contents

Figures

1. Introduction

The United Nations Convention to Combat Desertification (UNCCD), adopted in Paris on 17 June 1994, includes the following definitions:

- "desertification" means land degradation in arid, semi-arid and dry subhumid areas resulting from various factors, including climatic variations and human activities;
- "combating desertification" includes activities which are part of the integrated development of land in arid, semi-arid and dry subhumid areas for sustainable development which are aimed at:
  - prevention and/or reduction of land degradation;
  - rehabilitation of partly degraded land;
  - reclamation of desertified land.

Mauritania is one of the Sahelian countries most severely affected by the periods of drought that have been occurring since 1968. The resulting desertification is exacerbated by human activities, which have compounded climatic factors, with direct consequences for an already precarious situation – bringing about degradation of the environment and the general socio-economic conditions of the country, and the progressive impoverishment of a population that is 70 percent rural.

The main effect of desertification has been a reduction in the amount of arable land, grazing land, forests and water resources. Various studies show that mobile sand dunes today cover two-thirds of the country's land area.

The devastating effects of desertification and drought on agricultural productivity and yields have resulted in:

- endangerment of rural inhabitants' food security and standard of living;
- large-scale movements of people toward major urban centres;

Sand encroachment threatening the town of Nouakchott

- reduced water supplies for human and livestock needs;
- substantial economic losses.

In view of the extent of the phenomenon, Mauritania, like many other countries affected by drought and desertification, has expressed a firm political will to combat this scourge.

It was in this context that the Sahel Club and the Permanent Inter-State Committee for Drought Control in the Sahel (CILSS) were established. In 1980, CILSS designed a drought control and development strategy for the countries of the Sahel, with the two main objectives of bringing about food self-sufficiency and environmental balance. However, implementation of the strategy did not have the anticipated results because of the complexity of the desertification problem. Recognizing this failure, the Mauritanian Government decided to incorporate desertification control into an overall process of sustainable development of the country, encompassing technical, socio-economic, juridical and institutional factors, a decision leading to:

- formulation of a Desertification Control Master Plan (PDLCD);
- formulation of a Multisectoral Desertification Control Programme (PMLCD);
- formulation of a National Action Plan to Combat Desertification (PAN-LCD);
- formulation of a National Action Plan for the Environment (PANE).

Within this framework, national-level programmes and projects have been implemented with the support of development partners in order to foster conservation and agrosilvopastoral development and combat sand encroachment. These programmes and projects include:

- the Nouakchott Green Belt Project, financed by the Lutheran World Federation (LWF);
- the Sand Dune Stabilization and Fixation Project, financed by the United Nations Development Programme (UNDP), the Danish International Development Agency (DANIDA) and the United Nations Sudano-Sahelian Office (UNSO);
- the Sand Encroachment Control and Agrosilvopastoral Development Project (PLEMVASP), also financed by UNDP, DANIDA and UNSO;
- the Oasis Development Project, financed by the International Fund for Agricultural Development (IFAD) and the Arab Fund for Economic and Social Development (AFESD);
- the Kaedi Green Belt Project, financed by the European Union;
- the Integrated Natural Resource Management in East Mauritania Project, financed by the German Agency for Technical Cooperation (GTZ);
- the Support for the Rehabilitation and Extension of the Nouakchott Green Belt Project, with financing from the Walloon Region of Belgium and the support of Prince Laurent of Belgium.

2. Understanding sand encroachment

Sand encroachment is said to take place when grains of sand are carried by winds and collect on the coast, along water courses and on cultivated or uncultivated land.

As the accumulations of sand (dunes) move, they bury villages, roads, oases, crops, market gardens, irrigation channels and dams, thus causing major material and socio-economic damage. Desertification control programmes must then be implemented in order to counter this very serious situation.

Before designing such programmes, information is needed about the factors and processes fostering the formation and movement of sand masses, i.e. wind and soil.

WIND EROSION

The main causes of wind erosion are:

- a violent wind blowing over large areas;
- stunted or sparse vegetation;
- a degraded soil that is mobile, bare and dry.

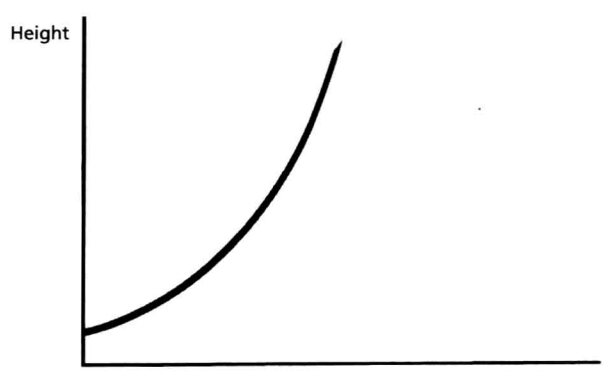
Violence of wind

The first factor affecting the displacement of soil particles is the direction, speed and duration of the wind. When a wind blows predominantly from one direction, it is known as a prevailing wind. Wind speed is zero at ground level, but increases in force the higher it is from the surface of the ground, its speed increasing as the logarithm of height (Figure 1).

A wind cannot lift sand particles off the ground until its speed at 30 cm above ground level, measured with an anemometer, is at least 6 m per second. Wind speed is an essential factor, for it determines the force of sand removal. The greater is the speed, the greater the carrying capacity.

The second factor is the size and density of sand particles. Particles with a diameter of about 0.1 mm are the first to be removed, whereas a violent wind is needed to remove larger particles.

FIGURE 1
Wind speed in function of altitude



Curve S = f(h), according to Henin

Source: Henin *et al.*, 1960

The nature of the movement of particles varies depending on their size (Figure 2):

- The largest particles roll or slide along the ground in a mechanism known as reptation or creep. The grains of sand that move in this way are between 0.5 and 2 mm in diameter depending on their density and the wind speed. When they start to travel more slowly because of the braking effect of the sand mass, the saltation mechanism becomes possible.
- Medium-sized (0.5 to 1.1 mm diameter) particles move forward in successive bounds, in a mechanism known as saltation. After leaping into the air, these particles fall back to the ground under the effect of weight; 90 percent of them reach a height of no more than 30 cm, moving on average between 0.5 and 1 m along the ground. The saltation mechanism is of vital importance in triggering wind erosion.
- Very fine particles, with a diameter of 5 microns or less, are shot into the air in the form of dust by the impact of larger grains. These particles then remain suspended and may be carried a long way in the form of a dust cloud, which often reaches an altitude of 3 000 to 4 000 m.

General mechanisms involved

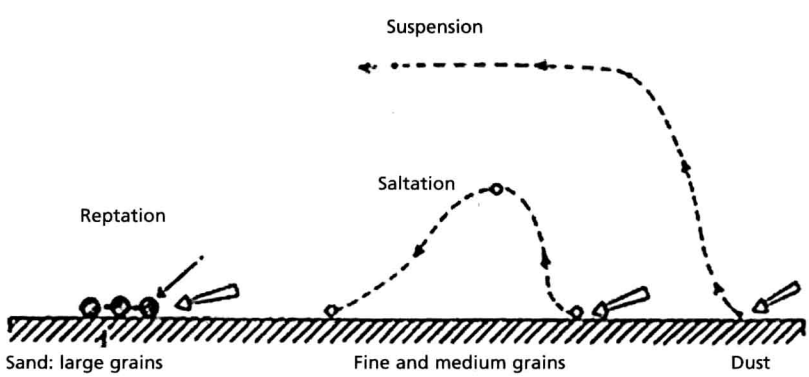
Particles in movement are the site of various interactions, the main ones being the avalanche effect, sorting and corrosion.

The avalanche effect is the result of saltation. As the grains of sand fall back, they cause the displacement of a larger quantity of particles, so that the more intense the saltation process caused by the wind, the greater the number of particles set in motion, until a maximum or saturation point is reached, where the quantity lost is equal to the quantity gained at any given moment. The distance needed to reach this saturation point will depend on the sensitivity of a soil to erosion: on a very fragile soil, it can occur over a distance of about 50 m, whereas it will require more than 1 000 m on a really cohesive soil.

The sorting mechanism concerns the wind's displacement of the finest and lightest particles, leaving behind the larger particles. This process gradually impoverishes the soil, since the organic matter made up of small light elements is the first to be removed.

Corrosion is the mechanical attack on the surface as the sand-laden wind blows over it. In arid regions, it is the aggravating cause of soil erosion and is seen in parallel streaks or the polishing of rocks.

FIGURE 2
Ways in which particles are carried by the wind



Source: Lemoine, 1996

State of vegetation

Vegetation preserves the cohesion of the surface layer of soil, retains particles, resists the avalanche effect and is the best protection against the negative effects of wind. This is why wind erosion is such a threat in arid and semi-arid regions where natural vegetation (whether woodland, bushland or grassland) is sparse, stunted or non-existent and where rainfall is low and irregular.

Moreover, unsustainable harvesting of such slow-growing stands leads to rapid degradation of the soil, which lacks protection and is therefore subject to the action of the wind.

Nature and state of soil

Wind erosion is the result of the wind's attacking the soil. Such erosion takes place if the soil has the following characteristics:

- mobile, dry and finely crushed (coarse-textured, rich in fine sand, poor in clay and organic matter);
- a uniform surface with no natural or artificial obstacles;
- sparse or non-existent plant cover;
- covering a sufficiently large area lying in the direction of the wind.

Soil that has been dried out over a long period is found especially in arid and semi-arid zones.

The soil's susceptibility to erosion can be exacerbated by poor farming practices (clearing of large areas), poor pastoral practices (overgrazing, with loosening and powdering of the soil) and unsustainable harvesting of forests, all of which make it extremely vulnerable to the action of the wind.

In Mauritania, soil is generally deep, fragile and predominantly sandy, and is for the most part located in zones with an annual rainfall of less than 100 mm.

ORIGIN OF SAND

When sand is carried by sea currents and accumulates along the shoreline in substantial quantities, it forms coastal dunes.

If it comes from the hinterland, it forms inland dunes, in which case the sand is either non-indigenous, coming from a considerable distance and having particles with a diameter of less than 0.05 mm, or indigenous, being of local origin and coming from the decomposition of mountain rocks (sandstone), the disaggregation of alluvial soil following the disappearance of plant cover, or from silt carried down by wadis following water erosion of their catchment basins.

For a long time, sand encroachment in Mauritania was considered a consequence of material carried from both near and far. However, according to Raunet (1985) and Khatteli (1989), non-indigenous material is insignificant compared with indigenous material.

EFFECTS OF WIND EROSION

On soil

The wind first carries off the finer parts of the soil – alluvium, fine sand and organic matter – thus weakening the soil structure. As the soil becomes sandier, it is more vulnerable to the wind and has a reduced water retention capacity. Its colour turns from grey to white and then to red as it is scoured. The terrain is gradually broken up by the creation of small mounds surrounding the woody and grassy vegetation as this degrades. The land gradually becomes unsuitable for cultivation.

On vegetation

The wind has both mechanical and physiological efforts on vegetation.

- ***Mechanical effects.*** The soil particles that are carried off collide with stalks and leaves with a force that abrades their tissue. In the zones from which the particles

are carried off, roots are uncovered and the vegetation risks being uprooted, while in zones where the particles are deposited the vegetation is steadily buried.

- ***Physiological effects.*** The wind increases evaporation and dries out plants, mainly in the dry season. The air's evaporating power is proportional to the square root of the wind speed. Moreover, the soil's water retention capacity is reduced, leading to water stress. The surrounding or moving mass of dry air tends to absorb humidity and exacerbate the water deficit – and this deficit is the main factor determining local vegetation, inasmuch as the latter has to adapt to the severe shortage of water.

WIND-BORNE ACCUMULATIONS

When the wind grows lighter, it loses its capacity to carry sand particles, which are then dropped. Forms of sandy accumulation vary widely, depending on landform, the nature of the soil on which they encroach, the presence or lack of vegetation, and the size of the grains of sand.

The main forms of accumulation found in Mauritania are wind veils, nebkas, barchans, linear dunes, sand ridges, pyramidal dunes, aklés and ergs.

Wind veils

Sand particles are carried over hard, flat, uniform surfaces, forming sandy veils of varying thicknesses, which are a constant threat to villages, roads, railways and irrigation channels. This type of wind accumulation is the source of the surface sand encroachment found almost everywhere in the country, which becomes particularly serious following clearing, forest fires and overgrazing.

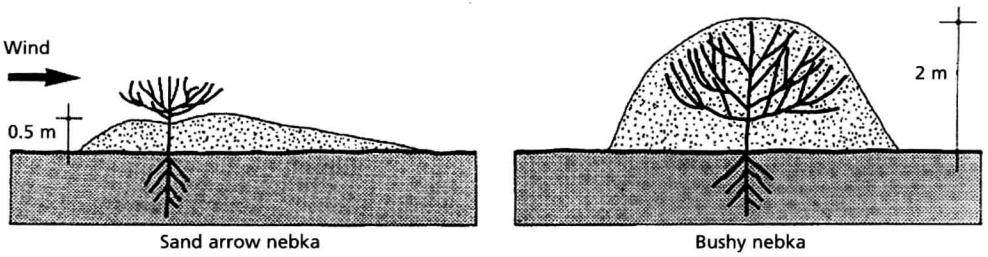
Nebka dunes

These accumulations are caused by the presence of a rock, plant or other obstacle in the path of sand particles in movement. There are two types of nebka: sand arrow nebkas, which are small ovoid dunes (50 cm in height, 150 cm in length and 40 cm in breadth) lying in the direction of the prevailing wind; and bushy nebkas, similar to sand arrow nebkas, but capable of reaching a height of 2 m and a length of 3 to 4 m (Figure 3).

Barchans

These are huge crescent-shaped dunes convex to the wind (Figure 4). There are several stages in their formation: they start as sandy shields, then turn into barchanic shields, then barchanic dihedrons, and finally full-scale barchans. Barchans tend not to remain isolated, but can join up and form complexes ranging from train-like successions of barchans to real dune massifs.

FIGURE 3
Nebkas



Source: FAO, 1988