

DESERTIFICATION AND VEGETATION MONITORING

Muoghalu J. I.

Obafemi Awolowo University, Ile-Ife, Nigeria

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Contents

1. Introduction
 - 1.1. Desertification
 - 1.2. Vegetation Degradation and Destruction
2. Causes of Desertification and Vegetation Degradation and Destruction
 - 2.1. Natural Causes
 - 2.1.1. Drought
 - 2.1.2 Herbivory by Wild Animals
 - 2.2. Human Causes
 - 2.2.1. Vegetation Cover Degradation and Regeneration
3. Monitoring: Indicators of Desertification and Vegetation Destruction
 - 3.1 Degradation of Vegetation Cover
 - 3.2 Overgrazing due to an Increase in Livestock Population
 - 3.3. Overcultivation
 - 3.4 Fuelwood Collection and Vegetation Exploitation
 - 3.5. Groundwater Status, Alkalinization, and Salinization
 - 3.6. Urbanization
 - 3.7. Sand Drift and Sand Encrustation
4. Conclusion
- Glossary
- Bibliography
- Biographical Sketch

Summary

In recent years, concern has been increasing because of increasing vegetation degradation and destruction and desertification of arid and semiarid lands with attendant consequences for mankind and the ecosystem in general. The human activities that exacerbate these phenomena arise as a result of population growth and expansion of economic activities. Some of the causes of these phenomena are overgrazing, overexploitation, overcultivation, urbanization, alkalinization, and salinization. These phenomena, desertification and vegetation degradation and destruction will continue to intensify as human population increases. Though the causes of these phenomena are known, a full understanding of how they operate and monitoring of how they set in or evolve with the passage of time is essential. For monitoring purposes the following indicators of desertification and vegetation destruction namely overcultivation, overgrazing, overexploitation of vegetation resources (fuelwood, logging, seed and fruit gathering, etc.) alkalinization, and salinization, urbanization, and sand drift and sand encrustation should be regularly monitored.

1. Introduction

1.1. Desertification

Approximately half of the countries of the world are affected by problems of aridity. Roughly 35% of the world's land surface can be classed as dry lands (over 6.1 billion ha) and ~15% of world's land surface is semiarid. One problem is common to all arid zones: the fragility of the balance of arid ecosystems and the accompanying potential threat of desertification provoked in most cases by human intervention in these ecosystems. The perception has often been that dry land degradation is getting worse and is a process that can be attributed to specific causes and perhaps countered.

Because the problem is more common in drylands and the end product is desert-like, it has been common to speak of desert spread, desert advance, and desert encroachment. Various terms have been applied to the process of increasing desert-like conditions, namely desertification, desertization, aridization, and xerotization. Desertification has come to be the most widely used of these terms and was probably originated by Aubreville in 1949. Desertification has variously been defined. Le Houerou defined it as a combination of the processes which result in more or less irreversible reduction of the vegetation cover, leading to the extension of new desert landscape to areas which were formerly not desert.

At the United Nations Conference on Desertification (UNCOD) in 1977, desertification was defined "as the diminution or destruction of the biological potential of the land, which leads ultimately to desert-like conditions and is an aspect of the widespread deterioration of ecosystems under the combined pressure of adverse and fluctuating climate and excessive exploitation." In practical terms, desertification, which is characterized by the spread of desert conditions beyond desert margins or by the intensification of desert conditions within arid regions, is accompanied by diminished productivity.

In human terms, desertification may be seen as a lowered carrying capacity for livestock, diminishing crop yields, a progressive reduction in real income or in social well being, and thus a reduction in the number of people supported in an arid zone.

The definitions of desertification which imply spreading or encroaching desert fail to recognize that the process often takes place *in situ* and can be well away from desert margins. Though desertification affects mainly arid and semiarid areas, it is also found elsewhere. It is the result of a long historical process through which natural phenomena and human activities reinforce each other in changing the characteristics of natural environments.

Many parts of the world's drylands have experienced and are continuing to undergo changes towards more desertic conditions, whereby the productivity of natural or managed ecosystems is lowered with adverse effects on the livelihood of their human populations. For example, delegates to the May 1984 12th Governing Council Meeting of the UN Environment Program (UNEP), in the assessment of seven years of antidesertification efforts were told by UNEP that the number of people threatened by

severe desertification had increased from 57 million in 1977 to 135 million (rural population only), or from 80 to 230 million (urban and rural populations combined). They were also told that 6 million ha of land continued to be irretrievably lost through desertification or degraded to desert-like conditions every year, while the amount of the land reduced to zero economic productivity increased from 20 to 21 million ha y^{-1} . It has also been reported that between 50 000 and 70 000 km² of useful land is going out of production every year in the world because of desertification. Many of the changes can be traced over centuries, but often there has been a noticeable acceleration of desertification in recent decades, at times associated with human tragedy.

The areas prone to desertification are reported to include 27 million ha of irrigated farmland, 173 million ha of rain fed cropland, and a little over 3 billion ha of rangeland. Most of these areas are in the developing countries with tropical grasslands and especially those belonging to the group of least developed countries, several of which have suffered from the serious international economic situation and from adverse climatic conditions.

About 50% of the people most directly threatened by desertification live in the Sahel. Other parts of the world that are particularly threatened are the Andean areas of South America, Brazil, Mexico, and parts of Western Asia and the Indian subcontinent. The increasing land deterioration caused by desertification has had severe effects on agriculture and therefore on domestic supplies, on export, on the balance of payment, and on economic growth in these countries.

In the past three decades, concern has been increasing because of increasing desertification with dramatic consequences for mankind. General Assembly Resolution 3337 (XXIX) on international cooperation to combat desertification assigned high priority to developing concerted international action to combat desertification. There is a need for an understanding of the major physicochemical biological and environmental causes of desertification and their relationship with socioeconomic factors. Their monitoring on a constant basis can promote a better understanding of the development of desertification and an accurate forecasting of the consequences of human intervention.

1.2. Vegetation Degradation and Destruction

Since the discovery of agriculture, human beings have been degrading and destroying vegetation globally. Clearing of natural vegetation for agriculture, grazing and/or logging, urbanization, infrastructural development, and desertification—or more precisely the degradation of semiarid to arid vegetation under the combined influence of drought and overexploitation of a marginal ecosystem—having been the major anthropogenic process transforming the land cover. The human activities that impact on vegetation arise as a result of population growth and the expansion of economic activities.

The human impact on vegetation will continue to intensify as human population increases from 1998's 5.4 billion towards the projected 10–12 billion in 2050 of the latest UN estimates. The destruction of vegetation cover has a lot of socioeconomic

ecological consequences. The destruction of vegetation is robbing human population of sources of fruit, staples, medicinal plants, construction material, industrial raw material, and genetic material from the wild needed to improve domesticated crop species so that they can withstand the constant challenges from disease, climate, pests, and genetic drift away from vigor.

It also implies destruction of wildlife habitats and has drastically reduced productivity and species diversity of animal populations while rare species are being threatened with extinction. It involves the loss of the protection that the plant cover gives to the soil—exposing the soil to water and wind erosion and desertification process. To avert the adverse effects of vegetation degradation and destruction on the different world ecosystems and on humans, serious effort should be made to stem the rate of devegetation. This could be achieved through regular monitoring of the causes of vegetation degradation and destruction globally to determine when drastic changes in global vegetation types have occurred and to put in place measures to mitigate them.

2. Causes of Desertification and Vegetation Degradation and Destruction

The causes of desertification and vegetation destruction are usually grouped into natural and human causes. Desertification has been blamed on long-term climatic changes, cyclic fluctuations in climate, and periodic droughts and destructive consequences of human activities.

2.1. Natural Causes

Natural causes are primarily due to physical and biological events: drought, climatic change, and pest or disease outbreak. In dry lands, plants often grow near their limits of tolerance, so even slight changes in environmental factors or a little disturbance can lead to more bare ground, species loss, and degradation.

2.1.1. Drought

In an arid environment, the main limiting factor for plant production is the amount of water in the soil available to the vegetation. Droughts are common in arid regions. It occurs when a region has insufficient moisture to meet the demands of plants, people, livestock or wildlife. The absence or shortage of rain and the temporary character of the problem are the most visible elements. Drought may be a meteorological drought when rains fail to reach a certain level over a particular period of time in a given area; agricultural drought when the combined effects of amounts and distribution of rainfall, soil water reserves, and evaporation bring about a drastic reduction of agricultural yields and livestock leading to food scarcity and other associated problems; or hydrological drought due to changes that reduce the absorption and storage of moisture in the soil.

Drought can lead to desertification but desertification may occur without there being drought. Drought need not be a cause of desertification but it often highlights or triggers clear signs of desertification. Long and recurrent drought causes soil erosion thus accelerating the ongoing process of desertification. During a drought, the wind erodes

the denuded and deteriorated soil. When the rains finally come, the water runs off quickly from a soil that has lost its retention capacity, taking with it organic material and topsoil and causing floods with considerable material damage and loss of life. Drought years and below-average rainfall conditions result in sparse vegetation which, with excessive pressure from livestock and man causes soil to be blown more vigorously in the subsequent year. The sand particles removed by the wind tend to accumulate in particular spots in the form of sand sheets or dunes. This removal continues until a compact layer of soil is reached, the final result being a surface composed of stones and exposed harder soil horizons, so that water penetration into the soil is reduced. The remaining perennial plants can barely survive and germination in general becomes difficult for both annuals and perennials. The "glazed" surfaces allow the water to run off easily, leading to water erosion with the formation of rills and gullies. However, during years of adequate rainfall, the ground cover by vegetation is enough not only to protect the soil from wind erosion but even to cause the soil particles stirred up by winds to be deposited around stalks of plants. This plant cover also provides an obstacle to runoff and slows down water erosion, while the roots reinforce the physical resistance of the soil substratum and encourage water infiltration.

2.1.2 Herbivory by Wild Animals

Wild animals may degrade vegetation enough to cause desertification. Rodents occur abundantly in almost all habitats in the arid region and are an important factor in the desertification process. They contribute seriously to soil erosion. They not only consume and destroy natural and cultivated vegetation, but also excavate large amounts of stabilized sand, which are readily drifted by strong desert winds. Feeding chiefly on seeds, rodents also ravage sprouting vegetation, lowering its regeneration rate. Their burrowing activity is injurious to soil conservation. Termites (common in many semiarid environments) may aggravate heavy grazing by wild herbivore or domesticated livestock and "tiger stripes" (vegetation/bare ground) may sometimes result from such damage. Locusts might denude vegetation cover enough to trigger desertification. Vegetation is destroyed on a large scale by locust invasion. Every piece of vegetation that is fighting to survive is devoured by locusts, leaving the sandy surface at the mercy of the strong desert winds. Even large trees are totally defoliated and sometimes even collapse under the sheer weight of the insects.

2.2. Human Causes

It has been said that desertification is a long-term physical and pervasive phenomenon caused by human action over the natural environment and, in particular, in arid and semiarid lands. Humans are both the cause and victims of desertification. The increasing destructive influence exerted by humans on the environment as a result of population growth and the indiscriminate use of enhanced technical measure are the major causes of the advance of desertification. Le Houerou has stated that it is humans who create the desert—the climate only provides the right conditions. Harmful human activities that destroy vegetation and cause desertification include overcultivation, overgrazing, overexploitation, mismanagement of water resources, urbanization, salinization, and alkalinization of soil as a result of faulty irrigation techniques.

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Biographical Sketch

Dr Joseph Ikechukwu Muoghalu is a senior lecturer at the Department of Botany of the Obafemi Awolowo University, Ile-Ife, Nigeria. He received his doctoral degree in 1989 and has since worked at the Obafemi Awolowo University, Ile-Ife, Nigeria lecturing and researching in plant ecology. His research interests include nutrient cycling, savanna functioning, structure and management and degradation and pollution of the environment. He is the author and co-author of over 21 scientific publications and reports.