# Desertification and Degradation of Africa's Rangelands

**Jerrold L. Dodd**

Conventional and politically correct wisdom usually states or implies that massive areas of Africa have been and are being desertified by domestic livestock. I recently reviewed the literature on the issue and found that the published scientific evidence does not support this conclusion (Dodd 1994). Nearly all arid and semiarid environments are characterized by extreme year-to-year weather fluctuations that cause enormous changes in ecosystem appearance. Consequently, it is difficult and, sometimes, nearly impossible to distinguish between short-term and long-term trends as well as temporary and permanent changes.

Hellden (1988) cites several definitions of desertification and concludes that common features of all are conditions of decreasing productivity with long lasting and possibly irreversible desertlike conditions. Most definitions of desertification include humans or humans in concert with drought as the driving force behind the process. Mainguet (1991) reviews the literature and concludes that desertification "is the ultimate step of land degradation: irreversibly sterile land, meaning irreversible in human terms and within practicable economic limitations".

Degradation was one of the first terms used to define the process of change in ecosystems toward more "arid" states (Stebbing 1935). In its modern usage degradation generally refers to decreases in productivity or unfavorable changes in species composition but does not indicate that the changes are permanent or desertlike. Inconsistency in terminology in this area continues to reflect an incomplete understanding and the lack of agreement of the causes, permanence, and endpoints of these changes in ecosystem status.

## Perceptions and Extent of Desertification/Degradation in Sub-Saharan Africian

Analysis of satellite imagery indicates massive annual fluctuations in the north-south position of green vegetative cover along the southern boundary of the Sahara within the past decade. This phenomenon was described as expansion and contraction of the desert by Tucker et al. (1991) and referred to in the media as the "shrinking desert". However, boundaries of deserts are zones, not discrete lines defined by one attribute, and do not change on such short time frames. The use of such valuable information to imply that the area of the Sahara desert actually changed in the past 10 years symbolizes the current state of confusion in interpretation of the dynamics of arid lands by both the scientific community and the lay public.

Speaking of desertification and the way it is commonly used in the media and in modern geography courses, Binns (1990) states "The common image conjured up by the term is one of an advancing Sahara desert inexorably moving south, smothering villages and destroying farmland and pasture once and for all." He continues "....this image has been further reinforced by being portrayed as an environmental catastrophe, the product of a long-term decline in rainfall exacerbated by unwise human practices such as overgrazing, burning and deforestation." Binns argues that this impression is inappropriate and for much of Africa is blatantly incorrect. After attending a scientific conference on the issue in the fall of 1990, Mace (1991) concluded that "Sometimes we are so sure of something that we don't need to see the evidence. That Africa's rangelands are being reduced to desert through overgrazing by domestic livestock is received wisdom. But, as became plain at a recent meeting such a view may be seriously flawed". In the following paragraphs I review the viewpoints and their

*The Turkana district of northern Kenya where the land is barren of grasses because of an extended drought lasting around 2 years. Field examination indicated that the drought was so severe that around half of the shrubs in the scene are dead. The remainder are in drought induced dormancy.*

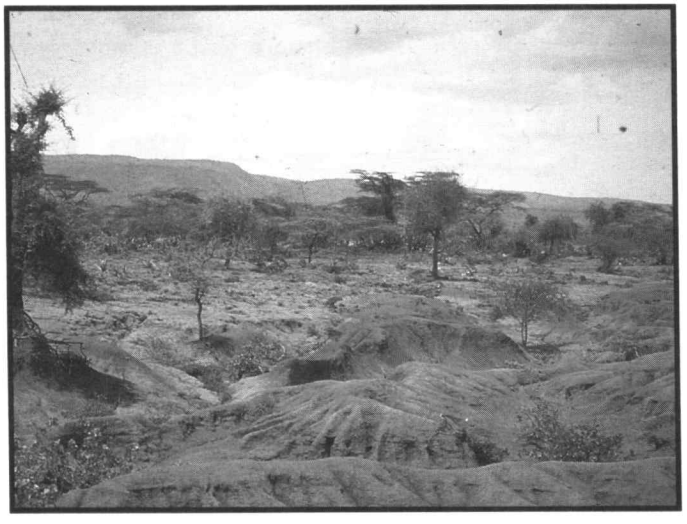
Dodd is professor, Rangeland Ecology and Watershed Management Department, University of Wyoming, Laramie, Wyoming 82071.

The author is grateful to J. Ellis, W. Laycock, T. Reeves, D. Swift, Q. Skinner, L. Bulla, M. Coughenour, V. Kituku, M. Halakhe, J. Miller, and N. Georgiadis for their various forms of assistance in preparation and review of the original BioScience article that this paper is based on. I also thank the American Institute of Biological Sciences for permission to publish the original copyrighted paper in condensed form.

**Editor's Note:** This paper is a requested condensed version of the paper "Desertification and Degradation of Sub-Saharan Africa: the Role of Livestock" by J.L. Dodd which appeared in *BioScience* in January, 1994. Readers are referred to the original article for more detail.

changing perspectives from the 1930's to the present time. Then, I reconcile some of the different views by examining new evidence and new paradigms for interpretation.

*Pre-1960 Literature and Views.*The earliest writings on desertification and degradation were done near the beginning of the twentieth century but Stebbing (1935) seems to be quoted most often regarding early assessment of the question in Africa. Stebbing was a European forester and visited Africa to evaluate questions pertaining to the perceived conversions of the forests to a sort of false savanna in the West African Colonies. He concluded the forests were being taken over by the southward encroachment of the desert and that the process was caused by humans. Rodd (1938), who lived many years in Africa, questioned



*A scene in northern Kenya where annual precipitation is about 20 inches. Potential native vegetation for the area is a rich tree-grass savanna. The picture is taken in the frontier between agriculture and pastoralism (agro-pastoral zone) where mixed-farming results in cropping of some land and abusive grazing on the remainder. The result is incredibly high rates of erosion.*

Stebbing's understanding of the Sahara situation. He claimed great ebbs and flows of desert boundaries through time and attributed it to fluctuations in weather. Rodd pointed out the risk of making judgements on changes in vegetation and vegetation boundaries based on observations spread over anything but "longish periods of observation" because of the extreme variability in annual precipitation.

*Post-1960 Literature and Views.* The last major drought of the Sahel lasted 10 years, 1964-1974, (Hellden 1988). In 1975 Lamprey (1988) led a team in assessing environmental conditions in northern Sudan in the first formal attempt to document the spread of the Sahara and concluded the boundary between desert and subdesert scrub in the Kordofan area had shifted south about 60 miles since 1958. Neither Lamprey nor Stebbing offers scientific evidence in support of their contention that human activities precipitated the alleged change, e.g., Lamprey (1988) "It was generally understood by the natural resources specialists on the reconnaissance teams that the ecological degradation taking place in northern Sudan is largely due to past and current land use practices but is accelerated during periods of drought."

In a study using various types of remotely sensed information of the Kordofan area between 1962 and 1979 Hellden (1988) concluded that Lamprey was wrong in his interpretation that the desert boundary had moved at all, let alone 60 miles since 1958. Perhaps of more importance was Hellden's finding that the very visible degraded and desertified rangeland around the villages studied in the area had not expanded during the 1962-1979 interval. This observation contradicts the common belief that overgrazing exacerbates the effect of drought on range vegetation. Hellden concluded that there were no long lasting desert conditions created in the Kordofan area but that crop yields and rangeland productivity were severely reduced during the 10-year drought. However, both rangeland and cropland productivity recovered rapidly after the drought—without any substantive change in human behavior.

Binns (1990) reviews a variety of information available on the extent of the desertification problem and concludes that the phenomenon is much less widespread than commonly reported. The scientific work of Hellden (1988) and Tucker et al. (1991) support this view and show the preponderance of change in the northern part of the sub-Saharan region is driven by abiotic forces and is reversible.

## Paradigms for Understanding and Management

Traditionally, rangeland scientists have based their understanding and management of rangelands on the range succession-retrogression model prompted by Clementsian ecology. This concept, which assumes drought or grazing perturbed communities return to their pre-disturbance state fairly quickly through succession, works well in many circumstances but fails in others. Several scientists have proposed alternative ideas that do not assume such equilibrial successional dynamics.

*Standard Range Succession-Retrogression Model.* As described by Westoby et al. (1989) this model, "..supposes a given rangeland has a single persistent state (the climax) in the absence of grazing. Succession towards this climax is a steady process. Grazing pressure produces changes which are also progressive and are in the opposite direction to the successional tendency." The model presumes drought and grazing has similar effects on plant communities and that overgrazed or drought damaged range can recover by resting or reducing stocking rates. The range succession model has its greatest failings as an aid to understanding and managing arid and semiarid rangelands, where episodic events are important and influences of grazing and intrinsic vegetation change act intermittently.

*State-and-Transition Model.* This model assumes that for a single piece of rangeland there exists a set of discrete and relatively stable states or communities of vegetation

states also exists. Transitions between states, i.e, the change from one relatively stable community to another, are triggered by large changes in weather (such as a drought or unusually wet cycles), intense grazing pressure, fire, or combinations of these ecological factors.

*Thresholds and State Model.* Friedel. (1991) adds the idea of thresholds to Westoby's state-and-transitions model. Thresholds are phenomena which inhibit transition between different relatively stable states of rangeland ecosystems. Laycock (1991) describes the critical attributes of a threshold as a boundary in space and time between two states wherein the initial shift across the boundary is not reversible on a practical time scale without intervention. Laycock reviews and describes considerable published evidence which supports his conclusion that many arid and semiarid North American rangeland types fit the states and thresholds model much better than they fit the traditional range successional model. The traditional model appears to work well in more mesic grasslands. However, in the absence of fire most mesic grasslands of the world will not fit the model because woody plants increase dramatically. Laycock points out a common error that occurs when a vegetation type is in a stable lower successional state and the land manager does not recognize it as one of several stable states. Changes in grazing management (stocking rate, rest, system, etc.) or even removal of livestock results in no change in the state of the vegetation. This certainly is in agreement with the views of Westoby et al. (1989) who point out that heavy grazing or a combination of no grazing plus fire, etc., is often needed to change states and that managers must be open to various approaches to intervene. In this regard Laycock (1991) cites evidence where heavy uses by browsers (deer in one case and domestic sheep in another case) were effective in shifting range plant communities from brush dominance to grass dominance. Similar herbivore-vegetation interactions occur in African rangelands.

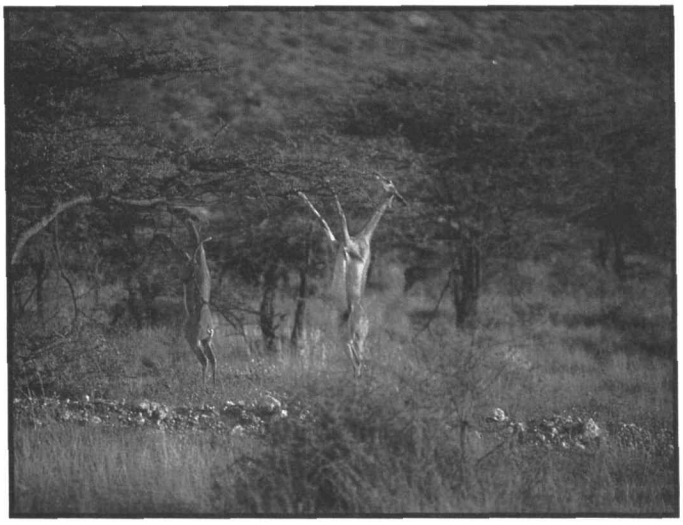
*Non-equilibrial Persistent Model.* Ellis and Swift (1988) define a non-equilibrial but persistent model for arid lands. They developed the idea from the literature and from their decade-long investigations of the Turkana ecosystem in northern Kenya. Turkana rangelands, like most other arid rangelands in Africa, are non-equilibrial, i.e., the ecosystems are usually not responsive to grazing pressure but, instead, are almost completely regulated by abiotic controls.

*Selection of Paradigms.* The question of which paradigm of ecosystem dynamics to utilize for understanding a particular rangeland type in Africa is not easily answered. Existing evidence strongly supports the non-equilibrial point of view for dry rangelands while the equilibrial view seems to be a workable model for most mesic rangelands. The long-term community ecology of most of the African rangeland types, which are intermediate between dry and mesic, is not well enough understood to make unqualified statements on where a particular model will work.

## Influence of Grazing on Rangelands

Several authors assess the mechanisms whereby herbivory affects change in arid rangelands (Dodd 1994). Heavy doses of herbivory can clearly change species composition, productivity, and ground cover. It has also been demonstrated that grazing can increase spatial heterogeneity of soil resources and subsequent plant growth patterns. Finally, the question of biofeedback between land surfaces and the atmosphere has been investigated via application of sophisticated models. However, the question of how much, and at what geographic scale, grazing related change must take place on arid rangelands to have a measurable and ecologically meaningful impact on weather is still very much unanswered.

A large body of literature addresses the issue of domestic animal impacts on different types of rangelands in Africa (Dodd 1994). This literature is mainly based on short term studies or anecdotal information. In reviewing it I found no scientific evidence that nomadic or even commercial style use of domestic livestock causes irreversible changes in range vegetation away from watering points and habitations. Therefore, in reference to Mace's (1991) observation about our propensity for drawing conclusions on widespread animal caused desertification in Africa without examining the evidence it appears that, in fact, such supporting evidence does not exist. On the other hand, the literature verifies that very heavy use in high animal concentration areas does cause permanent changes in vegetation. It occurs not only near high volume watering points and villages in nomadic rangelands but is especially prevalent on rangelands closely linked to crop agriculture in Africa and throughout the world. This agro-pastoral frontier often contains extraordinarily high stocking rates of domestic animals which severely alters rangelands.



*A semi-arid rangeland of northern Kenyan used by Samburu nomads. Picture was taken in an average weather year. The animals are gerenuk.*

## Implications for Development

The rangeland degradation/desertification problem in Africa as well as in other rangelands of the world is not a simplistic question of livestock impacts but is, also, a lack of understanding of how abiotic factors regulate these systems. Consequently, it is common for casual observers to attribute undesirable changes to livestock and desirable changes to good weather.

Westoby et al. (1989) and Ellis and Swift (1988) both offer sound advice for improved management of African rangelands. The first suggestion is for managers to abandon the equilibrial idea for rangelands where it simply does not work. Assumptions of equilibrial ecosystem dynamics in non-equilibrial systems leads to frustration, failure, and false expectations from management. Westoby et al. recommend opportunistic management tactics wherein the manager understands: the alternative stable states that exist for a particular rangeland type, the opportunities (burning, browsing, grazing, resting, etc. under specific prescriptions) for making a given transition between states, and the risks associated with a particular transition choice. They describe the current western approach as defensive and being typified by conservative stocking rates designed to prevent the unwanted (degradation) from happening. Of course, in abiotically controlled systems the unwanted changes occur regardless of stocking rate and recovery from such environmental traumas may well be independent of stocking rates.

Ellis and Swift (1988) point out the virtues in understanding the attributes of relatively successful pastoralists in a given rangeland setting. Unfortunately, indigenous pastoral cultures are often incorrectly perceived by agrarian-culture-dominated governments and foreign donors as ignorant and noncooperative. Assistance programs should enhance positive land use patterns of pastoral cultures rather than replace them. For example, agricultural development schemes frequently encourage conversion of the better rangelands to croplands in order to increase human edible plant material. The lands that are converted are frequently the rangelands that pastoral cultures relied on in dry seasons or years for emergency feed supplies for their animals. When dry periods come, these converted rangelands provide no sustenance for the human population either directly in the form of crops or indirectly in the form of animal products.

Conversion of rangelands to croplands is driven by the human population explosion occurring primarily amongst urban and agrarian societies. Unless this problem is solved, desertification resulting from conversion of rangelands to marginal croplands that eventually fail and destructive grazing in the agro-pastoral frontiers of Africa and other parts of the world will continue. The current hysteria regarding negative impacts of livestock on rangelands in Africa as well as most other parts of the world may be useful in drawing attention to land use issues in general. However, the alarm is counterproductive when it vilifies cultures that use rangelands for sustainable production of animal products to nurture human life and lifestyles. The use of rangelands by hunting and gathering cultures is a sustainable use but can support only small populations. Rangeland livestock production using ecologically sound management practices is probably the only sustainable land-based food production scheme capable of supporting larger human populations in arid and semi-arid regions and it should be encouraged in Sub-Saharan Africa.

## Literature Cited

**Binns, T. 1990.** Is desertification a myth? Geography 75:106-13.

**Dodd, J. L. 1994.** Desertification and degradation in sub-Saharan Africa: the role of livestock. BioScience 44:28-34.

***Dregne, H.E. and C.J. Tucker. 1988.*** *Desert Encroachment.* Desertification Control Bull. 16:16-19.

**Ellis, J.E. and D.M. Swift. 1988.** Stability of African pastoral ecosystems: alternate paradigms and implications for development. J. Range Manage. 41:450-59.

**Friedel, M.H.** 1991. Range condition assessment and the concept of thresholds: a viewpoint. J. Range Manage. 44:422-426.

**Hellden, U. 1988.** Desertification monitoring: is the desert encroaching? Desertification Control Bull. 17:8-12.

**Lamprey, H. 1988.** Report on the desert encroachment reconnaissance in northern Sudan: 21 October to 10 November 1975. Desertification Control Bull. 17:1-7.

**Laycock, W.A. 1991.** Stable states and thresholds of range condition on North American rangelands: a viewpoint. J. Range Manage. 44:427-433.

**Mace, R. 1991.** Conservation biology: overgrazing overstated. Nature 349:280-281.

**Mainguet, M. 1991.** Desertification: Natural Background and Human Mismanagement. Springer-Verlag. Berlin Heidelberg New York London Paris Tokyo Hong Kong Barcelona Budapest.

**Rodd, F. 1938.** The Sahara. Geograph. J. 91:354-55.

**Stebbing, E.P. 1935.** The encroaching Sahara: the threat to the West Africa Colonies. Geograph. J. 85:506-24.

**Tucker, C. J., H. E. Dregne, and W. W. Newcomb. 1991.** Expansion and contraction of the Sahara Desert. *Science* 253:299-301.

**Westoby, M., B. Walker, and I. Noy-Meir. 1989.** Opportunistic management for rangelands not at equilibrium. J. Range Manage. 42:265-74.