

Desertification: an appeal for a broader perspective

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ABSTRACT The term 'desert' has many meanings, but usually refers to an area with a certain climate, vegetation cover, or desolation. 'Desertification' is a vague and often confusing concept because of the many meanings of the term 'desert'. The current definition by the United Nations confines desertification to arid areas. This rather narrow definition limits political and economic actions and constrains programs aimed at combating desertification or reversing land degradation. In this paper, an Icelandic case history is used to illustrate the limitations associated with climatologically-based definitions of desertification. Severe land degradation can lead to the formation of barren land, a desert, in any climate. Desertification is often initiated when ecosystem resilience is reduced through factors associated with drought and/or human activities. However, other factors, such as cold spells, extreme weather events, volcanic eruptions and other environmental stresses can be equally or more important. Severe degradation of ecosystems in Iceland has resulted in the formation of extensive barren deserts in spite of humid climate. The Icelandic example also illustrates that the loss of soil water storage capacity can be as serious a limitation to ecosystem function in humid climates as it is in dry climatic regimes.

It is argued that the climatologically-based definition of desertification used by the UN-Convention to Combat Desertification (UN-CCD) has many negative consequences. Severe land degradation is a global problem not restricted to arid zones. As a result of its narrow definition, the UN-CCD may hamper the development of international, social, political, and scientific programs aimed at combating desertification. Evolution of the CCD from its current regionally limited concept towards a more comprehensive framework which embraces all severe land degradation, is needed. Such an evolution would enhance communication, promote research and help to counter land degradation at the global level.

Key words: CCD, land degradation, desertification, Iceland.

1. INTRODUCTION

Degradation and desertification of the World's land resources affects the livelihood of today's human population and that of the generations to come. Desertification has devastated the productivity and biodiversity of large areas, and the damage is often irreversible when measured on the time-scale of

the human lifespan. Desertification may already be causing damage to the world's ecosystems at the same scale as has been predicted for global warming (Dale, 1997). Furthermore, extensive land degradation may be a major factor in the alteration of Earth's climate (e.g., Bolle, 1995). This threat to the World's environment was the subject of a recent United Nations convention, the Convention to Combat Desertification (UN-CCD) (see Cardy, this volume).

The study of desertification is relatively new. The name appeared first in a scientific text about 50 years ago (Auberville, 1949). The affected areas are characterized by large differences in natural conditions, but are normally associated with arid climate. The desertification concept is still evolving. The humid but intensively desertified Icelandic landscapes provide an alternative perspective as compared to arid areas to investigate the concept of desertification.

2. DESERTIFICATION IN ICELAND

Iceland is a 103,000 km² island in the North-Atlantic Ocean. The climate, strongly influenced by the warm Gulf Stream, is described as cold temperate in the lowlands and sub-arctic in the highlands. Permafrost is nearly absent. The country is mountainous with lowland areas along the coastline and river plains. The island is humid in most areas. Rainfall generally varies between 600 and 2000 mm yr⁻¹ in lowland areas, but large tracts of North-east Iceland receive less than 600 mm. Despite the low evapotranspiration and relatively high rainfall, a large percentage of Iceland's terrestrial ecosystems have been devastated since the arrival of man to the country, about 1100 years ago (Thorarinsson, 1961; Arnalds, 1998). The consequence has been the formation of landscapes which are almost totally barren; or deserts. These barren areas do not fit the climatic definition of "polar deserts" (e.g., Rieger, 1983), as the climate is much milder and more humid than found in polar areas.

Icelandic ecosystems evolved in the absence of large grazing animals. Fully vegetated ecosystems covered most of the country when man arrived and initiated livestock grazing and wood harvesting. Sources for reconstructing past ecosystem structures include pollen analyses, historical records, soil remnants, and relic vegetation (e.g., Einarsson, 1963; Thorarinsson, 1961, 1981; Arnalds, 1987; Hallsdottir, 1995; Kristinsson, 1995; Gisla-dottir, 1998). These reveal that a large portion (perhaps >25%) of the Icelandic lowlands and lower highlands were once covered with woodlands of birch and willows, and that most of central Iceland was mantled with fertile Andosols and vegetation.

Severe desertification appears to have begun soon after the settlement about 1125 years ago (Thorarinsson, 1961, 1981; Gudbergsson, 1975). The main cause for the massive ecosystem degradation is believed to have been animal grazing and wood harvesting. The soils, mostly Andosols, were very susceptible to erosion by wind and water, and to cryogenic processes (Arnalds, 1990; Arnalds et al., 1995; Figs. 3 and 4 in Archer and Stokes, this volume). The surface was subjected to frequent volcanic ash deposition (Thorarinsson, 1961; Sigbjarnarson, 1969; Magnusson, 1994) which intensified eolian processes where the vegetation had been disturbed by utilization. The climate was already becoming cooler when man arrived (Bergthorsson, 1969) and this cooling trend continued long after the arrival of man. Sand encroachment on vegetated land also played a major role, especially in the highlands (Arnalds et al., 1997). The cumulative effect of cooler climate and increased eolian deposition added to the susceptibility of Icelandic soils to erosion (Arnalds, 1999).

The desertified soil surface has quite different soil properties from the former Andosol cover. It lacks nutrients, has very limited water holding capacity, and maintains <5% vegetation cover (Arnalds et al., 1987). More than 37,000 km² of the 103,000 km² land area are now classified as barren deserts, with additional 15,000 km² having limited plant production (LMI, 1993). Birch woodlands now cover only about 1% of the country (Sigurdsson, 1977). Most of the barren desert surfaces, which characterize present day landscapes, have formed during the past 1100 years.

The Icelandic language has two special terms for deserts. The first is 'auðn' (plural 'auðnir'), which is related to 'auður', meaning "empty" or "deserted". The second term, 'eyðimörk', can be translated as "deserted area" and is commonly used to describe the barren landscapes of the world's arid regions. The term 'auðn' is more often applied to the barren Icelandic landscapes. The Icelandic 'auðn' has traditionally been used synonymously with "desert" in English literature (i.e., Anderson and Falk, 1935).

The results of desertification in Iceland have been similar to those reported world-wide: severely reduced productivity; increased demands for food from the land with population growth; and starvation. Social unrest and loss of independence to Norway in 1262 AD (and later to Denmark) is often attributed to the devastation of Icelandic ecosystems (e.g., Sigbjarnarson, 1969). Desertification continued through the middle-ages and is presently recognized as a major environmental problem. Iceland regained independence from Denmark in 1944. The Icelandic Soil Conservation Service was established under Danish rule as early as 1907, to battle encroaching sand as its first aim (A. Arnalds, this volume).

3. WHAT CONSTITUTES A 'DESERT' AND 'DESERTIFICATION'?

A mutual understanding of the desertification concept is vital for communication among scientists, administrators, politicians, and the general public. It has been said that "*no meaningful assessment can be carried out without a clear-cut definition of the problem, hence the need for an unequivocal voice*" (UNEP-DC/PAC, 1990). Several authors and organizations have stressed the need for a clear definition of desertification in order to advance scientific understanding and to promote international co-operation and remedies (e.g., UNEP DC/PAC, 1990; Behnke and Scoones, 1993; Rubio, 1995). Binns (1990) emphasized the need to investigate theoretical definitions of "desertification" and several comprehensive texts have been written about the nature and evolution of the term (Mainguet, 1994; Odingo, 1990; Rubio, 1995; Thomas and Middleton, 1994).

There have been many attempts to weave contrasting perceptions of desertification into a single definition. Even so, no definition has gained full acceptance and the desertification terminology is still subjected to debate. Thornes (1995) noted that most texts on desertification begin with a discussion of definitions.

3.1 Desert as a dry area

To many, the term "desert" simply means an arid area, vegetated or not, with set climatic boundaries. Annual precipitation is often used to define deserts as is done in the Harper Encyclopedia of Science (Newman, 1967), the Dictionary of Geology (Whitten and Brooks, 1974) and the Oxford Dictionary of Natural History (Allaby, 1985). Desertification in this sense would simply imply a decline in rainfall, i.e., to become more arid. Similar are definitions based on indices of aridity, as represented by the ratios of precipitation, evaporation and sometimes transpiration (e.g., Cooke et al., 1993).

The vast majority of deserts will, by people's perception, always be in the arid regions of the world, may they be vegetated (as are many US deserts) or barren seas of sand. When it comes to desertification, however, it should be kept in mind that many dryland ecosystems are deserts based on a climatic definition, before degradation alters the ecosystems. Relating desert and desertification by some measure of aridity can therefore be difficult or impossible.

Set climatic boundaries provide the basis for the UN Convention to Combat Desertification in another way (CCD, 1994; see also Rubio, 1995): "*Desertification is land degradation in arid, semi-arid and dry-subhumid*

areas resulting from various factors, including climatic variations and human activities." This definition emphasizes land degradation, but within certain climatic boundaries. Many have argued strongly for such limitations, e.g. "dry ecosystems turned into desert" (Mainguet, 1994).

3.2 Desert as an area of limited plant growth or production

The term 'desert' has often been defined on the basis of vegetation cover or productivity (low production or the lack of plant cover). Definitions of desert and semi-desert biome types are based on structure or physiognomy which is a response to environmental features (Whittaker, 1975). Desertification could then be defined as long-term reduction in vegetation cover or productivity. Changes in ecosystem function can also serve as the basis for the definition of desertification. Glantz and Orlovsky (1983) concluded that "with all factors cited in the existing definitions, desertification would encompass most kinds of environmental changes related to productivity".

Definitions of desertification such as "spread of a desert", "intensifying the desert", or "dry ecosystems turned into desert", are often in reference to reductions in vegetation cover. Many of these systems "turned into desert" would have been classified as deserts before any ecosystem changes occurred, based on climatic factors. While decreased vegetation cover is often among key attributes of desertification, it is important to note that many climatically defined deserts have considerable vegetation cover while others are barren. This makes definitions of desertification based on changes in vegetation cover often difficult to apply.

'True deserts' and 'natural deserts' are terms that have been used in contrast to an induced 'desert condition'. The emphasis on 'desert condition' is reflected in the first UN definition of desertification: "...can lead ultimately to desert-like conditions" (UN, 1977). Glantz and Orlovsky (1983) pointed out that 'desert conditions' cannot be created in a desert, only at its fringes. Thomas and Middleton (1994) stated that the new and improved UN definition (CCD, 1994) "...firmly returns to the desert margins". The perception that desertification mainly occurs at the desert fringes is debatable and has contributed to the infamous 'marching desert debate' (see Forse, 1989; Binns, 1990; Helldén, 1991; Mainguet, 1994; Pearce, 1992; Thomas and Middleton, 1994).

3.3 Desert as a desolate area

The word 'desert', the root of 'desertification', has a Latin origin and describes a desolate or deserted condition. The Latin word has Egyptian roots

connotating abandonment (see Mainguet, 1994). This meaning, a desolate or sparsely populated area, was perhaps the original intention of Auberville (1949) when he coined the term desertification.

It can be argued that moving away from rainfall limitations to a more inclusive definition, as is reflected by the word 'desolate', would generate several conceptual problems. Many mountain, forest steppe, and tundra regions, often in near pristine condition, are sparsely populated and are therefore desolate. It is undoubtedly unacceptable to most people to describe these areas as desert areas, especially those that are covered with vegetation. Further, it would provide a poor basis for the inventory of desertified areas. The positive aspects of such a definition of desertification lies in avoiding the problems associated with aridity-based definitions discussed earlier.

No single, conclusive ecological definition of the term 'desert' has been accepted. The different perceptions of the term "desert" can be viewed as contrasting paradigms that complicate the discussion about desertification. More than one perception may be used simultaneously without making a distinction between different and even contrasting meanings. The "desert" is at the root of the "desertification" concept and this makes it difficult to define the term "desertification". The pursuit of global definition of desertification may ever be in appropriate and has been questioned (e.g., Perez-Trejo, 1992). The Icelandic example suggests that the definition of the term 'desert' should not *solely* be based on aridity, but should rather include barren areas wherever they occur. This would make the term "desertification" more robust, in that the process can occur in any climatic zone.

4. GLOBAL RECOGNITION OF SEVERE LAND DEGRADATION

4.1 Limitations to the UN definition of desertification

The definition provided by the UN-CCD on desertification is very important, as it defines the scope of the Convention. During the negotiations for the Convention, it was decided to limit the focus on dryland areas of the earth, i.e., "... *in arid, semi-arid and dry-subhumid areas*". An important reason for including climatic limitation in the UN definition of desertification was that the UN Convention to Combat Desertification was primarily meant to focus on the African situation in a pressing search for relief. This is reflected in the subtitle of the convention: "*in those countries experiencing serious drought and/or desertification, particularly in Africa*". In other words, global politics have shaped the definition. However, as discussed

earlier, climatic restrictions of the term desertification are among the key reasons for the continuing debates about definitions.

Severe land degradation leading to nearly total devastation of ecosystems does occur outside the regions specified in the UN definition, as exemplified by the Icelandic case history. Severe degradation is also common on slopes in humid areas subjected to intense land use.

The climatic constraints of the UN-CCD definition have other limitations. Arid and semi-arid ecosystems are adapted to variations in annual rainfall. Barren areas may form during drought periods, but recover when rains resume. This was well expressed following the Sahelian droughts 1968–1974 and 1979–1984. There is ample evidence that the productivity of these ecosystems was restored with the return of rain (e.g. Helldén, 1991), as long as ecological disturbance thresholds associated with human activities were not exceeded (see Archer and Stokes, this volume).

4.2 Arid areas or marginal lands

The central concept of the UN Convention, “arid areas”, may have to be replaced by the “marginal lands” concept. The term “marginal lands” would encompass ecosystems which are most susceptible to disturbances such as intense land use. In Iceland, deforestation and grazing are major causes for desertification, ecosystem degradation, and ultimately the creation of extensive barren wastelands. The parallels of desertification causes and processes between drier regions and the more humid Iceland are striking. The difference is the nature of the stress which makes these systems vulnerable to disturbance, i.e. dryness versus coldness. Too much rain in steep terrain, as exemplified by the effects of hurricane Mitch in Honduras in 1998, and volcanic eruptions, are other “natural” stress factors that interact with intensive land use to cause extreme land degradation.

Another point to consider is that ecosystem function is as strongly dependent on the fate of water on the ground as on overall rainfall. If the soil loses its ability to store water and supply it to plants, water shortages will be intensified in any climatic zone and contribute to degradation (Thurow, this volume; Imeson and Cammeraat, this volume). In Iceland, this scenario is taken to an extreme: erosion processes remove rich Andosols with high water holding capacity, replacing them with sandy soil surface with limited ability to store water and nutrients. As a result, water shortage becomes a severe limitation in spite of a humid climate.

Many authors have pointed out the importance of resilience in relation to desertification (e.g., Archer and Stokes, this volume; Tongway and Hindley, this volume). Warren and Agnew (1988) stated that “*degradation occurs when resilience is damaged*” and Rubio (1995) stressed that climatically

extreme regions are more sensitive due to lesser resilience. When ecosystem resilience of marginal lands is reduced by the use of the land by man, the system's capacity to absorb stress or to respond when released from stress is diminished. This can be brought on by natural fluctuations in environmental stresses, such as drought and cold spells, and accelerated by human land use pressure. A new steady state may be reached with reduced productivity or a major collapse brought on resulting in near barren land (see Archer and Stokes, this volume).

4.3 Alternatives

There are at least two plausible alternatives to the current scope of the UN-CCD as determined by CCD definition of desertification. One is to change or improve the definition, the other is to broaden the context of the Convention.

The first alternative involves the adoption of a simple and open definition such as "degradation causing long-term reduction in the productivity of the land". Similar definitions have been suggested by Biot (1993) and by the EU DeMon project (Hill, 1996). Desertification would, in this context, be a broad scientific, social and political concept. More detailed definitions could be made for specific purposes, including local or regional assessments of the problem.

The other alternative is to change the scope of the Convention from desertification to severe land degradation with lasting effects on productivity. Marginal lands, such as arid, cold, steep terrain, and other fragile ecosystems would be most vulnerable to such degradation. This is no easy task, as international conventions are complex and involve long and tedious negotiations before agreements are reached. This alternative may be difficult, but merits discussion.

Severe land degradation is a global environmental problem. It is not constrained by political or climatic boundaries. Land degradation in humid, mountainous areas can cause massive desertification in drier lowlands because of poorer quality of irrigation water. Severe land degradation needs to be dealt with at a global level regardless of climatic boundaries. If neither of the alternatives outlined above are used, it is quite possible that it will be deemed necessary to develop a new international convention dealing with land degradation in general. That could greatly limit the success of the current CCD. This further underlines the need for a critical investigation of CCD conceptual problems and possible alternatives.

5. CONCLUSIONS

“Desertification” is a vague concept because the term ‘desert’ can have many different meanings. The recent UN definition (CCD, 1994), land degradation within arid areas, has a broad acceptance, but is subjected to severe limitations. As such, the definition excludes many areas of the world subjected to severe land degradation, for example India and SE-Asia, Central and much of South America. It puts an unnecessary narrow perspective on the problem which has damaging effect on international, social, political, and scientific communication in this field. Evolution of the CCD convention from the currently regionally limited concept towards a more comprehensive, robust convention, embracing all severe land degradation, is desirable. Such evolution of the CCD convention would enhance communication, research, and encourage counter measures at the global level.

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