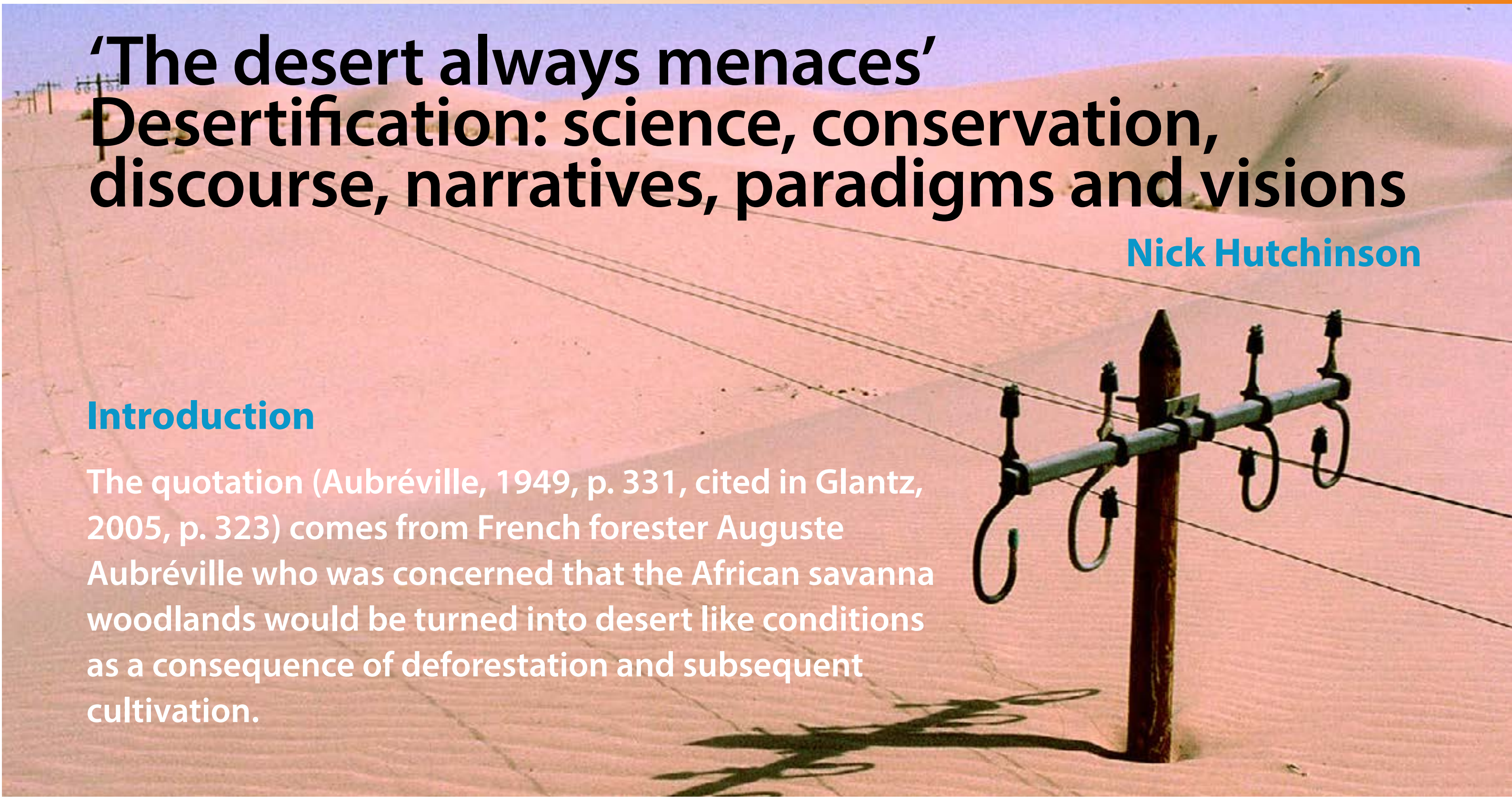
DESERTIFICATION



'The desert always menaces' Desertification: science, conservation, discourse, narratives, paradigms and visions

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Introduction

The quotation (Aubréville, 1949, p. 331, cited in Glantz, 2005, p. 323) comes from French forester Auguste Aubréville who was concerned that the African savanna woodlands would be turned into desert like conditions as a consequence of deforestation and subsequent cultivation.

The intention is to build on the notion that 'Geography integrates knowledge from the natural sciences, social sciences and humanities to build a holistic understanding of the world' (ACARA, ND). The discussion is applicable to the Year 10 Unit 1, Environmental change and management and the Senior Secondary Curriculum Unit 3, Land cover transformations.

There are more than one hundred published definitions of desertification that have appeared in the literature (Thomas, 1997, 585). Many of them carried the connotation of disaster (Dregne, 1987, 8) but even if most geographers and others working in this field accept the United Nations Convention to Combat Desertification definition of desertification, in effect the dispersed, patch-like degradation of land in arid, semi-arid, and dry sub-humid areas (Grainger, Stafford Smith, Glenn, & Squires, 2000, 365), there is widespread recognition of its complexity. It has been described as a phenomenon revealed by drought, seemingly caused by people, made worse by socioeconomic or biophysical factors, made manifest through vegetation or soil loss and perhaps exhibiting irreversible destruction of the biological potential and diminished abilities to support people and their livelihoods (Mainguet, 1991, 4).

It has also been described as ever expanding desert wastelands (Carlson, 2013), expanding desert – an urgent problem (Reynolds & Stafford Smith, 2002, 7), a living environment becoming sterile and barren (Nicholson, Tucker & Ba, 1998, 815) or, more graphically of all, referred to in: *China's Growing Deserts Are Suffocating Korea* (French, 2002) and *Chile: President Piñera Says Desert Growing 'A Metre Per Day'* (Depsky, 2013).

An examination of desertification through the lens of physical geographers, environmental geographers and those that sit more comfortably in the social sciences and humanities help to unravel this conundrum. Much of the evidence comes from the Sahel but other case studies are alluded to.

Desertification and biogeophysical feedback

The inspirational text for this discussion of desertification is titled *Geography and the Enlightenment* (Livingstone & Withers, 1999), a text that examines Geography's place within this historical period. Influences of the Enlightenment on geographical thinking included both a predilection for rational knowledge and the rise of science as both a technique and worldview (Livingstone & Withers, 1999, 5). It encompassed an engagement with colonialism (12) that developed distinctive ideas about geography - particular ideas and practices, conceptions of truth and notions of reason, unearthed through exploration, revealed through accumulated data and demonstrated through cartographic techniques. The rationalised structures of thinking of 17thc and 18thc Europe preceded what Peet (1998, 9) termed modern geographical thought.

One strong element of geographical thought that emerged in the middle of the last century was a geography that could integrate physical and human geography through nomothetic science, that is science that emphasises law-giving and explanation, as opposed to idiographic science that privileged description (Hubbard, Kitchin, Bartley & Fuller, 2002,13). Geography as nomothetic science, infused with the ideas of positivism, adopted processes of inference, observation, deduction and, cause and effect (28). And, the genesis of positivist science lies in the Enlightenment. Enlightenment thinking processes can be traced through to key themes that permeate physical geography today, 'the search for universality in explanation, the study of stability and change in the physical environment, and the primacy of empirical information to study the environment' (Inkpen, 2005, 24).

The biogeophysical feedback hypothesis

An explanation for the prolonged drought in the African Sahel in the 1970s and 1980s, the ***biogeophysical feedback hypothesis***, was set out in what has been termed a classic paper by climatologist Sharon Nicholson and her colleagues (Nicholson, Tucker & Ba, 1998, 815). The paper, by meteorologist Jule Charney and others (Charney, Stone, & Quirk, 1975), speculated that albedo changes resulting from overgrazing and degradation had resulted in a highly reflective surface and had produced a decline in rainfall across the Sahel. In simple terms the vegetation cover was reduced during the drought years and this situation was exacerbated by overexploitation by humans and animals. This, in turn, initiated a positive feedback loop through higher albedo values (the proportion of sunlight that is reflected back into the atmosphere rather than absorbed by the soil). Higher levels of reflectivity lead to less heat absorption at ground level with fewer thermal currents ascending to form rain-bearing clouds. As a consequence, there is less rain, leading to further exploitation, an extension of the desert in a self-aggravating process (Linacre & Hobbs, 1977, 20).

The biogeophysical feedback mechanism, as expressed in the Charney article, claimed that the 1970s Sahel drought was as result of desertification and when the UN proclaimed that some 35 million km^2 of land had been lost (Nicholson, Turner & Ba, 1998, 818) a powerful discourse of desertification was unleashed in scientific, political and institutional circles.

A number of scientists led by geographer Alan Grainger, including Mark Stafford Smith, a CSIRO scientist based in Alice Springs, Victor Squires, a dryland management consultant from South Australia, and Edward Glenn, an environmental scientist from Arizona concluded in 2000 that 'there was no conclusive proof of this

Approaching dust storm, Arizona. Source: Wikimedia Commons

[the biogeophysical feedback mechanism], nor of other suggestions that the drought was caused by global climate change, and variation in sea-surface temperatures seemed to offer a more convincing explanation (Grainger, Stafford Smith, Glenn & Squires, 2000, 370).

Arizona-based arid lands scientists, Charles Hutchinson and Stefanie Herrmann pointed out that the 'relationships between climate and land degradation in drylands are much more complex and less well understood than initially assumed' (2008, 66). There could be local effects of increasing albedo. Biologist Uriel Safriel and environmental engineer Zafar Adeel (2005, 631) explained that albedo might also increase locally following dust storms. These dust storms are initiated after the removal of vegetation. But, again Hutchinson and Herrmann (2008, 66) assert that there are major uncertainties revolving around the roles of surface albedo and atmospheric dust.

The initial biogeophysical feedback mechanism hypothesis argued that desertification actually contributes to drought, and not vice versa (Herrman & Hutchinson, 2005, 1). The original proposal stemmed from work by Joseph Otterman (1974), an environmental scientist from Tel-Aviv University 'citing the example of the Sinai–Negev region, where the denudation of bright sandy soil by grazing on the Egyptian side increased albedo and decreased surface temperature compared to the more densely vegetated Negev side' (Herrmann & Hutchinson, 2005, 540). However, it was Charney and his colleagues that scaled up the hypothesis using Global Circulation Model experiments to postulate increased albedo could enhance large scale atmospheric subsidence in high pressure cells located above deserts and thus, increase desiccation. In the General Circulation Model experiments, using atmospheric models developed at the Goddard Institute of Space Studies, albedo was increased over several semi arid regions, including the Sahel. The results indicted a significant reduction in rainfall and a southward shift of the heat equator, the inter-tropical convergence zone. 'These studies generally concluded that a positive feedback exists, with such changes reducing rainfall and thereby further altering the vegetation and soil and promoting desertification' (Nicholson, Tucker & Ba, 1998, 819)

When satellite measurements of actual sub-Saharan albedo were gathered there was no evidence to indicate a pronounced and prolonged increase in albedo, or, at least, one that would produce significant differences in rainfall (Herrmann & Hutchinson, 2005, 540). Any such effects were local rather than trans continental and occurred over short periods of time rather than sustained episodes, both of which would be prerequisites for the Global Circulation Model to operate.

In short, the empirical evidence for the biogeophysical feedback mechanism did not support the modelling hypothesis. To illustrate some of the complexities involved in using finer scale studies to then generate an hypothesis a number of empirical studies can be examined. In North America, surface temperatures in the Sonora were generally 2° to 4°C higher on the brighter, more heavily grazed Mexican side of the border than on the U.S. side (Nicholson, Tucker & Ba, 1998, 821). The less heavily grazed areas on the U.S. side of the border did show increased soil moisture and cloudiness, but no changes in rainfall (821). Although case studies at a coarser scale indirectly support the idea that desertification can at least potentially have an influence on weather and climate (821). Grainger and his co-authors conclude that, 'The present consensus, based on empirical and modelling studies, is that the main impacts of desertification on climate are at local and regional levels' (Grainger, Stafford Smith, Squires & Glenn, 2000, 370). Geographers Simon Batterbury and Andrew Warren (2001a, 3527) support this conclusion, 'Current research provides strong evidence that changes in surface characteristics, including vegetation, affect local and regional rainfall patterns significantly.' But they implacably assert that the biogeophysical feedback mechanism at a macro scale 'remains disputed' (3527).

Nicholson and her colleagues had conducted a sixteen yearlong study between 1980 and 1995. Their analysis clearly demonstrated that the extent of the Sahara Desert and the Sahel fluctuated every year according to variations in annual rainfall totals. There was, 'No progressive change in either the desert boundary or the vegetation cover in the Sahel is evident during the 1980–95 analysis period' (1998, 827). Similarly, the year-to-year variations in surface albedo were small in comparison to the albedo changes described by Charney and colleagues. They pointed to complexities in the recovery of vegetation patterns after dry periods and the interactions between plant species and grazing animals. They concluded, 'These earlier papers used crude representations of the biosphere and somewhat unrealistic changes of surface conditions' (Nicholson, Tucker & Ba, 1998, 820). Nicholson (2011, 443) explains, 'Field observations, aerial and satellite photos, and vegetation information all show that the albedo changes that occur are much smaller than Charney's theory requires and that they are inconsistent with changes in rainfall and vegetation that occur.' Nevertheless, despite the absence of supporting empirical evidence for the Charney hypothesis, (Herrman & Hutchinson, 2006, 20) the modelling studies help us to understand the interrelationships between land surface and atmospheric processes.

A simple interconnection between increased albedo and desertification is much more complex than was originally assumed.

Below: Senora Desert Museum, Arizona. Source: Wikimedia Commons