Desertification: Inappropriate images lead to inappropriate actions

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SHORT REPORT

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Desertification: Inappropriate images lead to inappropriate actions

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Abstract

Among policy institutions, researchers in other fields, and the public, there is an enduring misunderstanding of the nature of desertification. To a considerable extent, its meaning has been reduced to just two eye-catching images: sand dunes encroaching on productive land and habitations and bare, cracked soil surfaces. Yet neither of these is an indicator of desertification—sometimes called dryland degradation. Rather desertification results in a wide range of changes, including erosion, loss of biodiversity, decline in soil fertility, and reduced carbon storage. Surprisingly, it is the pictures themselves, not the scientific literature, that have fixed this erroneous concept in the minds of even some who work in the field of land degradation. The results of this confusion include inappropriate management efforts, mistaken premises in research, and ill-informed policies at local to global scales including misleading prognostications of institutions—even at the level of United Nations agencies.

KEYWORDS

cracked soil, desertification, dryland degradation, sand dune encroachment, UNCCD

1 | THE ISSUE

In the light of the recent publication of the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) Land Degradation and Restoration Assessment (IPBES LDR, 2018) and others including "The Global Land Outlook" (UNCCD, 2017), the third edition of the *World Atlas of Desertification* (Cherlet et al., 2018) and the UN Statistical Commission Sustainable Degradation Goals (SDG) indicator framework (United Nations, 2015), this is an opportune time to draw attention to a persistent misunderstanding of the nature and perceptions of desertification.

Following the Sahel famines in the 1970s and 1980s, the phenomenon was illustrated by images of just two conditions: sand dunes encroaching on productive land and buildings (Figure 1a–c) and apparently unproductive, bare soil with cracked surfaces (Figure 1d–f). Yet neither of these is a consequence of desertification as defined in the United Nations Convention to Combat Desertification (UNCCD, Article 1f, 1994)—"'land degradation' means … processes arising from human activities and habitation patterns, such as … soil erosion caused by wind and/or water; deterioration of the physical, chemical and biological or economic properties of soil [and] long-term loss of natural vegetation" (United Nations, 1994; Vogt et al., 2011). To a surprising degree, it is images of just these two conditions, not the scientific literature, that maintain the mindset. It is not that all images are misleading, rather the problem is with the specific subjects of these two images—sand dunes and bare, cracked soil.

This misunderstanding is widespread in policy discussions, some research communites and particularly with the public at large. For

The concept of desertification is frequently articulated by eye-catching images of just two land cover types: spreading sand dunes and cracked soil surfaces, but neither of these are caused by anthropogenic dryland degradation. These stereotypes have long had a detrimental effect on the understanding of desertification in research, policy making, and for the general public.

FIGURE 1 Examples of two land conditions mistakenly associated with the concept of desertification; (a–c) the 'spreading desert'; (d–f) cracked, bare soil surfaces. Photo credits: (a) UNCCD (b) Lao ; (c) Brooks ; (d) UNHCR ; (e) United Nations ; (f) UNCCD [Colour figure can be viewed at wileyonlinelibrary.com]

example, a Google Image search for the term "desertification pictures images" found, out of 168 images, 43% spreading sand dunes, 29% cracked soils, and 28% appropriate images. Similarly, a Bing search for "desertification" found, out of 249 images, 31% spreading sand dunes, 50% cracked soils, and 19% appropriate images (note: some images appeared more than once in both searches, but, assuming no bias between categories, the proportions should not be affected: Both searches were conducted on August 19, 2019). Another indicator of how deep-rooted are these images is postage stamps, presumably issued to draw attention to desertification or in order to recognize events related to it, such as the annual World Days of Desertification (United Nations General Assembly, 2018) and the periodic UNCCD Conferences of the Parties (COP). The illustrations on the stamps are almost exclusively of sand dunes or cracked soil surfaces (Figure 2). That desertification is shown on postage stamps at all is testimony to how widely accepted is the concept. Toth and Hillger (2012) remark, "… one small postage stamp can speak a 1000 words." These examples illustrate the ubiquitous mindset that encroaching sand dunes and cracked soil surfaces are the characteristic results of desertification.

Although sand movement does occur under the action of wind, dunes encroaching on cultivated land and settlements as a result of human actions is a minor phenomenon (Bellefontaine et al., 2011). In China, where degradation by sand movement ('sandification') is a major problem, only 5.5% is said to be caused by encroachment at the edges of existing dunes and sand sheets (Wang, 2004). Damage caused by inappropriate tillage practices, overgrazing by livestock,

FIGURE 2 Postage stamps intended to draw attention to desertification and associated events, which illustrate the common misunderstanding of the nature of desertification. That is, the (a–c) spreading desert and (d–f) cracked soils (Toth & Hillger, 2012) [Colour figure can be viewed at wileyonlinelibrary.com]

construction, and vehicles to vegetated soils susceptible to degradation can open patches of bare soil to erosion by wind. Frequently, the blown sand and silt are trapped around remaining bushes, creating small dunes known as nebkhas, often forming a landscape of small dunes and residual, degraded vegetation. Their cause—anthropogenic removal of the surface vegetation—is quite unlike edge-encroachment by existing dunes, which is mostly a natural process and therefore not related to desertification as defined by the UNCCD (United Nations, 1994; Vogt et al., 2011).

More recently, images of cracked soil surfaces (e.g., Figure 1d–f) have been added to the engulfing dune archetype, but these are even less related to anthropogenic degradation. Frequently, the images show an apparently destitute person standing on an area of cracked soil (Figure 1d), suggesting desperation in the face of desertification. But cracked soil surfaces are common and always natural. There are two main types that naturally form cracks on their surfaces: Vertisols and depositional Fluvisols or Entisols (Fluvents; IUSS Working Group WRB, 2015; Soil Survey Staff, 1999). Both contain clay minerals that shrink when dry, creating the polygonal patterns of cracks that swell when rewetted, closing the cracks. Shrinkage and swelling occurs in both types, but the cracks are wider and deeper in Vertisols. Both types can be reasonably fertile.

Vertisols form in areas with rainfall between 250 and >1,000 mm yr^{-1} that have marked wet and dry seasons. They contain secondary or inhereted minerals formed by long-term, soil chemical processes. The soils are generally deep and dark (Figure 1d). They can be formed in lowlands where clays accumulate or gradual weathering of argillaceous limestones, shales, or basic rocks such as basalt (Soil Survey Staff, 1999). Vertisols generally have a stable structure owing to the strong bonds between the clay particles and are therefore little affected by erosion. Owing to soil movements that can break their roots, perennial herbs and trees are naturally absent, which can mistakenly suggest degradation. The soils are, however, often cultivated for annual crops because of their relatively high fertility.

The second type of cracking soils—takyric properties (IUSS Working Group WRB, 2015) or takyric Fluvisols or Fluvents (Soil Survey Staff, 1999; Figure 1e,f)—generally are found in much drier conditions than Vertisols. They occur in arid conditions with periodically flooded soils (IUSS Working Group WRB, 2015) and can form on a wide range of loamy and sandy soils and are largely natural. On gentle slopes, rainfall with adequate force can dislodge surface materials resulting in sediment-carrying runoff. The sediment later settles in depressions. Heavier particles are deposited first and fine grained materials last, forming thin 'skins' or microlaminae (Valentin & Bresson, 1992). If these crusts contain shrinking/swelling clays, when dry, they develop characteristic, polygonal cracks as a result of anisotropic shrinkage. The crusts are easily damaged by vehicles and livestock hooves but can reform after rain. Because the cracking is caused by the natural shrinkage of clay minerals in the dry season, it does not, in itself, indicate drought or land degradation. Millions of people support themselves on fertile and workable Fluvents, although mechanized farming is often limited because of their softness. Cracked surfaces also occur naturally on saline soils.

Thus, desertification does not consist of encroachment by existing dunes nor is a cracked soil surface symptomatic of degradation as both generally occur naturally and without human agency. A consequence of this misinterpretation is that attention is diverted away from more urgent management, policy making, and research activities.

Another cause of misunderstanding must surely be the ambiguous meaning of the word 'desertification' that inevitably invokes a notion of desert expansion which, as discussed here, is not its technical meaning. It might be wise to replace the word with a more appropriate term, but a change in the established title of the UNCCD and the vast accumulation of publicity and policy materials makes this unlikely.

2 | WHAT ARE APPROPRIATE IMAGES OF DRYLAND LAND DEGRADATION AND DESERTIFICATION?

There is a wide variety of actual types of dryland degradation. The list is long (Prince et al., 2018; Figure 3). It includes gulley erosion due to loss of ground cover caused by overgrazing; sheet erosion exposing roots and killing trees; forest degradation and deforestation; wildfire that causes biomass loss, nutrient losses through volatilization, accelerated erosion, formation of water repellent surfaces prone to water runoff and erosion, increasing CO_2 emissions, and is sometimes followed by invasions of alien species; soil compaction along cattle pathways especially where they gather to drink, reduced rainfall infiltration and increasing runoff, which, in turn, can lead to erosion; habitat loss that endangers native species; dust storms and loss of top soil caused by bare soil in fields, especially large-scale, mechanized, dryland farming; salt efflorescence due to overirrigation; uncontrolled populations of feral animals that graze and browse useful vegetation; bush encroachment, often attributed to overgrazing in dryland, changes in fire regimes, land abandonment, and CO_2 increase; alien species establishment; loss of biodiversity due to habitat loss; and overgrazing by livestock leading to erosion and loss of soil carbon.

Beyond local degradation, desertification has far-reaching effects from national to continental to global scales. These include its effect on climate (Nicholson, 2000); the source of intercontinental airborne dust transport (Nicholson, 2011); diminished sequestration of carbon in drylands (Olsson & Ardö, 2002) which, while small on an area basis, given the vast global extent of drylands, are a major global sink; food insecurity; and a role in causing human migration (Leighton, 2016). Images of these conditions, such as those in Figure 3, can be as eye-catching as encroaching sand dunes and cracked soil surfaces but, unlike them, are depictions of the actual effects of desertification.

3 | IMPLICATIONS OF INAPPROPRIATE IMAGES

From the start of the concerns about desertification following the Sahel disaster, the main emphasis has, understandably, been on practical management, not research, which has a longer lead time. However, unfortunately, the result of this early concept has been a perpetuation of the mistaken understanding described above. Many prevention and remediation actions have become unmoored from the findings of

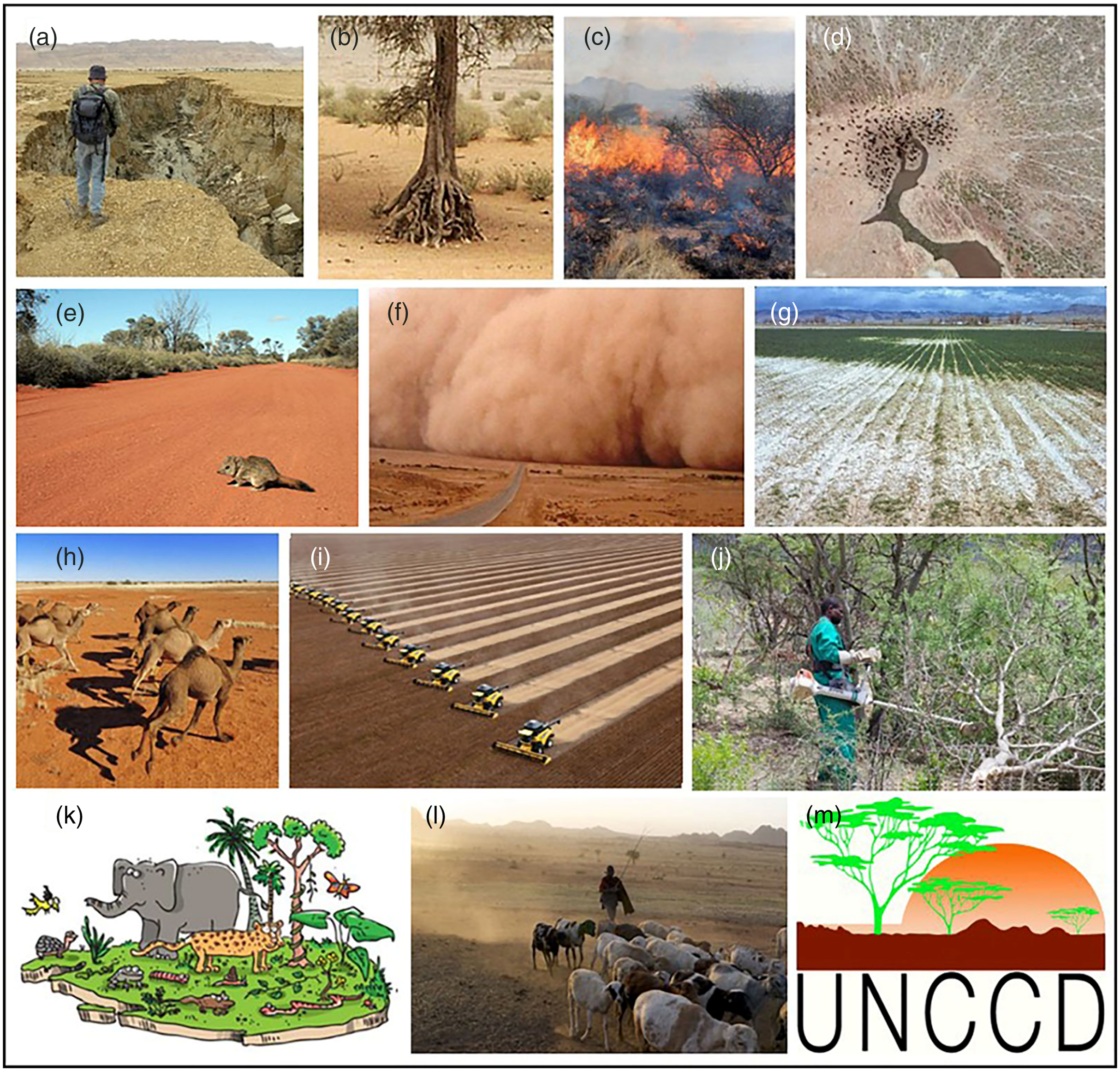

FIGURE 3 Images of actual types of desertification (human-caused dryland degradation). Image credits are given in parentheses. (a) Gulley erosion (Wilson); (b) sheet erosion (Salmon); (c) biomass loss by wildfire (Joubert, Zimmermann); (d) soil compaction by cattle (PEER); (e) habitat loss endangering biodiversity (Hamilton); (f) loss of top soil in dust storms (CENESTA); (g) salt efflorescence (Yadav); (h) heavy consumption of vegetation by feral animals (Shutterstock); (i) increased susceptibility to erosion caused by mechanized agriculture (Project Wadi Attir); (j) bush encroachment (De-Bushing Service, Namibia); (k) declines in entire fauna due to habitat loss (Biodiversity Sri Lanka); (l) overgrazing by livestock (Caravani); (m) a current UNCCD logo exemplifying a new understanding of the nature of desertification (compare with Figure 1a,f) (UNCCD) [Colour figure can be viewed at wileyonlinelibrary.com]

research. As Reenberg (2012) has observed, many programs intended to 'combat desertification' are based on "… environmental myths … simplistic narratives … even with new scientific knowledge … project formulations … [are routinely based] on … mindsets that were … rejected decades ago." Behnke and Mortimore (2016) add misdirection and institutional inertia (e.g., "when the United Nations finally created the Convention to Combat Desertification (UNCCD) in 1994, policy was seriously disconnected from science"). The intersection of science and policy remains weak at best (Adeel et al., 2007), although attempts to bridge it are emerging, such as the UNCCD publication "The Global Land Outlook" (UNCCD, 2017), the IPBES Assessment (IPBES LDR, 2018), and the 3rd edition of the World Atlas of Desertification (Cherlet et al., 2018). Current biophysical research on desertification is addressing its geographic location and severity, predisposing factors, the biophysical mechanisms involved, and practical methods for prevention and remediation. Generally, but not completely, research has caught up and is now a large and expanding field, especially in regions with extensive drylands, such as China, but less so in policy formulation.

The consequences of these misconceptions can be enormous. For example, the massive, continent-wide, geoengineering projects to build "green walls" of trees, intended to halt the encroaching Gobi Desert in China (Jiang, 2016) and on both the north and south sides of the Sahara in Africa (Bellefontaine et al., 2011; Reenberg, 2012).

These actions have cost billions of dollars (e.g., Adeel et al., 2007; Frimpong, 1995; Jiang, 2016; Sweet, 1987). Although these actions are often said to control desertification, research frequently concludes that they are founded on an outdated conception of its nature (Prince et al., 2018) and are largely ineffective for desertification control.

There is a continuing drive to address desertification by policy-making institutions at the highest levels, for example, the United Nations Sustainable Development Goal (SDG) "15.3: By 2030, combat desertification, restore degraded land and soil, including land affected by desertification …" (United Nations, 2015). Effective action is urgent because, by 2050, it is anticipated that four billion people will inhabit dryland regions, who will certainly be affected by land degradation and its unanticipated ramifications (UNCCD, 2017). It is urgent, therefore, that the widespread misconception of desertification is corrected.

4 | CONCLUSION

Although a seemingly trivial matter, illustrations of encroaching sand dunes and cracked soils, as described here, misleading though they are, remain surprisingly influential. Therefore, it is long past time to promote a more correct concept of desertification at all levels—at the popular information level and at the highest governmental decision-making levels. Critical audiences include (a) local, national, supranational, and global policy makers; (b) land owners, users, and managers who interact directly with the land and respond to the policies defined by the first group; (c) the scientific community that both needs and produces information; (d) international, national, and non-governmental organizations who direct development; (e) society at large, that supplies financial, political and popular support; and (f) the media, which translates and distributes the information to other groups (Vogt et al., 2011). Both words and images are necessary; however, they need to be correct representations, not given only for effect. The images of actual desertification are in fact as strong, if not stronger than the two that are generally used. Eye-catching images of actual forms of desertification (Figure 3) could advance both policy and the fundamental understanding in both socioeconomic and biophysical sciences and assist the needed paradigm shift (Kohler & Kotiaho, 2018) in the understanding of the nature of desertification.

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