

ARIDnet: seeking novel approaches to desertification and land degradation

by J F. Reynolds, D M. Stafford Smith, and E. Lambin

“Drought and desertification threaten the livelihood of over 1 billion people in more than 110 countries around the world.”

Kofi Annan (as quoted in the UN Convention to Combat Desertification)

Desertification is viewed by many as one of the most critically important global environmental change issues [1-3]. Long associated with land degradation in drylands, desertification is equated to (among many other things) a reduction in the biological and, hence, economic potential of the land to support human populations, livestock, and wild herbivores. Potentially, it affects about a fifth of the world's human population and is intimately linked to global environmental change through climate, biodiversity loss, human dimensions of change, and land cover change. In response, the United Nations established the Convention to Combat Desertification (CCD), whose aim is to “target poverty, drought and food insecurity in dryland countries experiencing desertification, particularly those in Africa” [4]. The CCD establishes the role of national governments in enacting policies to combat land degradation with support from the large infrastructure that has evolved to mobilize resources for implementation, including the CCD Secretariat in Bonn and the Global Mechanism, housed at the International Fund for Agricultural Development (IFAD) in Rome.

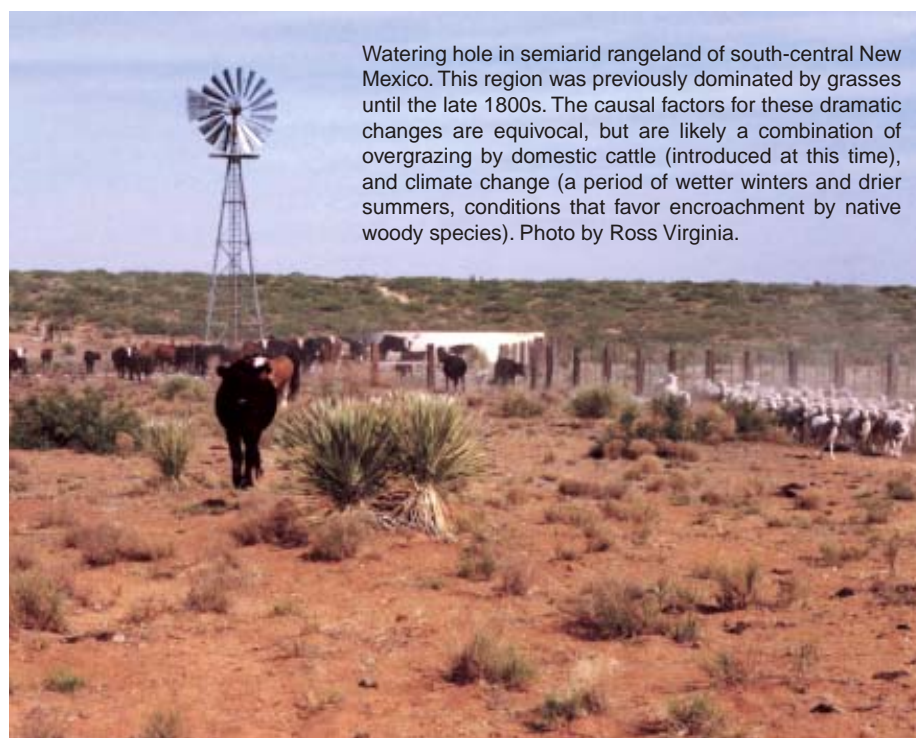
On the other side of the coin, desertification is also a very contentious topic, evoking much disagreement and controversy [5,6]. Although some sources routinely report that up to 70% of all drylands, which cover about 40% of the land surface of the globe, are ‘desertified’, other authors suggest the figure is no more than 17% (see review in [7])! While the reasons underlying the uncertainty and confusion are numerous (replete with countless angles, pitfalls, and interpretations), the bottom line is that desertification is a complex topic, not amenable to simple solutions or answers. We strongly believe that these

issues can only be resolved via a simultaneous consideration of the roles of the (i) meteorological; (ii) ecological; and (iii) human dimensions of the problem and its interactions, which play out in varying and complex ways for different locations, time periods, and scales of concern, e.g., household vs. national policy. The failure to recognise and include these interdependencies in decision-making has slowed progress in developing the necessary synthetic framework for tackling the enormous

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problem of dryland degradation.

Desertification is presumed to be the outcome of land degradation in drylands. However,



Watering hole in semi-arid rangeland of south-central New Mexico. This region was previously dominated by grasses until the late 1800s. The causal factors for these dramatic changes are equivocal, but are likely a combination of overgrazing by domestic cattle (introduced at this time), and climate change (a period of wetter winters and drier summers, conditions that favor encroachment by native woody species). Photo by Ross Virginia.

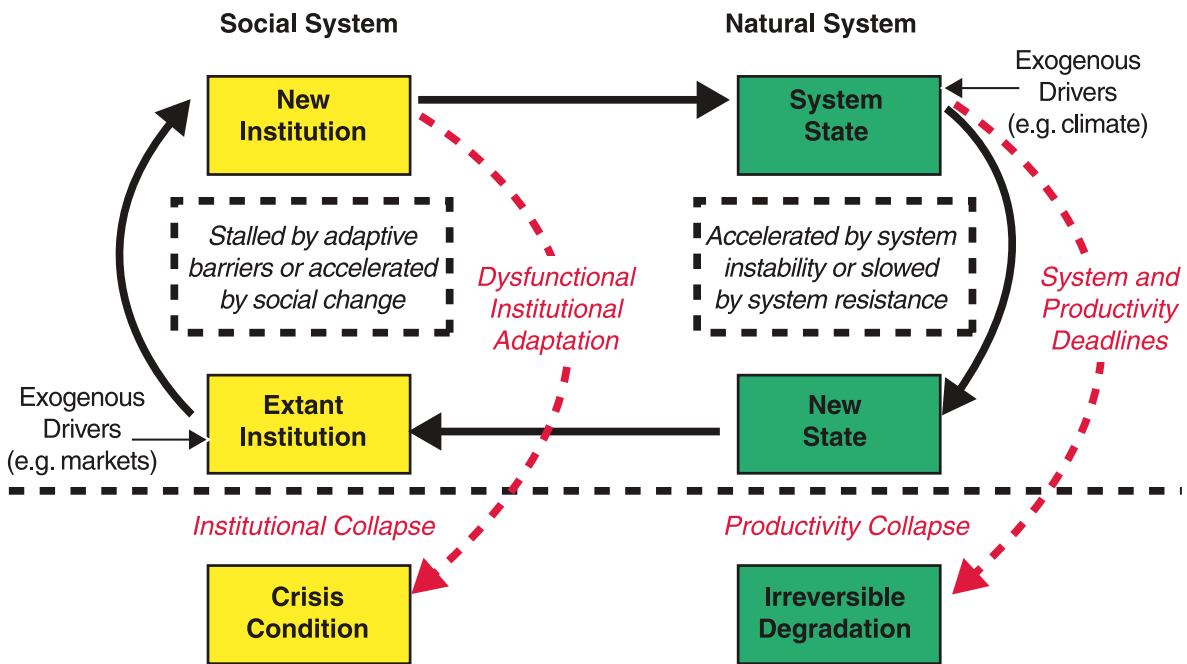


Figure 1. Sustaining a balance between change in natural and social systems is key to understanding land degradation in drylands. The systems are not static and, even under conditions of dramatic change and uncertainty, sustainable land use is possible when the rate of change and spatial overlap in the human and environmental systems are matched (illustrated by the cycle above the dashed line). Accelerated environmental change and decelerated or uncoordinated community adaptation can lead to social crises and irreversible environmental degradation (red dotted lines and *italic text*) (see [9]).

issues surrounding the causes of, consequences of, and political responses to land degradation and its importance, the extent to which land changes are ‘natural’ (e.g., climate-driven) vs. anthropogenic (e.g., overgrazing), whether or not it is reversible, how to determine the amount of land affected or at risk, and the role of abatement



This study site in semiarid rangeland in south-central New Mexico was established in 1912 by the U.S. Department of Agriculture to measure aboveground biomass production by native black grama grass (*Bouteloua eriopoda*). Today, the site is dominated by woody shrubs (*Larrea tridentata*) and bare soil (likely due to a combination of overgrazing by domestic cattle and climate change).

Photo by Jim Reynolds.

efforts aimed at social and institutional vs. scientific and technological issues, remain largely unresolved. As noted above, the problem is complex but at least threefold: first, there is no standardised meaning for land ‘degradation’ that fits all situations; second, land degradation is often triggered or exacerbated by climate variability, mainly drought, so that the causes are not necessarily anthropogenic; and third, not all ‘changes’ have a direct, immediate affect on human welfare. Yet farmers are generally only prepared to accept that they may need to change their management practices if land degradation is a direct consequence of their activities and/or it directly impacts them (or other members of society) (see Box).

Hence, in any elaboration of what constitutes land degrada-

tion, it is essential to make it clear that whilst biophysical components of ecosystems and their properties are involved (e.g., soil erosion and the loss of vegetation), the interpretation of change as ‘loss’ is dependent upon the integration of these components within the context of the socio-economic activities of human beings (often via a generic use of the term ‘productivity’). We further propose a model for understanding and predicting conditions of arid land degradation in the context of the balance between natural and social systems (as summarised in Figure 1).

New Directions

In an effort to address the challenge underlying desertification, the GCTE (Global Change and Terrestrial Ecosys-

tems) and LUCC (Land-Use and Cover Change) programmes of the International Geosphere-Biosphere Programme (IGBP) joined forces on a new initiative on desertification. The intent was to bring together researchers representing various global change programs on natural and human-influenced systems to stimulate new approaches to this 'old' problem. One of the first activities was a Dahlem Conference (<http://www.fu-berlin.de/dahlem/>) entitled "The Meteorological, Ecological, and Human Dimensions of Global Desertification"; the key product of this meeting was the development of a new synthetic framework for global desertification, which we call the Dahlem Desertification Paradigm (DDP). As is the case for many paradigms, the constituent ideas themselves are generally not new, but bringing them together reveals a fresh view of an 'old' problem, providing a new depth of insight. The DDP focuses on the interrelationships within coupled human-environment systems that cause desertification, drawing heavily from the chapters of our Dahlem book [8], and considers non-linear processes, resilience, vulnerability, traditional range ecology, human perceptions, panarchy theory, social structures, and economic factors. The main points of the DDP are that:

- socio-ecological systems in drylands of the world are not static;
- while change is inevitable, there does exist a constrained set of ways in which these socio-ecological systems function at different, interlinked scales, thereby allowing us to understand and manage them;

- an integrated approach, which simultaneously considers both biophysical and socio-economic attributes in these systems, is absolutely essential to understand land degradation;
- the biophysical and socio-economic attributes that govern or cause land degradation in any particular region are invariably 'slow' (e.g., soil nutrients) relative to those that are of immediate concern to human welfare (e.g., crop

yields, the 'fast' variables). It is necessary to distinguish these in order to identify the causes of land degradation from its effects; and

- restoring degraded socio-ecological systems to a sustainable state requires outside intervention.

An elaboration of these main points is provided in the form of nine assertions that embrace a hierarchical view of land degradation and highlight key

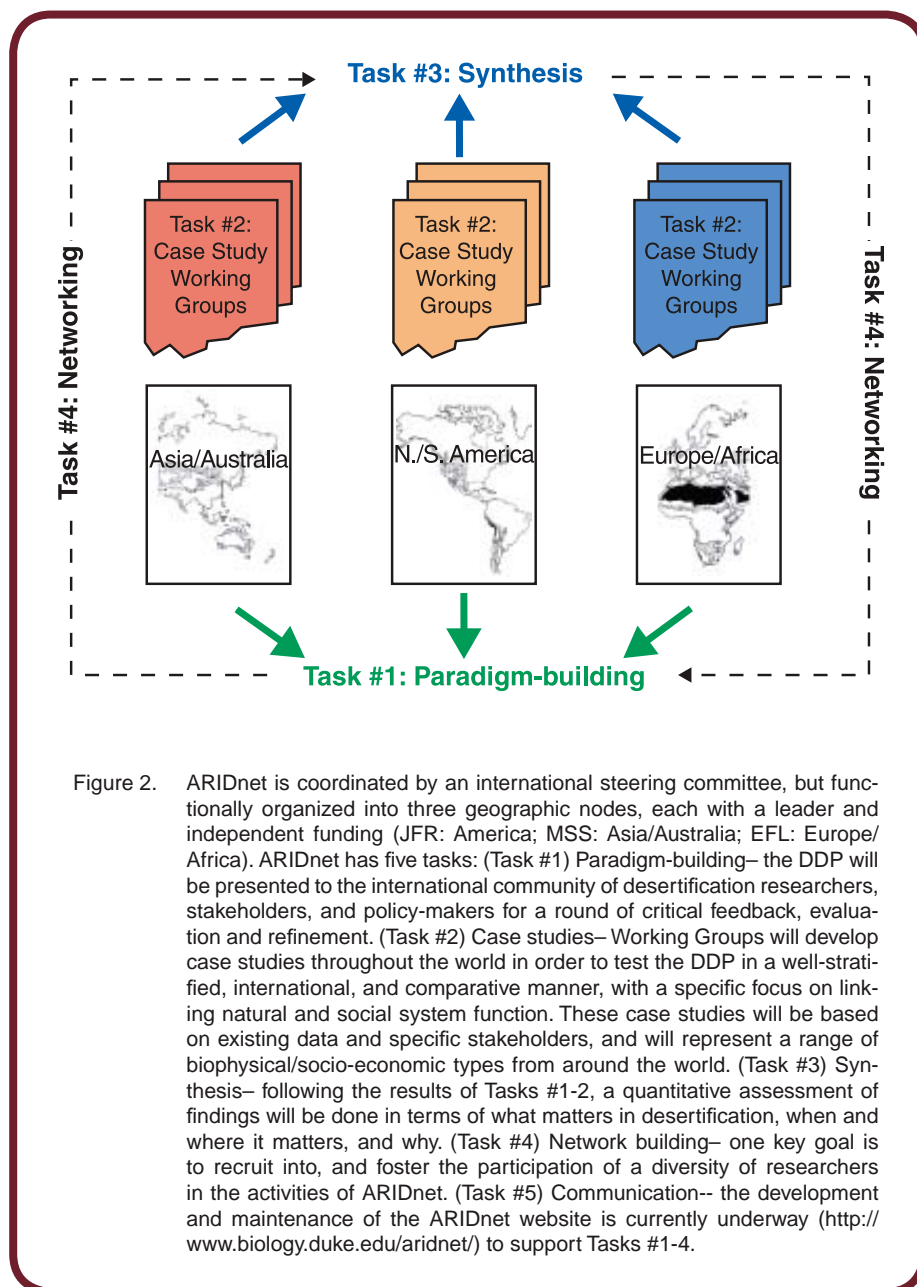
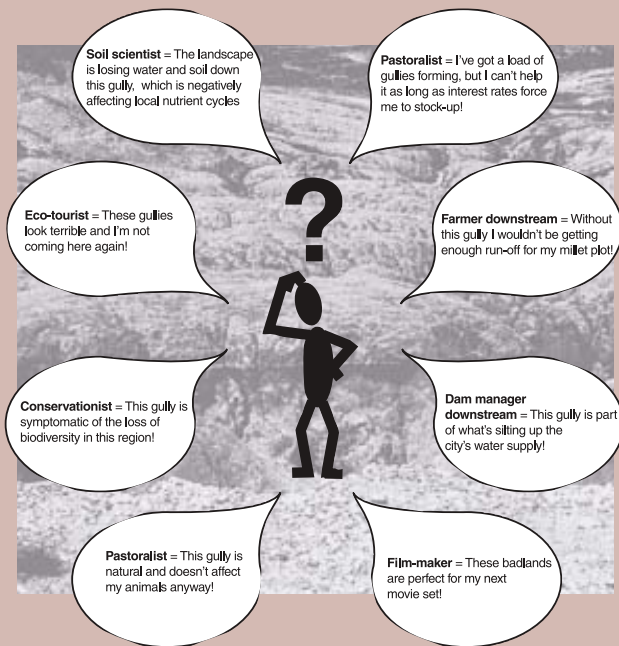


Figure 2. ARIDnet is coordinated by an international steering committee, but functionally organized into three geographic nodes, each with a leader and independent funding (JFR: America; MSS: Asia/Australia; EFL: Europe/Africa). ARIDnet has five tasks: (Task #1) Paradigm-building– the DDP will be presented to the international community of desertification researchers, stakeholders, and policy-makers for a round of critical feedback, evaluation and refinement. (Task #2) Case studies– Working Groups will develop case studies throughout the world in order to test the DDP in a well-stratified, international, and comparative manner, with a specific focus on linking natural and social system function. These case studies will be based on existing data and specific stakeholders, and will represent a range of biophysical/socio-economic types from around the world. (Task #3) Synthesis– following the results of Tasks #1-2, a quantitative assessment of findings will be done in terms of what matters in desertification, when and where it matters, and why. (Task #4) Network building– one key goal is to recruit into, and foster the participation of a diversity of researchers in the activities of ARIDnet. (Task #5) Communication-- the development and maintenance of the ARIDnet website is currently underway (<http://www.biology.duke.edu/aridnet/>) to support Tasks #1-4.

Box. 'Land Degradation' is (partly) in the eye of the beholder



Is this gully "desertification"? One stakeholder group may emphatically conclude that the answer is 'yes!', while another may conclude (and with equal conviction) that the answer is obviously 'no!' We argue that the answer to this question depends on its context, specifically: the type of land involved (soil types, vegetation, soil fertility, etc.); its use history; a consideration of the views of the various stakeholders involved; and the spatial and temporal scales of concern. To illustrate, we present an example loosely based on studies by Shi and Shao in the Loess Plateau in northern China, which because of its long history (over 5000 years) of human activity—combined with its unique soil (deep loess) and climate—there has been intensive soil erosion. This has resulted in profound impacts on the ecological, social and economic structures in the region and not surprisingly "solutions" have been entrenched within these structures. In some

areas, visitors will immediately observe the large number of erosion gullies amongst grazing cattle and naturally conclude that they must be caused by overgrazing. In some instances this will be correct. Yet, a variety of alternative and equally plausible explanations exist: (i) natural phenomena (wind and water) produce erosion gullies; (ii) gullies, regardless of their cause, may have (in some cases) absolutely no effect on those things that concern human values, e.g., meat or milk production by cattle; (iii) even if the gullies are the direct result of overgrazing, the root causes are often complex (and vary with location), involving local government incentives, economic drivers, natural drought, etc.; and (iv) in those instances where erosion gullies are not a local concern, they may well be creating problems elsewhere (e.g., siltation and hence production losses downstream). In sum, what superficially appears straightforward may in fact be multifaceted, eschewing overly simplistic answers!

Shi H, and Shao M. (2000) Soil and water loss from the Loess Plateau in China. *Journal of Arid Environments* 45:9-20.

linkages between socio-economic and biophysical systems at different scales (see [10] and summary at <http://www.biology.duke.edu/aridnet/>).

The intent is that the DDP, while general, is specific enough to yield testable hypotheses that will help to move the debate on causal mechanisms of desertification forward. We expect that progress will stem out of attempts to apply this framework to particular systems that are different from the ones most familiar to us. To accomplish the latter, we have established ARIDnet (Assessment, Research, and Integration of Desertification research network). ARIDnet (Figure 2) is an initiative

on global desertification that emphasises the interdependencies of natural and human systems as mechanisms of desertification. It evolved out of our belief that there is a pressing need for new and creative interdisciplinary approaches for addressing the global problem of desertification, as well as for new thinking that transcends regional and disciplinary concerns. ARIDnet is a consortium of researchers from various global change projects on natural and human-influenced systems, including: the Center for the Integrated Study of the Human Dimensions of Global Change (CIS-HDGC, Carnegie Mellon University); the Inter-

national Human Dimensions Programme on Global Environmental Change (IHDP); and the GCTE and LUCC projects of IGBP. The general objectives of ARIDnet are: to foster international cooperation and exchange of ideas about desertification as summarized in the DDP; to open communication channels to foster more practical, field-level interactions with stakeholders in sustainable land management; and to use the concepts, experiences, and applications developed by participants to support on-going international discussions on the principles, criteria, and policies related to global desertification, and especially the CCD.

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