Journal of Arid Environments (1996) **33**: 309–320

A framework for tackling drought and land degradation

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(*Received 20 April 1995, accepted 10 July 1995*)

Environmental changes (purely physical changes) need to be distinguished from environmental problems (environmental issues that affect peoples lives). An environmental problem is a cultural construct and cannot be divorced from a particular economy and culture. Hence any study of, or proposal to, mitigate drought and land degradation must take account of land-use systems and the relationship between environment and society. A framework for understanding environmental problems such as drought and land degradation is suggested, which seeks a better definition of environmental problems.

Keywords: desertification; drought; land degradation; Sahel; environmental change; environmental problem

Introduction

The impacts of environmental change are likely to be most serious in the dry lands. This is not difficult to substantiate by historical analogy: the droughts of the mid-1980s produced millions of environmental refugees in Africa and this says nothing of the suffering of those left behind, or of the suffering in other less acute though still devastating events (Warren, 1993). Four major droughts have occurred in the west African Sahel this century, during the 1910s, 1940s, 1970s and 1980s (Nicholson & Palao, 1993). The last was the most severe, affecting, for example, at least half of Sudan's population (Olsson, 1993). Druyan (1989) suggested that by 1990 the cumulative impact of drought in the Sahel would have resulted in the deaths of hundreds of thousands of people with millions more displaced. Odingo (1992, p. 6) described the regional conditions as especially severe, noting that 'after a 20 year series of droughts, the Sudano-Sahelian region remained the most permanently vulnerable area and desertification had adversely affected the well being of some 80–85% of the population of the region'.

Over Africa as the whole, the U.N. Office for Emergency Operations in Africa (1986) estimated that 19 million people had been affected by drought and 3 million displaced. These statistics cannot, thankfully, be remotely realised by any other of Earth's environmental problems impacting in different climatic regions.

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Even if we somewhat temper our belief in them, the statistics are alarming. The UNEP Atlas of Desertification (1992) produced some dismal figures. It claimed, for example, that 70% of the agricultural land in the dry parts of the world were affected by land degradation; that one-sixth of the world's population was threatened by desertification; that each year 6 million ha of land was lost to production; and that this land was worth US$ 42·3 billion (1990 prices). Some 20% (1 billion ha) of the world's dry land area was believed to be experiencing some form of soil degradation. The area where terrain was not reclaimable (extreme degradation) or required major engineering works (strong degradation) was estimated to cover 0·138 billion ha or 14% of the total. Moreover, aridity was seen to be increasing for most of Africa's dry lands, and large areas of Asia and the Americas.

The approach to these problems by the United Nations Conference on Environment and Development (UNCED, 1992) included: strengthening the knowledge base and developing information and monitoring systems; developing comprehensive drought preparedness and drought relief schemes; and encouraging and promoting popular participation. But there will be major difficulties in achieving these objectives, not least as regards funding, for it is estimated that they would amount to $9 billion (globally), most of it needed in some of the poorest nations. Even if sufficient funding can be found, success is hampered by a fundamental obstacle: the confusion over the nature and causes of the problems.

Agnew (1989, 1991*a*), Agnew & Warren (1993), Binns (1990), Mainguet (1991), Thomas (1993), Thomas & Middleton (1994), Toulmin (1993), Warren & Agnew (1988), Warren & Khogali (1992) and Warren (1993) have pointed elsewhere to the way in which confusion has multiplied and obstructed the environmental cause in the dry lands. This paper seeks to summarise some explanations for the confusion and to suggest a framework for the analysis of environmental problems. The key issue is shown to be the failure to distinguish between environmental changes and environmental problems.

Environmental problems and environmental changes

It is useful to make two sets of distinction early in any discussion of the problems of the dry lands. First, there is the nature of the problems themselves: there are three main types: (i) drought: moisture supplied below average for short periods of 1–2 years; and (ii) desiccation: process of aridisation lasting decades; and (iii) land degradation: a persistent decrease in the productivity of vegetation and soils (Warren & Khogali, 1992). Each of these predicaments prompts different environmental strategies. Drought requires food storage and short-term relief; desiccation demands more radical measures such as resettlement and changing land-use patterns; while land degradation is more amenable to corrective and preventative measures.

The second set of distinctions is between environmental changes and environmental problems: (i) an environmental problem concerns the impact of the environment upon people, and the impacts of people upon the environment; and (ii) an environmental change concerns any change in a physically monitorable facet of the environment.

Environmental problems are cultural constructs and cannot be divorced from their particular economic and cultural setting. It is these rather than simple environmental changes that concern the people who attempt to make their living from the dry lands, and should be central to the international campaign. Yet most of the data on drought and desertification have concerned changes rather than problems. For example, of the over 200 listings in 1993 on the science and social science citation index (BIDS), two-thirds were concerned with the metabolic and physiological impacts of water stress upon crops, trees and ecosystems. Only a handful considered impacts upon society. A recent review article by Druyan (1989) divided research on the causes of drought in the

Sahel into studies of: interannual trends and periodicities of precipitation; its spatial patterns; synoptic conditions; statistical correlations and teleconnections; and General Circulation Models. No mention was made of increasing water demands or land-use changes. Gordon (1993) chose to regard drought in Australia as a purely climatological phenomenon, as did Hulme (1993) for the Sahel and Jury & Levey (1993) for South Africa.

The relationship between a change and a problem is usually assumed rather than demonstrated. More emphasis is needed on problems rather than mere changes. Studies of and strategies to alleviate drought and land degradation must take more account of relationships between the environment and society. We need, first to understand why the confusion between change and problem has arisen.

Areas of confusion between environmental changes and problems

The sources quoted in the introduction to this paper raise four main reasons why uncertainty clouds the discussion of environmental conditions in the dry lands: the paucity of data; confusion over definitions; inherent variability; and institutional inertia.

The paucity of data

Data are inevitably limited in sparsely populated and impoverished regions such as the dry lands. The problems of data collection on physical systems are exacerbated by the harshness of an environment in which dust, sudden storms or high temperatures can cause instruments to fail. Legates (1995) discusses the inadequacies of rainfall networks and notes that in global terms arid areas are under represented yet observes that the demand for accurate precipitation climatologies has increased over the last decade. The practical problems of establishing environmental monitoring programmes were listed by Izrael & Munn (1986). They saw them as: technological; lack of understanding of physical processes; cost; and inflexibility in modifying procedures and finances. There is also a lack of political commitment to long-term environmental monitoring, the cost of which is probably prohibitive unless more assistance is found from international agencies. Furthermore, the distribution of data that have been collected can be interrupted by conflict and a lack of funds as shown by the reduction in the number of rainfall stations providing data in the Sahelian region of Africa through the 1970s and 1980s (Farmer, 1989). A more detailed analysis of rainfall data availability in the Sudan by Hulme (1990) revealed a decline in rainfall stations from around 500 in the 1950s to less than 100 by the 1980s. For Africa as a whole, Hulme (1992) calculated that from a possible list of over 2000 stations, only 30 had a complete record of monthly rainfalls between 1931 and 1990 and the spatial coverage was poor in the arid regions. The UNEP's (1992) analysis of rainfall trends in the arid areas of north-east Brazil and north China also shows a recent decline in rainfall data availability.

Data on desertification are even more unreliable. Rates for the southward advance of the Sahara have been severely questioned (Ahlcrona, 1988) and in 1991 Mainguet (p. 15) wrote, 'The theory of an encroaching desert, which has now been scientifically rejected, is still a fixed idea in the minds of governments, donors, and journalists; this much change'.

UNEP data on desertification have been repeatedly criticised as being too loosely defined and collected to be of anything but publicity value (see Binns, 1990; Hellden, 1991; Agnew & Warren, 1993; Thomas, 1993; Thomas & Middleton, 1994). Rozanov (1990, p. 52) states, 'There is no consensus at present concerning the status of

desertification in the world as a whole or in its various regions'. However this has not stopped the publication of numerous data on the global threat of desertification, recently culminating in the UNEP (1992) Desertification Atlas.

When information is inadequate confusion abounds and misinterpretation occurs. Webb (1993), examining drought and food supply in Ethiopia, noted that the scarcity of sound information on households led to the (mistaken) view that households and household strategies were largely uniform. Olsson (1993) questioned the reality of the statistics for high death rates from drought and famine reported for Sudan in the 1984 drought and elsewhere in the Sahel in the 1970s. The figures, he felt, had been exaggerated by the media and scientists. Kelly & Buchanan-Smith (1994) noted that aid donors had begun to accept that death rates had been exaggerated but that this had the effect of famine going largely unnoticed in the 1991 Sudanese drought because of growing scepticism and the lack of adequate monitoring systems.

Confusing definitions

The definition of desertification and land degradation are too numerous to list here, and have been reviewed very adequately elsewhere (Glantz & Orlovsky, 1983; Verstraete, 1986). One of the main confusions have been the distinction between changes and problems outlined above. There has been a vain demand in the agencies for scientifically measurable criteria (comparable with those that are measures of global warming or biodiversity), without the acknowledgement that the environment is interpreted and made use of in many different ways. Environmental impacts are functions not only of mere physical changes, but also of the ability of an economy or culture to withstand those changes. Different definitions are inevitably attached to different stake-holders. The resulting conflicts and confusions have produced constantly shifting sets of definition, between definitions that exclude climatic deterioration and emphasise mismanagement, and those that put the emphasis the other way around. Needless to say, the confusion of definition has had a major role in the inability of institutions to respond to the problems concerned. For example Cardy (1993, p. 5) noted that in 1991 the UNEP took desertification to be, 'land degradation in arid, semi-arid and dry subhumid areas resulting mainly from human activities', thus implicitly excluding secular climate change. A year later at the Earth Summit (UNCED, 1992) the definition of desertification became, 'land degradation in arid, semi-arid and dry subhumid areas resulting from various factors including climatic variations and human activities'.

The problem of definition extends also to drought (Yevjevich *et al.*, 1977; Copans, 1983). Here too, some definitions consider only physical environmental changes (meteorological and agricultural drought); others consider environmental problems such as the impacts upon a land-use system or society. Agnew & Anderson's (1992) review showed there to be a number of definitions. A 'meteorological drought' is said to be 'a period of at least 15 consecutive days without 0·1 mm of rain in any one day'; or 'drought occurs when rainfall is less than 80% of normal levels'. An 'agricultural drought' is said to be 'a period of dry weather of sufficient length and severity to cause at least partial crop failure'; or 'when soil moisture is depleted so that the yield of plants is reduced considerably'. A 'socio-economic' drought is said to be 'a water shortage which adversely affects the established economy'; or 'a period in which moisture availability falls below the current requirements of some or all living communities in an area; or 'drought that is a condition of moisture deficit sufficient to have an adverse effect on vegetation, animals and man over a sizeable area'.

If drought is seen as purely a meteorological event (e.g. Palmer, 1965; Beran & Rodier, 1985) then the causes are sought in climatological conditions and processes, as demonstrated by discussions for more than 20 years on climate change in the Sahel

region (Hulme & Kelly, 1993). If drought is defined in terms of water supplied to a community, then possible causes also include changes in demand, perhaps brought about by land-use intensification or population increase. The type of definition employed then prejudges the causal factors which are used to explain the environmental problem. If only physical definitions are used then only physical causes may be investigated.

Temporal and spatial variability

The variability of hydrological systems in semi-arid environments, though sometimes debated, is now well established (Sharon 1972; 1981; Jones, 1981; Rodier 1985). To be understood, however, variability must be seen not merely as a series of changes, but as a series of impacts upon communities. One aspect of analysing temporal dry land variability and establishing changes, concerns the difficulty of determining environmental 'norms'.

Figure 1 shows the impact of declining rainfall over the last 20 years upon flow in the River Senegal. The meteorological droughts of the 1910s, 1940s and 1970s are clearly identifiable. The data in Fig. 1 have been produced using deviations from the mean discharge calculated for the period 1931 to 1960. Figure 2, however, employs a mean calculated over the more recent period which suggests that the 1950s and 1960s were an abnormally wet period. As data are only available at different locations for a variety of periods of observation, it is difficult to establish regional averages. Asking the questions, 'which period is wet, which is dry, which is normal?' misses the more fundamental questions: 'which period have local communities adapted to?' and 'are they able to respond to recent environmental changes?' Changing the period over which means are calculated and choosing different thresholds from which to judge 'abnormality' in the physical system may be a statistical exercise of interest to environmental scientists, but may have little relevance for the inhabitants of dry-lands.

The dry-lands are spatially very variable, both in social and physical terms. Yet there is a tendency to treat huge regions as being homogeneous, to aggregate data and to generalise over conditions. The rainfall analysis in the Atlas of Desertification (1992) showed Sahelian rainfalls as experiencing a substantial decline since the 1970s. Yet

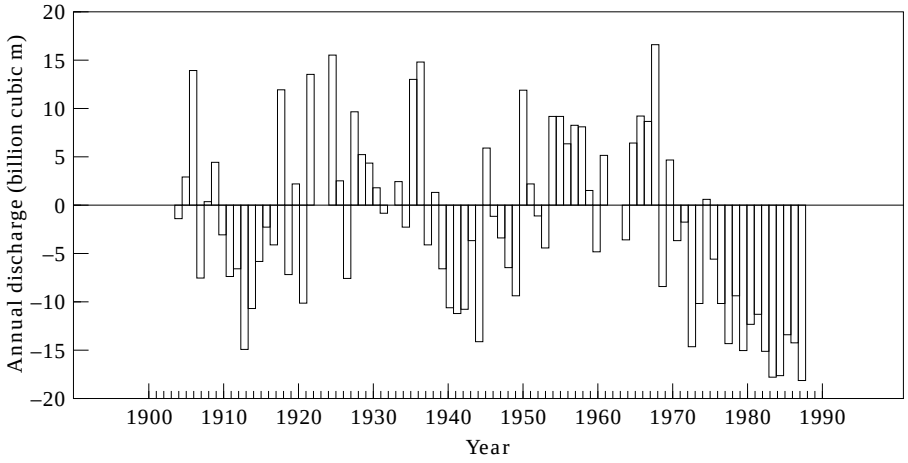

Figure 1. Annual departures from mean discharge of River Senegal at Bakel (mean calculated 1931–1960).

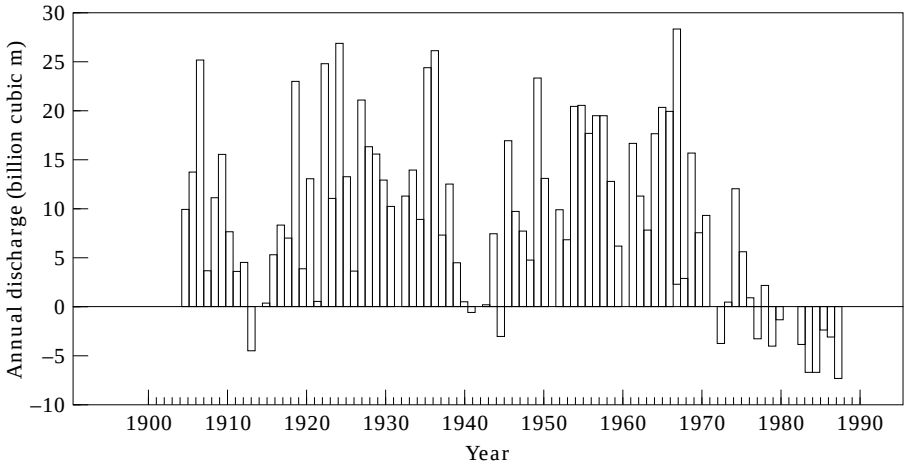

Figure 2. Annual departures from mean discharge of River Senegal at Bakel (mean calculated 1970–1987).

Figs 3 to 5 indicate that for individual stations rainfalls display quite different trends. Agnew (1990) showed the marked spatial variability of meteorological drought in the 1970s, and more recently Nicholson & Palao (1993, p. 386) noted 'The Sahel cannot be treated as homogeneous with respect to rainfall variability'.

They went on to segregate three distinct climatic regions. Just as physical environments undergo change, so do social systems. Allan & Warren (1993) noted that the proportion of dry-land inhabitants in the Middle East and northern Africa following a nomadic lifestyle had fallen from over 20% in the 1950s to less than 3% by 1990. Gilbert White's call in the 1960s for arid land scientists and planners to recognise spatial heterogeneity has been largely ignored: 'No two points of the arid

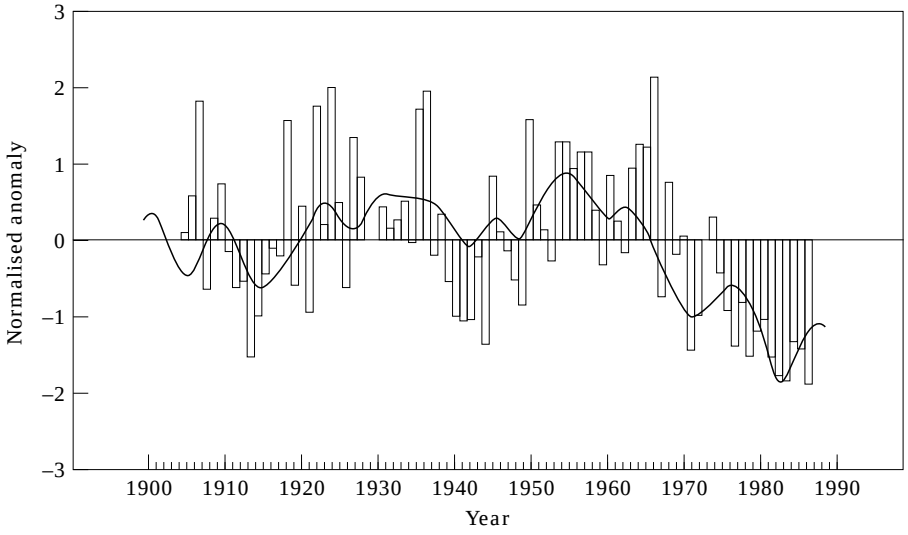

Figure 3. Climate trends for the Sahel. (□) = discharge of River Senegal at Bakel (mean calculated 1904–1987); (–) = Sahelian rainfall (based on U.N.E.P. 1992).

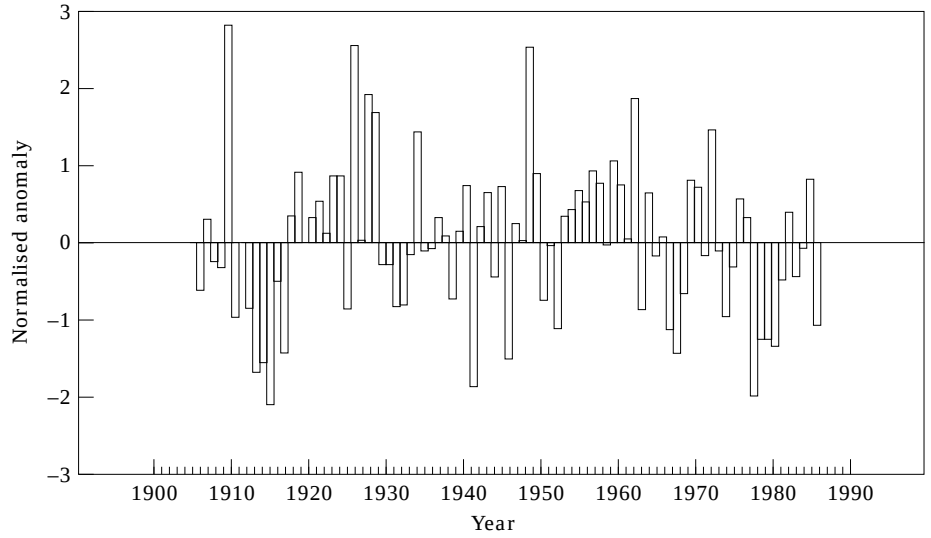

Figure 4. Annual rainfall departures at Niamey, Niger using a mean calculated from 1904–1993 (recent data from Climate Research Unit, University of East Anglia).

zone are alike in all respects: each has its own unique combination of terrain, soil, vegetation, and moisture.' (from Kates & Burton, 1986, p. 127).

Much still needs to be studied on the spatial variability of dry-land environmental systems. Regional averages should be treated with caution and 'snap shots' of dry-land change avoided. There is, however, no lack of initiatives and it is hoped that projects, such as ROSELT (1994), to undertake long-term ecological monitoring in the Sahel will provide much needed baseline data.

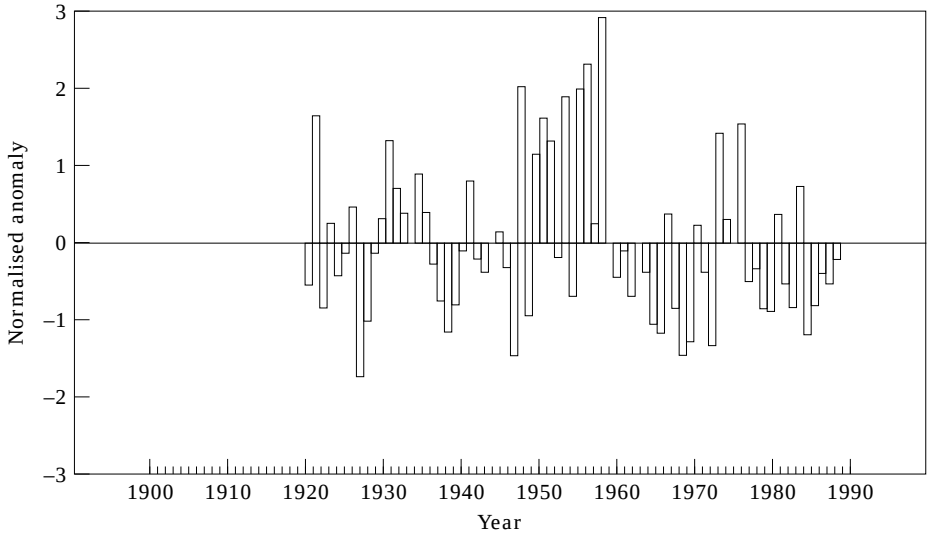

Figure 5. Annual rainfall departures at N'Guigmi, Niger using a mean calculated from 1921–1993 (recent data from Climate Research Unit, University of East Anglia).

Institutionalisation

An increasingly serious problem in dry-land management has been the institutionalisation of their environmental issues (see Asmerom, 1994 for a review of the institutions involved in desertification at regional and international scales). The United Nations Conference on Desertification in 1977 called for a set of institutions, such as funding mechanisms, assessment systems, and plans. These institutionalised and maintained the momentum of poorly developed conceptualisations of the issues as demonstrated above in the continued use of unwieldy and confusing definitions.

As perceptions have changed, these mechanisms seem increasingly dated, and have become one of the most serious obstacles to progress. One facet of the problem that was only accepted in UN thinking after the UNCED conference at Rio de Janeiro, was the issue of the long drought of the 1970s and 1980s. Until then, the UNEP's definition of 'desertification' had steadfastly excluded climatic causes of the problem, and concentrated attention of the notion that the main issue was environmental mismanagement. Even the synergy between drought and mismanagement was thus sidelined.

Another issue that became deeply entrenched in institutional thinking, and illustrates its problems has been 'overgrazing'. Range management authorities and central planners of all kinds were until very recently working on ecological and anthropological models of pastoralists and grazing ecology that were derived from the 1930s. There was mutual support between the scientific paradigm and the institutions whose planning was predicated on it. The change to a new ecological model of 'instability but persistence' and a new view of pastoralists as efficient, communally organised opportunists has come about in an almost classic kuhnian paradigm shift. Drought is again being seen as more damaging than overgrazing; the paradox is that drought may often preserve pastures against overgrazing by killing stock or forcing them to migrate (Ellis & Swift 1988; Westoby *et al*., 1989*a*, *b*, summarised in Warren, 1995; Behnke *et al*. 1993). Individuals, some even from within the institutions, have had serious doubts about the validity of the older paradigms (Sandford 1983; Nelson, 1988), but have been unable to break away from the rigid definitions imposed by the institutional framework.

A new framework for approaching dry-land management

The following framework can be called 'EPOCHS'. It is a sequence of analytical steps:

Environmental conditions
Problem definition
Occurrence (intensity)
Cause
Help/Solution

The starting point must be an understanding of the environmental conditions, remembering that the environment is highly variable in space and time. Only then can an environmental change (drought, desiccation, or land degradation) be identified and related to local communities (problem definition); and the intensity and duration determined (occurrence). Appropriate solutions or other types of help/assistance can only be effectively marshalled when the cause is established; the cause can only be assessed when the incidence and type of environmental problem is known; and this in turn requires effective environmental monitoring and understanding of environmental processes.

The need for rigorous assessment can be exemplified by recent drought reports.

Drought is brought about when water availability drops below some threshold for a specific economic activity or ecosystem. This can be due either to a fall in supply or an increase in demand. Lower rainfall is only one possible cause of drought.

An 'agricultural drought' has been defined as 'refer[ing] to any combination of restricted water supply (e.g. as a result of low rainfall or poor water storage) and/or enhanced rate of loss (resulting from high evaporative demand) that tends to reduce plant productivity' (Jones, 1992). Such a drought can be caused in one of two ways: by decreasing the moisture supply to plants; or by increasing the demand for water. A decrease in supply could occur because of: abnormally low rainfalls; reduced inundation; falling ground-water table; increased surface runoff; increased salinity; soil degradation. An increase in the demand for water could happen in one of three ways: the introduction of new, more water-demanding crops; by new systems of mixed cropping or multicropping; or by the introduction of irrigation systems.

When a comparison is made between the incidence of drought brought about by a decline in rainfall (meteorological drought) and the amount of moisture in the root zone of a millet crop (agricultural drought), some of the confusion over drought in the Sahel can be explained (Agnew, 1991*a*,*b*). Pastoral, northern areas of the Sahel appeared to have been experiencing an extensive phase of meteorological drought (although observations are scanty), while farmers in the marginal lands to the south had been affected by agricultural drought. Moreover, since agricultural (millet) drought was shown to have been rare in the traditional millet growing region, attempts to explain declining yields might better look to soil degradation and land-use practices. By extension of this argument, there could also be more judicious use of the words 'desertification' and 'land degradation' and this would greatly help to reduce much of the confusion over their incidence and causes.

Thus, dry land environmental problems can be caused as much by changes in land-use (not necessarily 'mismanagement'), as by environmental change. For example, the increase in the area of cultivation for cash crops, more extensive use of irrigation, and the switch to non-indigenous crop species such as maize may be one of the main causes of the greater incidence of agricultural drought in Africa. Higher population density may have decreased the flexibility of land-use systems to accommodate cultivation, and thus created as great a problem as decreased rainfall or increasing erosion.

These are not easy questions. There is a need for much more analysis of long-term adaptations to environmental changes and Webb (1993) calls for more understanding on how different levels of society are able to respond to environmental changes. But, with notable exceptions (Mortimore, 1988, 1989*a*, *b*; Mace & Houston, 1989; Mace, 1990), this work has not been widely undertaken. But just as there is a danger of ignoring the importance of human responses, there is also a danger of ignoring the underlying physical environmental conditions. This should be avoided if the EPOCHS framework is followed.

Conclusions

Following at least two decades of growing concern over the occurrence of drought, desertification and climate change in the dry-lands there is now a sceptical back-lash in which the incidence and impacts of such environmental problems are being questioned. Agnew (1995), Agnew & Warren (1993), Binns (1990), Hellden (1991), Thomas (1993), Thomas & Middleton (1994) and Toulmin (1993) criticised the collection and interpretation of much of the evidence of desertification and questioned the reliability of many of the aggregate statistics. Olsson (1993) was more forthright, dismissing the 'pseudo-scientific debate on desertification' which he believed had undermined real analysis of the causes of human suffering. Norse (1994, p. 134) goes even further in suggesting that 'food insecurity has stemmed from institutional factors'

rather than the threats from environmental degradation, population growth, climate change and economic growth.

The irony in these analyses is that they show the difficulty of managing the dry-lands, one of which being their complexity, is leading to a disregard for their problems. The further irony is that it is these difficulties and complexities that make some of the dry-lands the poorest on earth, and adds to their powerlessness in a world that is obsessed with much less tangible environmental issues. A new approach is clearly needed, and an approach that stresses the interactions of people with their environment, rather than one that regards the environment mechanistically. Highlighting this need in the dry-lands may introduce a more sympathetic approach to environmental problems in the rest of the globe. Following the Earth Summit in 1992, the Convention to combat Desertification (Speth, 1994; Westing, 1994) offers a new start on this road. Due to come into force early in 1997 (Toulmin & Brahimi, 1995), the Convention to combat desertification links the processes of land degradation to the social conditions of local communities (Anon, 1994; Iles, 1995) and thus emphasises the need for participatory development. It is hoped that the opportunity will be taken.

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