When is ecosystem change land degradation? A reply

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The studies of Perkins and Thomas (1993a,b) and Dougill (1995) in the eastern Kalahari have demonstrated that, as in many other semi-arid rangeland areas, bush encroachment represents a significant environmental response to pastoral intensification. Field surveys showed that a number of different *Acacia* species (notably *Acacia ataxacantha* and *Acacia erioloba*), as well as *Dichrostachys cinerea*, *Maytenus heterophylla* and *Terminalia secricea* are now prevalent in the region. At Uwe Aboo, the focus of our paper, the encroaching bush is primarily made up of *Acacia ataxacantha* – a species which shares many of the basic characteristics of *Acacia mellifera* which Martin Adams describes. Several of his points are worth taking up.

Firstly we would take issue with ... Adams' discussion is based on the pretext that 'the process involved in the spread of thickets, and the methods required to control them, are reasonably well understood.' But we do not share this view. To us it appears that the precise mechanisms causing bush encroachment remain only partly understood – and even Adams admits (page 1) that the 'role of environmental factors determining temporal and spatial changes in the physiognomic character of savanna vegetation (*i.e.* tree/grass ratio) is the subject of continuing debate.' Within this debate the most significant and recent ecological reviews (*e.g.* Frost *et al.* 1986; Walker 1987; Belsky 1991; Scholes and Walker 1993) have continued to stress the important role of soil hydrochemical characteristics (notably water and nutrient availability) in determining the nature of ecosystem structure changes. Adams' insistence that 'in the case of bush encroachment, preoccupation with soil processes is something of a digression' (page 1) therefore seems rather at odds with current thinking.

Work in the Kalahari has shown the resilience of infertile sandy soils to changes in profile patterns of soil water and nutrient availability.

Adams rightly points out that vegetation changes are not necessarily reversible, just because soil factors have remained unchanged. But the Sudanese (Adams 1967) and Serengeti examples quoted by Adams suggest that processes of ecosystem change associated solely with interactions of fire and herbivory are typically 'noticeably less persistent' (page 4).

This statement reiterates our main point – that only without deleterious impacts on soil hydrochemical characteristics can management strategies, based on the control of herbivory regimes or the use of fire, be implemented successfully.

The use of basal stem burning to control and eradicate *Acacia* encroachment, whilst offering a valid means of control, does not offer a strategy that would be readily employed in the low population density areas of the Kalahari. These areas are increasingly typified by absentee land owners (Tsimako 1991) who have a

limited input into management decisions, with cattle numbers remaining dependent on rainfall conditions and their influence on the number of cattle deaths (Vossen 1990; White 1993). Indeed bush encroachment is often viewed favourably by local residents as it provides fuelwood for borehole residents and controls the spread of intense fires (probably due to less continuous herbaceous biomass cover) (Perkins 1991). Favourable effects of bush encroachment on the scale presently seen (rarely extending beyond 1500 m from a borehole) are also predicted to occur in a pastoral sense because of the increased heterogeneity provided in fodder resources.

Scoones (1995) has coherently linked maximum sustainable pastoral production to the heterogeneity of fodder resources. Therefore it is maintained that in an area such as the Kalahari, where negative effects of bush encroachment are yet to be recognised in terms of pastoral production figures (White 1993), pastoral management should be concerned with the prevention of continued expansion of bush encroachment which could lead to the convergence of bush-dominant areas, as opposed to the eradication of bushes already present. To achieve this general aim it is essential that a greater ecological understanding of the interactions between inherently variable non-biotic factors (notably rainfall variability and fire regimes) and controlling biotic factors (including soil characteristics) is provided. In this regard the studies outlined in our initial paper simply represent the first stage of ongoing research in the area that seeks to explain temporal and spatial patterns of bush encroachment expansion. Examination of the temporal expansion of zones of bush encroachment will hopefully provide a much clearer understanding of the roles of drought events, good rainfall years and fires in contributing to the expansion of bush-dominant areas. These studies will also provide a greater insight into the interactions between the disequilibrium factors affecting savanna ecosystem form on a short temporal scale and longer-lasting changes, such as bush encroachment.

Bush Encroachment as Land Degradation?

The argument that bush encroachment in the Kalahari does not represent land degradation is a familiar one (see, *inter alia*, White 1993; Abel 1993; Dahlberg 1993) and one that we would stress is confined mainly to this particular region. It differs greatly from the conditions reported in Namibia by Adams where he states that average stocking rates have declined by 75 %. The soils-based data presented in our initial paper is simply used to support previous studies based on the lack of any decline in pastoral production in the Kalahari (White 1993), and the possible reversibility of ecological changes, due to the existence of 'pronounced shrub die-back' (Perkins and Thomas 1993:189) following drought events and intense fires. The existence of such ecological die-back mechanisms was supported by field observations in the study area, suggesting that all *Acacia* species do not possess the resistance to destruction by drought, fire or herbivory described by Adams for *Acacia mellifera*. Ecological evidence at the study site also suggests that bush encroachment may provide ecological resilience, in that sub-canopy areas (typified

by increased water and nutrient availability and protected from grazing due to the impenetrable thorny cover) retain high herbaceous biomass throughout the dry season. This ensures the existence of a healthy seed bank resource for grass species helping to maintain the co-existence of these two characteristic vegetation forms, so important in providing semi-arid ecosystems with resilient pastoral production systems (Scoones 1995).

To say that our views on land degradation are based solely on the fact that soil properties have remained unchanged is to over-simplify our case. Instead, our conclusions stem from a mixture of pastoral production data (White 1993), ecological observations (Perkins and Thomas 1993a,b), as well as from our own soil-based investigations.

Conversely, studies are designed to provide a new perspective supporting previous studies that have concluded that thus far pastoral practices in the Kalahari have not caused land degradation.

The importance of these findings links closely to the widely used definitions of land degradation, which in its broadest sense can be defined as 'a *persistent* decrease in the productivity of vegetation and soils' (FAO 1979; Warren and Khoghali 1992); or more precisely, as defined by Abel and Blaikie (1989), 'an *effectively permanent* decline in the rate at which land yields livestock products under a given system of management.' Incorporation of concepts such as persistence or permanence into these definitions, whilst theoretically justified, creates difficulties with application in semi-arid ecosystems typified by great natural variability and ecological change. It is in this regard that the authors maintain measures of the main determining factors which control vegetation productivity and community structure during growth pulses (namely soil water and nutrient availability) are of great importance in assessments of land degradation. This is especially true given that herbaceous biomass measures are directly affected by increased grazing, even if the growth rate of grasses remains unaffected by grazing pressure.

Control of Bush Encroachment

The Namibian case study outlined by Adams clearly states the possible negative implications of bush encroachment on pastoral stocking rates. Whether such effects will occur in the Kalahari remains to be seen. However, the expansive nature of bush encroachment in the Kalahari has been observed (Perkins and Thomas 1993a), although the timing of expansion or possible suggested natural control measures (fire and/or drought) have not been fully explained. The expansive nature of bush encroachment implies that if borehole density continues to increase more uniform stands of bush-dominant land would be created and consequently pastoral

production figures affected, due to the loss of ecosystem heterogeneity. Given the cost and labour intensive nature of basal stem burning practices, it remains the case that pastoral management strategies of this region should attempt to control further borehole drilling that could disturb the present balance of bush-dominant and grass-dominant areas. Cost implications of borehole drilling practices (often unsuccessful due to salinity problems), the losses resultant in pastoral production due to the decreased heterogeneity of fodder resources (Scoones 1995), and the control measures required when impacts on cattle production are noted need to be produced and publicised. In this regard, it is essential to incorporate information from other regions (a number of which Adams alludes to). However such information should be closely tied to the conditions experienced in the Kalahari. At present, it remains that ecological change has not (as yet) led to land degradation, but that careful management is required to maintain ecological diversity and with it the most economically productive sustainable pastoral resource.

Warnings over the need to limit borehole density remain given that this is main factor that could reduce the heterogeneity of the fodder landscape, assigned as the key factor causing the maximum pastoral utilisation of rangelands in both wet and dry years (Scoones 1995). Evidence from other areas suggests that increased borehole density will not equate to increases in profitability. This point can be argued from either equilibrium or disequilibrium standpoints and needs to be clearly stated to pastoral managers working in the area.

These conclusions remain specific to the Kalahari, which due to the recent pastoral exploitation and inherent ecological resilience mechanisms is yet to subjected to widespread land degradation. It is surely a great test for ecologists and range managers alike, to apply the improved ecological understanding and management experiences from other areas, to avert the widespread bush encroachment problems encountered elsewhere.

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In his response to our initial discussion in Paper 38c, Martin Adams raises a number of important points. Whilst this reply seeks to explain and clarify certain issues raised, we maintain that it is crucial to recognise the need for explanations of bush encroachment to be incorporated into 'new' ecological theories based upon disequilibrium concepts. In this regard, the comments of Adams are warmly

welcomed in demonstrating some of the difficulties involved in the dialogue between ecologists and mainstream pastoral managers still employing equilibrium based strategies.