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Responses to RANGE DEGRADATION IN BOTSWANA: MYTH OR REALITY? (Paper 35b) by Joao S. de Queiroz

CARRYING CAPACITY, RANGELAND DEGRADATION AND LIVESTOCK DEVELOPMENT FOR THE COMMUNAL RANGELANDS OF BOTSWANA
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THE DEGRADATION DEBATE:
IS CLARIFICATION POSSIBLE?
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COMMENTS
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CARRYING CAPACITY, RANGELAND DEGRADATION AND LIVESTOCK DEVELOPMENT POLICY FOR THE COMMUNAL RANGELANDS OF BOTSWANA

Nick Abel

INTRODUCTION

A useful debate is developing over carrying capacity and the degradation of communal rangelands in sub-Saharan Africa (Behnke et al. 1993). With a few lonely exceptions (e.g. Sandford 1983), scientists and policy-makers have in the past claimed that degradation is universal and livestock productivity lowered because of overstocking on communal range. This position has been mainly dogmatic. More recent research has not supported dogmatists (e.g. O'Connor 1985, Behnke et al. 1993, Biot 1993, Abel 1992, 1993); hence the debate, which impinges on livestock development policy in Botswana.

A new livestock development policy is being promoted by the Government of Botswana (Ministry of Agriculture 1991). This aims to privatise extensive areas of range, fence it and set stocking rate to 'carrying capacity'. This policy would, if it meets its aims, affect livelihoods, nutrition and livestock exports as well as ecological systems. Unfortunately it is written in apparent ignorance of the debate, and rests on old dogma. White (1992) challenged the policy on its biological, ecological, social and economic assumptions and effects. In a current Pastoral Development Network Paper, de Queiroz while agreeing that the new policy would carry a high social cost, argued that White had ignored the reality of range degradation in Botswana. He also claimed that there was no basis for White's statement that de-stocking would decrease the productivity of rangeland. This interchange is a fruitful development of the debate, which I join in an attempt to clarify it.

Confusion in the debate arises from the role of science in providing evidence and proof, conflicting theories of degradation, differences between definitions of degradation, assumptions about thresholds of degradation, and over the estimation of the impacts of stocking policy. I shall deal with these points in turn.

IDEOLOGY AND THE ROLE OF SCIENCE

I assert that policy-makers seek evidence to support their political agendas. They want proven evidence, and they wish to disprove the positions of other political groupings. It is my view that the carrying capacity concept, and the stocking density recommendations which stem from it, have been seized upon by the emerging middle class of Botswana as a justification for the privatisation of rangeland. Conservation and certain productivity arguments happen to coincide with, and are therefore employed to back policies which have their origins not in science, but in ideology. Part of this ideology is belief that the commercial ranch is more productive than the 'traditional' communal agro-pastoral system. Groups opposing this position identify with the peasant farmers who would be harmed by privatisation. Science is also used to support their case. But de Queiroz notes the limitations of science - it can provide only tentative understanding, never proof. When contradictory advice is offered by science, the reason is not necessarily the incompetence nor even the dishonesty of scientists. There are two more fundamental causes. One is the inability of any human to be perfectly objective - our assumptions, and what we see, are conditioned by our past, personalities and politics. The second cause is intrinsic to nature - the complexity and unpredictability of natural systems makes firm conclusions untenable. It follows that rigorous testing of hypotheses should replace rhetoric, that modelling is a fruitful way of exploring technical and policy issues, and that debate should replace dogma in the construction of policy.

THEORIES AND DEFINITIONS OF DEGRADATION

As de Queiroz pointed out, the diagnosis of degradation has in the past relied on a discredited theory of vegetation change. Using a circular argument (Abel 1992), range scientists have asserted that there is an ideal successional stage at which the vegetation could and should be held by adjusting the stocking density and timely burning. The theory on which range science and the carrying capacity concept have rested until now is classical succession (Clements 1936). This theory does not work where rainfall is highly variable, mainly because this variation is more important than stocking density in determining the composition, structure and productivity of vegetation in these circumstances (O'Connor 1985). An alternative 'state-and-transition' model has been proposed by Westoby et al. (1989). In Botswana, succession theory promoted by Field (1977, 1978), is entrenched in the ideology of the public service and continues to influence policy. Range degradation is consequently seen as: i) a shift in herbaceous species composition from perennials to annuals, and from more to less palatable species; ii) a decrease in cover and litter; and iii) an increase in bare ground and soil loss. In a modification of the theory, an increase in woody plants is also seen as degradation.

Any change in the density of a herbivore population will cause changes in these factors. The standing biomass of vegetation is related inversely to that of herbivores (Caughley 1979). Cattle numbers have increased in Botswana from less than 200 000 around the turn of the century, to nearly 3 000 000 by 1980. Small-stock have also increased (Arntzen 1989). Vegetation biomass, cover and structure are bound to have changed. Those who define degradation in these terms (e.g. Ringrose and Matheson 1986) will find it wherever herbivore numbers have increased. But this tautological definition has no ecological meaning, does not consider the reversibility or otherwise of ecological change, and since it takes no account of changes in productivity, does not contribute usefully to management or policy-making.

A more useful definition of degradation has been proposed by Abel and Blaikie (1989). In this definition degradation has occurred only when there has been an effectively irreversible decline in the rate of output of livestock products from the range under a specified system of management. Degradation is not defined in terms of its symptoms. The ground may be barer, but if the range still produces the same output per unit area, degradation, *for that system of management,* has not occurred. De Queiroz accepts this argument at the beginning of his paper, but subsequently contradicts it, as I shall show.

Major confusion in the debate arises when proponents of different land uses argue about the existence or otherwise of degradation. This is why it is necessary to define degradation in terms of a specified system of management. That means specifying the land use too. Land may be heavily degraded for purposes of nature conservation or wildlife utilisation, but unharmed for livestock production. Thus both sides in an argument may be correct, but they are arguing about different things. Cattle-keeping may well degrade the Kalahari for the purposes of wildlife conservation and management, assuming some of the changes are irreversible, but it does not follow that it is degraded for livestock production. There cannot be one definition of degradation encompassing all human objectives and all land uses.

A related source of confusion is the effects of one land use on others. A rangeland system may not be degrading in terms of the objectives of those who manage it, but it may be causing degradation in terms of some other use of resources. Thus the stocking strategy of a particular livestock system may be permanently affecting the quality or quantity of water for downstream users. For the purposes of livestock production the range may not be degrading, but in terms of water management, degradation is occurring.

De Queiroz confounds the argument by invoking postulated changes in the cycling of phosphorus in a wildlife system as evidence of degradation in the livestock system. It does not follow that a change in the distribution of phosphorus from accumulation in depressions in a wildlife system, to accumulation around boreholes in a livestock system, will cause a decline in the productivity of the latter.

The approach I advocate - defining degradation in terms of specified objectives of resource use - requires the analyst to distinguish, as de Queiroz failed to do, between causes and expressions of degradation. Ultimate causes are linked in a 'chain of causation' (Blaikie and Brookfield 1987) through intermediate processes to the expression of degradation in terms of an irreversible decline in the ability to meet objectives. De Queiroz attempts to define degradation in terms of changes in processes. This is not useful.

The usefulness of Abel and Blaikie's definition is that it enables the debate about degradation to be structured according to sectoral interests. Thus livestock interests would form one group, wildlife conservation interests another, water supply interests a third and so on. Analysis of the interests of each group requires a different approach, and is best conducted initially in a separate forum. By this means, confusion over objectives and definitions is reduced. Conflicts among the groups are best resolved once sectoral issues are clarified.

THRESHOLDS OF DEGRADATION

The conventional view of degradation is tied to the notion of 'carrying capacity'. This coincides with the stocking rate which does not cause degradation. The implication is that when density is at or below carrying capacity land does not degrade. When carrying capacity is exceeded, degradation begins. There is, with an important exception, no theoretical or empirical justification for this view. I will discuss this exception after examining the relationship between stocking rate and the rate of degradation.

Biot (1988) has demonstrated that the herbaceous productivity of a granitic landscape in eastern Botswana is likely to decline even in the total absence of herbivores. This is because, like many other semi-arid landscapes, it formed under a moister climate. Biot (1993) modelled the decline in herbaceous productivity for a range of stocking densities, and found no threshold that could be equated with a carrying capacity. He predicted instead that the rate of degradation increases smoothly and non-linearly with stocking density. Eastern Botswana is degrading whatever stocking decisions are made. The solution is not therefore to seek a so-called 'carrying capacity', as advocated in the new agricultural policy (Ministry of Agriculture 1991), but to decide on a rate of degradation that is socially acceptable. The concept of 'option value' (Pearce and Turner 1990), is useful here. Before discussing it, I will examine the exception to my earlier statement that there is no threshold of stocking density that can be equated with a carrying capacity.

Of the variables which determine rates of soil loss from range, the one most easily managed is herbaceous cover. A negative exponential curve describes the decline in soil loss with increasing cover. The point of maximum curvature is around 35-40% cover. As cover falls below this, the rate of soil loss increases exponentially (Abel 1993). Above it, the rate of soil loss is

relatively insensitive to cover. This relationship is a better criterion for settling stocking densities than the moving target of species composition.

I return now to the concept of the option value of a range. This is the value to future generations of using it in some unspecified way. We cannot know the value of an unspecified use to unborn generations living in a changed economy and environment. We can, though, estimate the 'option cost', the amount, discounted over time, which present generations must sacrifice to prevent the degradation of a resource and impairment of its option value. (Degradation must necessarily be expressed in terms of current land use, for the reasons already given). The 'correct' stocking density is the one which present generations are prepared to accept, with a view to maintaining option values; this decision is an ethical one, with two technical inputs. One is from models of land degradation, and the other from estimates of the costs of de-stocking. Abel (1992) applied this approach to a study area west of Mahalapye in eastern Botswana, and estimated that a move from current stocking densities to recommended rates (Field 1977) would cause a large fall in the value of outputs. This sacrifice is estimated to extend the life of the more erodible soils from around 500 to well past 1000 years. Soil life is defined here as the length of time for which that soil is able to produce grass. These soils covered some 5-6% of the 'hardveld' (soils of non-aeolian origin) in the 2700 km^2 study area. Other soils in the study area were generally much less erodible, and de-stocking is, according to the model used (Biot 1993), expected to have little effect on the length of their lives. The recommended stocking density is therefore likely to be unacceptable to current land users, and some higher level needs to be negotiated; the range of possible stocking densities should include the current one.

As White (1992) points out, stocking density is not the only, nor necessarily the most important consideration. Stocking strategy concerns the variation of stocking density in accordance with ecological and economic variations. A recent paper in this series (Hocking and Mattock 1993) discussed a practical approach to this. There is some evidence that rates of degradation could be slowed through strategic stocking, without reducing average stocking density. This approach was recommended by Abel et al. (1987). It is radically different from the 'carrying capacity' figures proposed under the new agricultural policy. It can extend over different timescales, and should do so to adapt if needed to climatic or other environmental changes (McKeon et al. 1993).

ESTIMATING THE IMPACTS OF STOCKING POLICY

Dogma has been the basis of most estimation of the effects of stocking density on livestock productivity in Botswana. It has been the consistent assumption of policy makers that livestock productivity increases if density is reduced. Rennie et al. (1977) provided support for this view. They compared the productivity of communal-area and research-ranch cattle, and found the former to have much lower mass gains per livestock unit. As Behnke (1985) and de Ridder and Wagenaar (1986) showed, if milk and draught power are included as outputs from the communal system, and if productivity is calculated as output/ha, the communal area system is actually more productive than the research ranch. Evidence that mass gain/ha increases even as output per livestock unit declines is plentiful (Butterworth, 1985), and old (Jones and Sandland, 1974). Some of it was collected in Botswana (APRU, 1980). It seems that the ideology of policy-makers has prevented acceptance, either in the Tribal Grazing Lands Policy, or the new policy. De Queiroz seems to have missed this literature, which is one reason for his misplaced preoccupation with changes in the productivity per animal as an indicator of degradation.

Abel (1992, 1993) modelled the productivity of cattle in the study area west of Mahalapye at actual and recommended stocking densities from 1978-1988. Reducing actual stock densities to recommended levels resulted in an estimated 27%-30% reduction in milk output, in the energy potentially-available from oxen, and in the total output of available energy from the system. Financial implications included a 40% decline in the potentially available value of draught power, a 12% reduction in the value of off-take, and a 27% decrease in the value of milk production. Gross margin/ha was expected to decrease by 18%. The effects of de-stocking on current users would be devastating. The benefit would be a substantial increase in the life of a small area of erodible soil. Whether the benefit to future generations is worth the cost to present ones is not for me, as an outsider, to say; but proponents of de-stocking should be aware that my estimates of benefits and costs disagree with their untested assumptions.

CONCLUSIONS

These are my conclusions:

- opponents in the debate over range management and livestock development in the communal areas should drop dogma, formulate hypotheses and test them; modelling has a part to play in understanding the behaviour of the complex systems we are discussing;

- like de Queiroz, I note that range science is undergoing a paradigm shift, and proponents of de-stocking should be sure they are not basing their case on outmoded theory;

- the debate would be clarified if degradation were defined in terms of an irreversible decline in output from a specified system of management;

- I agree with de Queiroz that degradation occurs in Botswana, but the term is a relative, not an absolute one. At least in relation to soil loss, there is no clear threshold of stocking rate at which degradation begins or ceases - the process is continuous, and the curve relating the rate of degradation to stocking density smooth. Technical analysis cannot in these circumstances set a 'carrying capacity', it can only estimate the costs and benefits of de-stocking, and of the extension of soil life;

- as White (1992) points out, in their pre-occupation with stocking density, policy makers are neglecting the potential benefits of stocking strategies;

- theory, empirical evidence and modelling all support White's (1992) contention that de-stocking will lower the productivity of communal range; in my study area the costs of de-stocking to recommended levels would be unbearable to herd owners;

- when de-stocking is considered necessary to conserve range, the option cost should be estimated. Scientists have a role to play in this. The actual stocking density should be set, however, not by scientists but through political debate which takes account of the needs of present and future generations.

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