

THE LOGIC AND LOGISTICS OF GRAZING REGULATIONS

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ABSTRACT

While overgrazing is widely recognized as one of the primary drivers of desertification, unlike other environmental problems, many countries have not taken basic measures to address it. After considering the sociological and biological dynamics associated with the phenomenon, the article reviews policies designed to reach sustainable levels of grazing that have been adopted in several countries. Establishing and implementing 'stocking limits' which ensure that land's carrying capacity is not exceeded have proven to be highly effective. The article reviews how such limits are set and responds to critics of such policies, arguing that in countries with pastoral populations, command and control provisions to limit grazing should be a critical component of national efforts to protect the commons. Copyright © 2009 John Wiley & Sons, Ltd.

KEY WORDS: desertification; grazing; legislation; rangeland management; regulation; stock limits

INTRODUCTION

Rangelands cover almost half the Earth's land surface, providing ecosystem services for over 600 million sheep and some 360 million cattle worldwide. For some 100 million herders, pastoral activities provide their sole source of sustenance (de Haan, 2005). Pastoral communities are particularly prevalent in Africa. For example they utilize 70 per cent of the lands in Kenya, 50 per cent in Tanzania and 40 per cent in Uganda (Fratkin, 2001). Overgrazing and poor land management have led to a erosion, especially in the drylands (Dregne, 2002) where the loss of land cover leads to a cascade of events linked to soil degradation and desertification (Evans, 1998).

There are countries, such as Mongolia, which remain convinced that as they have sufficiently large rangelands and small populations, traditional uncontrolled grazing on the 'commons' can continue without dire ecological consequences (S. Begzsuren, Chairman, National Academy of Sciences, Mongolia, personal communication, 2007; Behnke, Scoones and Kerven, 1993). Yet, empirical review of the land conditions following the explosion in the number of grazing animals raises questions about the sustainability of such an open approach to land utilization (Usca, 2005). With global population levels continuing to rise (Cohen, 2005) and many developing countries facing acute desertification (Brown, 2006), examples of sustainable, low intensity stocking on public lands increasingly appear anomalous.

The centrepiece of any successful land management strategy involves the concept of 'carrying capacity'. For purposes of this article, 'carrying capacity' is defined as the number of animals a selected piece of land is able to sustain; alternatively; it is the ability to continually produce fodder to sustain grazing and browsing by livestock and wildlife. In areas suffering desertification due to intense grazing, monitoring land conditions and decreasing numbers of livestock through sale or slaughter on a continuous basis is required in order to maintain a sustainable carrying capacity. Alternatively, long-term estimates of carrying capacity can be made, and stock levels determined accordingly.

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Estimates of global impacts vary but all are discouraging (Millennium Ecosystem Assessment, 2005). The most extreme evaluations report the degradation of hundreds of millions of hectares of rangelands during the past 60 years (Oldeman *et al.*, 1991), or an even more astonishing 73 per cent of the planet's rangelands 'severely affected' (Dregne and Chou, 1992).

Regardless of the precise global figures, the reality of overgrazing and the tendency to exceed carrying capacity in the drylands is as old as the Bible itself. The ancient Israelite patriarch Abraham and his nephew Lot parted ways in order to ensure adequate pasturelands for their flocks in the Negev Desert (Genesis, 13: 5–11). Two thousand years ago, the Talmud prohibited the raising of "small livestock" (goats, sheep) in the land of Israel presumably because of the damage anticipated to adjacent land owners (Baba Kama: page 79: B., 7:9–11). The ecological price of overgrazing even then was undeniable. Drylands, which are forced to support excessively intensive grazing, show a loss of biodiversity through the elimination of plant species that are popular with herds. In addition, soil is compacted on overgrazed lands; soil fertility and water infiltration is stymied. As ground cover disappears, the usual pathology associated with wind and water erosion sets in.

This description of land conditions following overgrazing in Uganda could be offered by any number of countries in Africa and Central Asia: '*These result in pasture degradation with change in vegetation cover quantitatively, in terms of biomass; and qualitatively in terms of replacement of high value grass species by unpalatable poor quality grass species and thorny shrubs all of which tend to lead to degradation and promote soil erosion and possibility of gully formation*'. (Kisamba-Mugerwa, 2001; pp 6–7)

Advocates for the adoption of public policies designed to address the issue of overgrazing enjoy a sound scientific basis for optimism. Degraded rangelands in the drylands have shown great resilience (Thomas and Middleton, 1994) and can be restored. When optimal levels of grazing are maintained, ecosystem services can be strengthened as diversity is enhanced through the culling of dominant species and organic material is added to the soils (Perevolotsky and Seligman, 1998). Even beleaguered Sudan has seen a surprising resilience in its rangelands when herds and pastoral activity were reduced as a result of war and migration (Olsson *et al.*, 2005). But reaching sustainable grazing intensities requires sustained government or community intervention and broad participation by local populations.

This article reviews the key 'drivers' behind land degradation from overgrazing and describes a variety of existing policies in several countries that have been adopted to address the issue with an emphasis on regulatory approaches and stock limits. It considers arguments that reject stock limits as an imprudent policy response, countering that it is in fact a critical component in overall grazing strategy. Rangelands, like all commons are subject to overexploitation, especially as populations rise and exceed age-old carrying capacity equilibriums. The question is not whether to regulate grazing and impose stock limits but indeed, how to do this effectively.

DIRECT AND INDIRECT DRIVERS

There are many causes behind the dynamics of overgrazing. Typically, policy analysts distinguish between 'direct' and 'indirect drivers' of desertification (Nelson, 2006). In the case of overgrazing—the *causa sine qua non* of land degradation is self-evident: too many animals overwhelm lands with modest regenerative capacity and push them beyond their natural carrying capacity (Geist, 2005). But this phenomenon can be considered a symptom of broader forces.

Overpopulation is the most obvious 'indirect' driver of overgrazing. Since the 1950s, dryland nations, especially in Africa were among those who saw the most dramatic demographic increases: Afghanistan, Burkana Faso, Burundi, Chad, Congo, Mali, Niger, Nigeria, Ethiopia, Egypt, Jordan, India, China and Kenya—all countries with highly vulnerable rangelands exhibited annual population growth rates of 2 per cent and more. As herd size grew by hundreds of per cent, traditional pastoral lands were steadily pushed beyond capacity (Runnstrom, 2003). Many individual countries have begun to reign in population growth, but globally, the explosion continues at a slightly slower rate (United Nations, 2005). Today, virtually all population growth is taking place in economically less developed regions, most of which have degraded rangelands (Cohen, 2005). The 50 per cent anticipated global population growth during the next 50 years could be devastating for pastoral societies if present land degradation trends continue.

Part of the reason for the grim prognosis is that non-pastoralist populations in Africa are growing far faster than pastoral groups (Reid, 2005). As the return per hectare is higher for intensively cultivated farms than for rangelands, farmers are squeezing out herders. Rwanda, with its traditional cattle economy offers an extreme example of this phenomenon (Huggins, 2005; Gasana, 2002). It is estimated that demographic changes reduced grazing land from 34 per cent in 1965 to 16 per cent in 1987. The subsequent increase in livestock density contributed to a rapid degradation of the remaining grazing areas. Even though the actual number of goats and livestock actually decreased over this period (Wyss, 2006) the reduction was not commensurate with the 53 per cent drop in available (and relatively low quality) rangelands.

As a recent report by the Kenyan government concludes: '*Accelerated population growth has meant that the traditional cultivation and grazing systems, which allowed land to rest and regain productivity, have collapsed and fallow periods have progressively been getting shorter with disastrous results on land productivity*'. (Republic of Kenya, 2004; pp 10–13)

There is no shortage of policy prescriptions for high population growth (Bongaarts, 1994). These range from empowering women, improving access to birth control as well as reproductive health and of course public awareness. Yet, international financial commitments to address the issue, such as those made at the 1994 International Conference on Population and Development in Cairo have not been met (Birdsall, 2001). While more than half of developing countries have national population policies, implementation remains problematic.

An additional indirect driver behind overgrazing dynamics involves fragmentation and subdivision of previous communal lands into individual parcels. This privatization facilitates intensive grazing on individually owned farms while truncating traditional pastoral mobility, which in the past allowed for seasonal adjustments. Nomadic pastoral grazing in many regions has traditionally been nimble and in retrospect, ecologically efficient, with herders moving their animals and crops according to local conditions. Reliance on rainfall created opportunistic range management strategies which traditionally eased pressures on arid and semi-arid rangelands (it also meant that pastoral economies were inherently unstable with well-documented, 'boom-bust' cycles) (Behnke, 1994; Scoones, 1994).

Accordingly, an immediate consequence of the fragmentation process is the transition from extensive/staged grazing system to an intensive/full-time grazing of individual parcels (Burnsilver and Mwangi, 2006). The result of this shift as many societies modernize is often considered to be inevitable, but leads to increased risks for herders who cannot opt for 'greener pastures' in the event of drought or degradation. The 'up-side' of the slow but steady intensification on lands involves expansion of economic diversification. A socially, environmentally and economically optimal response would allow for cooperation and sharing. But as is often the case, property rights create incentives that prevent such flexible land management strategies. Thornton (2003) suggests that pastoral systems can rebound economically if market integration improves, social capital mechanisms remain intact and economic diversification continues.

In response to the truncation of traditional nomadic routes, reaggregation policies have been proposed to allow for seasonal movement by pastoral communities. Yet, frequently, demographic and economic realities on the ground have become sufficiently ossified to make these more flexible options unrealistic (Coppock, 1998). Moreover, issues of social equity emerge when these programmes were attempted. For example, Burnsilver and Mwangi (2006) found that wealthier land holders appear to benefit more from reaggregation initiatives than poorer pastoralists, even if their needs are greater.

Ultimately, in most cases, fragmentation trends are rational responses to the economic incentives created intentionally or inadvertently by government programmes. This 'mismatch' between public policies and the ecological economic dynamics of local populations needs to be addressed. A survey of pastoralists in East African shows that existing support for subdivision constitutes a defence against external and internal threats rather than an embracing of private property rights *per se* (Burnsilver and Mwangi, 2006). Subdivision does not mean that all common solutions or 'collective actions' to address grazing challenges become impossible. It just means that more creative local policies have to be established.

Other indirect factors that exacerbate overgrazing dynamics may be cultural or religious. For instance, traditional Muslim principles regarding land tenure convey rights on the basis of continuous usage. This tends to support

farmer interests at the expense of herders' (IFAD, 1995). Post-colonial land reforms and nationalization of rangelands in arid and semi-arid countries strengthened this bias. The customary commons, which characterized much of traditional pastoral economies in sub-Saharan Africa, Central Asia and India, was deemed inefficient and replaced by allocation of rangelands to individual farmers. The remaining communal lands were often of poor quality and the collective norms and traditional discipline were replaced by profit maximization of private farms.

It is often argued that the problem of overgrazing is largely an institutional challenge. For instance, over a decade ago the International Fund for Agricultural Development called for the strengthening of traditional pastoral institutions and resource management practices. Empowering pastoral peoples is considered by many experts as the paramount challenge in pastoral and arid land development (IFAD, 1995; de Haan, 1997). Calls have been heard for devolution to local groups, restoring traditional governance structures. Establishing pastoral associations is an important step in this regard (Mearns, 1997). But despite the pleas for change, if anything, the situation today has worsened.

Addressing the social and geographic phenomena that contribute to overgrazing through a variety of policy tools and legislative mechanisms should be a top priority in countries facing desertification. Indeed, Article 5(e) of the United Nations Convention to Combat Desertification calls on National Action Plans to contain a broad menu of programmes to holistically address the pathology of land degradation (UNCCD, 1994), but this will take time—probably decades.

Along with long-term initiatives that will address indirect drivers of overgrazing, it is important to formulate policies that will keep the symptoms of land degradation in check and protect the basic ecosystem services of rangelands until these underlying dynamics can be changed. Just as environmental education may offer the best long-term solution to a range of ecological problems, in the interim, countries adopt environmental legislation and regulatory programmes to ensure that natural resources survive until behavioral norms evolve.

Regulatory interventions to address overgrazing certainly make sense from a theoretical perspective. Overgrazing is the 'quintessential' environmental problem about which the 'Tragedy of the Commons' paradigm was written (Hardin, 1968). Hardin described the dynamics by which communal lands led livestock farmers to add animals to their herds for individual enrichment, but to the common detriment, ineluctably leading to the collapse of ecological systems. Hardin envisioned one of two possible remedies—government regulation or privatization of lands and personally preferred the latter. This fundamental theoretical paradigm has come to justify myriad environmental regulations. Grazing is ultimately no different than activities that pollute common air or water resources.

Societal controls over the intensity of grazing of course did not wait for Hardin's theoretical analysis. There is in fact nothing new about conventional 'command and control' regulatory solution to overgrazing—stocking limits (Tal, 2007). Colonial governments from Palestine (The Forests Ordinance, 1926) to Nairobi (Kenya National Environmental Secretariat, 2002) enacted these policies and today they are increasingly common in countries that have are seriously addressing desertification problems. Modern stock limits have been introduced in the form of primary and secondary legislation from China (2001) to Morocco (IFAD, 2003) to North America (USC, 2006) with impressive results.

Hence more important than any theoretical discussion about rules for addressing overgrazing is presentation of efforts in countries that have chosen to embrace this logical response to the dynamics of overgrazing. This can be done through diverse policy initiatives from establishing stock limits (Israel, 1950) to issuing of individual licenses or through creation of individual liability for damage caused to cultivated areas due to grazing (Tajikistan, 1993a,b). We now consider specific legislative and policy responses from around the world that address overgrazing directly. These government interventions may provide models for rational, equitable and effective rangeland management strategies in a variety of jurisdictions and geographies.

CONTROL OF DIRECT DRIVERS OF OVERGRAZING

Voluntary Programmes

The vast majority of developing countries facing chronic overgrazing have chosen to adopt 'voluntary' approaches to address the problem. Kenya and Ethiopia are two such countries. A study contrasting the two countries' policies concluded: '*A commonly unsatisfactory experience with technical interventions in pastoral regions, which has*

contributed to disillusionment among pastoralists and agency personnel; overly optimistic development projections by planners; and unhappy donors. From the 1950s to 1980s development programmes in both countries have commonly included grazing blocks, veterinary campaigns, range planning, water development, marketing infrastructure improvements, breeding ranches, and various forms of pastoral associations. In the 1990s more typical interventions are localized, small-scale, and participatory including drought mitigation, re-stocking, women's programs, improvement of goats and camels, etc.' (Coppock, 1998).

Namibia, offers another example of voluntary national policies that seek to link pastoral communities to projected drought conditions. With precipitation being such a key factor in determining actual carrying capacity, farmers are expected to assess rangeland conditions in order to make informed decisions about the number of animals can be supported and determine whether sales are in order (Kambatuku 2003).

Under the Namibian system, ideally, farmers are to conduct visual assessments of fodder availability on a monthly basis. Guidelines and baseline reference photographs allow for a comparison of fodder availability over time. By comparing fodder availability on a variety of sites to the baseline photographs, a carrying capacity value can be attributed to the site and stocking rate recalibrated (Fagnoli, 2007). While estimates by definition are not precise, herders can make a reasonable assessment of the condition of biomass at each site, average monthly grass biomass per site, seasonal trends in biomass and long-term increases and decreases in grass biomass (Kambatuku, 2003, 12). As the extreme variations in precipitation drive carrying capacity at any given time, farmers are expected to take readings from rain gauges and aggregate them on a monthly and later yearly basis. If implemented, this kind of self-monitoring allows for pastoral communities to avoid a heavy hand of regulation and maintain optimal stock levels. Yet, in the absence of any ex post assessments that indicate meaningful success, there is no basis to believe that this policy orientation would be successful in any number of geographic and economic contexts.

An alternative policy has been the provision of subsidies for feed during times of drought. Many dryland nations have adopted such programs, assuming that they are an effective tool for protecting national livestock assets. North African and Middle Eastern governments, in particular, have had a policy of subsidizing feed grains as a centre piece of their emergency assistance efforts (World Bank, 1995). This undoubtedly keeps herds alive in the short run, but may be problematic in the long term. Besides the questionable social effect (subsidized feed tends to benefit wealthier herders only) and the doubtful overall economic benefit, subsidized feed may have a harmful effect on the rangelands. The tendency is for too many animals to be retained on the rangeland, thereby preventing normal regeneration of the vegetation after drought.

REGULATING OVERGRAZING THROUGH STOCK LIMITS

Some jurisdictions such as Northern Australia, (Archer, 2002) have responded to overgrazing associated with droughts through economic instruments (e.g., subsidizing fodder and supplementary feeds). For the most part, government interventions to control grazing are consistent with other environmental control regulatory proscriptions. Typically these are expressed as 'stock limits' although they can also take the form of grazing fees. (Cody, 1998). Such policies have been introduced in the form of primary and secondary legislation in China (2001), Namibia (2002), Morocco (IFAD, 2003), Australia (1999), North America (Taylor, 2006) and Israel (Tal, 2006), with a variety of results. A brief review of such countries' normative frameworks suggests that these policies can be effective as soil conservation policies in a variety of cultural and geographic contexts. The integrity of nomadic lifestyles and pastoral cultures of course needs to be respected as rules are formulated to adjust to the new demographic reality. And of course there is no single 'one-size-fits-all' institutional orientation. But like most environmental policies, successful implementation requires a combination of adequate political will and resources. Stock-limit policies are based on the recognition that a steady rise in human and animal numbers along with a shrinking of traditional ranges means that if grazing is not controlled it will devastate the resource base upon which it relies.

South Australia—Carrying Capacity Assessments

Australian grazing policy varies greatly between different jurisdictions. The Australian Parliament adopted laws that indirectly address the issue of livestock management (Australia, 1995, 2001). Yet these laws have fallen short

of a concentrated federal effort. Overseeing boards at the state level enjoy the power to require pastoral leases on public lands and require that management plans be submitted as a precondition to issuing them. These plans contain a declaration of stock levels and boards enjoy the authority to require stock size reduction, with fines for violation. In practice, however, States are given the primary authority to oversee the issue (Australia, 2002). While monitoring is done quite extensively, the size of the herds grazing on Australian rangelands is still considered problematic (B. Lay, Principal Pastoral Scientific Officer, Department of Water, Land and Biodiversity Conservation, South Australia, personal communication, 2007). In 1999, the federal government adopted “National Principles and Guidelines for Rangeland Management” (Australia, 1999, 2002) which sets some general recommendations. But in practice, each state has taken a somewhat idiosyncratic approach.

South Australia is the state that has most aggressively pursued a regulatory approach to managing rangelands. In this largely arid region, land degradation is particularly acute. Section 6 of the Act (Pastoral Land Management and Conservation, Act 1989 as Amended June 1, 2007; South Australia, 2005) stipulates stocking limits following an assessment of the carrying capacity of the land by an overseeing board. It requires that the assessments:

- (a) must be thorough;
- (b) must include an assessment of the capacity of the land to carry stock;
- (c) must be conducted in accordance with recognized scientific principles;
- (d) must be carried out by persons who are qualified and experienced in land assessment techniques.

Clearly, the results of these assessments have enormous economic implications for land holders and herders alike. Lessees are entitled to receive assessments upon their completion and are given 60 days to respond if they are dissatisfied with conclusions. Only after completing an assessment of the condition of land may the Board impose numeric stocking limits.

Other Australian states have taken radically different approaches. In 2003, Queensland, for example began to phase in a moratorium on land clearing of rangelands affecting 81 per cent of these lands (Queensland, 2003). Such a draconian policy is possible due to the generous compensation package made available for landowners (set at a level of 150 million A \$) and a tough enforcement approach that will fine at over 1500 A \$ per hectare of land on which trees are cleared without a permit (Bredhauer, 2004). It will be difficult to adopt such a programme in developing countries experiencing degradation without meaningful international assistance.

The US Taylor Grazing Act—Grazing Permits and Weak Implementation

The United States was among the first countries to create a comprehensive national regulatory framework for addressing problems of overgrazing. Among the many causes of the Dustbowl that ravaged agricultural communities during the early 1930s was the expansion of grazing onto marginal lands. The exposed soils were soon airborne, travelling with the wind in copious enough quantities to change the colour of the sky in the faraway capital of Washington. It was there that lawmakers in 1934 enacted the ‘Taylor Grazing Act’ (USC, 2006.) The law grants the US Secretary of Interior authority to regulate rangeland management by creating grazing districts on vacant lands which are to be administered and protected. While the law contains ‘conciliatory’ measures such as conducting research, coordinating flood control and reaching cooperative agreements with land owners, the Secretary is also granted regulatory powers. Section 315, for example contains provisions for imposition of fines for non-compliance.

Critics of the actual implementation of the Act over the years point to several factors that led to disappointing results. Chief among these are the revenues that could be gained for the Federal Treasury by selling grazing permits, creating a disincentive for tough stock limits (Rundle, 2004). The law also specifically states that the extractive use of vulnerable lands for mining of stone, coal, clay and for the felling of timber was *not* to be curtailed. Controlling these activities in some cases may be the most important intervention for preserving the integrity of the land. The extremely modest fine of 500 US \$, which remains the maximum penalty even today, ensures that the profit to be made from overgrazing will always exceed the price of unlikely enforcement.

Israeli—Clear Numeric Stock Limits

Regulation of grazing in Israel is more straightforward and ostensibly more stringent in practice than the American or Australian approaches. The British colonial administrators in Palestine operated on the assumption that goats posed a greater threat to land integrity than did other livestock forms (Wachs, 2009). Goats, with their aggressive grazing patterns and omnivorous inclinations were considered fundamentally different to sheep or cattle. As a result, legislation focused control efforts on goats, promulgating an Ordinance that banned them from forest reserves (Tal, 2006).

Once Israel received its independence, initial efforts to control grazing in Israel during the 1950s followed this orientation. Among the Country's first 'ecological' statutes was a law which proscribed goat grazing on public *and* private lands. The law created a bifurcated stocking limit where one goat could be allowed on four hectares of lands with intensity increased to one per single hectare when the land is irrigated (Tal, 2006).

For enforcement, the Minister of Agriculture (through a Grazing Authority or the Soil Conservation Branch) can ban grazing of goats on any public lands. In practice, permits are sold for a symbolic 25 cents (US) per animal head per month—which helps fund oversight activities. These include coordinating grazing schedules to ensure that animals spend the dry summers in the rainier northern areas of the Country, relieving pressures on the sensitive semi-arid lands. Israel's law is a criminal statute and violators face a maximum punishment of fines or 6 months in jail. In theory, government rangers with the power to enter private lands, seize (and sell) animals of non-complying pastoralists constitute a far stronger form of deterrence. In practice, compliance is attained by not reissuing grazing licenses for chronic violators of the standards.

It is worth noting that over the past 50 years, Israeli policy has evolved. Consistent with intermediate disturbance theory (Connell, 1978), local research showed that biodiversity and rangeland conditions were enhanced by moderate levels of grazing which eliminated competitive exclusion (Noy-Meir, 1975, 1996). Ecologists argued that goats were often preferable for grazing in forests, which provide the forage for over half the nomadic herds in the country. (The cleaning of underbrush is an important fire prevention practice.) Hence, the prohibition on goats in public lands has been eased. But the general stocking policy has been implemented fairly consistently. In practice, the number of grazing animals has not increased in Israel for the past 40 years and is steady at 100 000 with degraded lands in its semi-arid zones showing signs of restoration (Friedman, 2006).

China—Tough Medicine and Local Implementation

China has long suffered the effects of overgrazing and has identified it as a major source of desertification (Orts, 2003). Its comprehensive law for control of desertification contains a broad strategy with grazing among the many areas regulated. Indeed, China arguably has made a greater societal commitment to curtailing overgrazing than any country on the planet. Beyond the severity of its prohibitions, the Chinese regulatory approach is unique for its reliance on local governments for implementation. Local governments are expected to oversee a massive extension effort to implement plans that include adjusting livestock composition, rotation of rangelands, restoration of degraded pasturelands and in general preventing grassland degradation (China, 2001). Criminal penalties are to be imposed on anyone who would engage in activities in protected areas in contravention to the livestock limitations.

Namibia—Grazing Rights and Oversight by Chiefs and Traditional Authorities

In 2002, the Namibian Parliament enacted the Communal Land Reform Act. The Act establishes a communal land board in which land management authorities are vested. Article 29 of the Act ('Grazing Rights') creates a default access to the commonage area of traditional communities for grazing of stock by lawful residents. However, the Chief or Traditional Authority is empowered to stipulate conditions relating to the kinds and numbers of stock that may graze as well as the areas in the commonage where stock may be grazed at all. Grazing rights can be revoked by a Chief if these conditions are not met (Republic of Namibia, 2002). Implementation in practice has been less compelling. As traditional land tenure regimes do not set limits on livestock, experts are pessimistic about traditional leaders' alacrity for imposing new 'modern' standards. Even if awareness of carrying capacity dynamics could be successfully conveyed, it is not clear that local leaders have the 'ways and means' to implement and enforce decisions (W. Werner, Desert Research Foundation Of Namibia, personal communication, May 29, 2007).

QUANTIFYING CARRYING CAPACITY AND SETTING STOCK LIMITS

Reaching an optimal utilization of rangelands is one of the key problems associated with the aforementioned policies of stocking limits. On one hand, soil type, seasonal shifts, topography and precipitation conditions are highly variable and this diversity can create a broad range of land carrying capacities relative to small geographic areas. In order to reach optimal production levels and offer herders the best possible return on pastoral activities, a high degree of specificity is desirable. A 'one-size-fits-all' generic standard approach by definition will be highly inefficient. Some generalizations can be made in trying to establish optimal stock limits. The UN Food and Agriculture Organization, for example estimates that land degradation is most severe within a 5 km radius of settlements and water points (FAO, 2005). But soil types, rainfall patterns, drought cycles, flora type and distribution as well as forest canopy cover all affect lands' biomass potential and the physical carrying capacity of rangelands. Quantifying this level and translating it into stock limits is invariably a local exercise.

China, for instance by law requires that the carrying capacity of livestock should be set for local grass production (China, 2001). The local administrative department in charge of agriculture (animal husbandry) is charged with formulating standards and regulations for carrying capacity, and organizing their implementation.

In South Africa, the National Department of Agriculture is developing a draft policy for managing rangelands with the objective of governing the stocking rate and the extent of range usage by domestic livestock and wild herbivores (separate 'game' policy). This policy will rely quite extensively on national norms for carrying capacity in various yield types (rangelands) of the Country (South Africa, 2007).

The policy is to be based on detailed grazing capacity maps that are periodically updated using MODIS[®] remote-sensed data based on land-cover data sets. Ultimately, the maps will be based on whatever relations can be deduced between rainfall, vegetation productivity and an index of standing herbage. Tables in the *Natural Resource Atlas* quickly translate this into allowable numbers of animal units. The regional department of agriculture departments in the provinces are authorized to advise with regards to appropriate stocking rates, but are not empowered to impose them.

In the USA, two different approaches have emerged for quantifying carrying capacity and subsequently establishing optimal grazing intensity and livestock impacts:

- (1) forage utilization assessments;
- (2) evaluation of numbers and types of plants (Feller and Brown, 2000).

By assessing the percentage of a year's growth of a plant consumed by grazing animals—the sustainability of grazing regimes can be inferred and forage utilization standards set (US Rangeland Reform, 1998). Federal regulations establish a system of site-specific management plans which set stock limits based on the standards. Given the role of rainfall in maintaining land cover, standards are often seasonal in nature.

Critics of the American approach argue that they do not integrate ecological factors such as soil compaction, nutrient concentration or off-site impacts of animal wastes (e.g. non-point source pollution of surface water). An alternative 'ecological' approach might consider biodiversity factors. For instance, beyond erosion prevention, plant residues that remain on the rangeland after animals have moved on and their role in providing cover for wildlife could be included in assessments. Aesthetic criteria are also noticeably lacking from the present American approach (Feller and Brown, 2000). Yet, the US standards offer an objective basis for regulation and for adjusting stocking rates in efforts to reach optimal land use intensity.

Australia has devoted as much energy as any country in recent years to establishing reliable maps to drive land conservation policy. Regional Vegetation Management Plans prioritize those areas where lands need to be preserved and those in which pastoral (and agricultural) activity can continue. Efforts are led by the Department of Natural Resources and Mines. Inspections of ecosystems take place on the ground to ensure that they conform to remotely sensed patterns. Sample points are assessed and then assigned to the entire region rather than surveying it in its entirety. Given the relatively coarse scale utilized by these maps (1:100 000), sampling error is inevitable. When violations of stock limits are identified, prosecutions require additional 'ground truthings' to make sure that the illegal land use activities in fact damaged areas designated for protection.

South Australia's site-specific approach to evaluating carrying capacity has generated a small industry of assessments by consultants who determine the 'capacity of land to carry stock'. This is an expensive process especially as the spatial scale is so extensive and the level of detail required considerable. Some local experts argue that the cost of conducting these assessments is equivalent to the rent received from pastoral leases (G. Bastin, Australian Collaborative Rangelands Information System, personal communication, 2007).

The experience in all countries that have begun to characterize carrying capacity at even modest levels of resolution appear to agree that reaching optimal local grazing intensities is a time-consuming and costly enterprise. The process may well exceed the present technical and manpower capacity of many developing countries where overgrazing is most severe. Setting generic standards based on conservative estimates for land types—such as those established in Israel may be a less economically optimal but far more practical approach.

CRITICS OF STOCK LIMITS

Establishing controls on grazing is conceptually indistinguishable from placing limitations on the exploitation of other public natural resources—be it an aquifer or a forest. Fisheries, for example have been the subject of regulatory interventions for some time. Indeed, as countries sought to deal with the scourge of over fishing, legislation emerged which has begun the successful restoration of fishing zones (New Zealand Fisheries Act, 1996; US Sustainable Fisheries Act, 1996).

Despite the popularity of stock limits during the 1980s and 1990s some international agencies, such as the FAO have assailed these proven solutions out of hand for Africa (de Haan, 1997). The FAO dismisses stock limits as simplistic and ineffective. The position relies on the following rationale:

- The irrelevance of carrying capacity estimates given variable weather conditions (lands are almost by definition—under or overutilized, depending on rain-driven pastureland availability);
- the result of concentrating animals into limited grazing areas, which makes the areas (and herds) vulnerable to drought cycles;
- the undesired consequence of impeding mobility of other pastoralists;
- the difficulty of enforcement.

The report concludes: '*Attempts to regulate stocking rate should be stopped. First, the carrying capacity of rangelands in these non-equilibrium environments cannot be estimated with any acceptable degree of reliability. Second, such estimates can even be dangerous, as they may lead to the wrong intervention in an attempt to control stocking rates. Third, even apart from the technical flaws in the estimation of the carrying capacity, experience has shown that it is almost always impossible to enforce stocking rates*'. (de Haan, 1997 Chapter 2 at <http://www.fao.org/docrep/X5303E/x5303e05.htm>)

Each of these points requires at least a cursory rebuttal: the fact that carrying capacity is a function of rainfall—a stochastic phenomenon—does not make it irrelevant. Variability of rainfall has been accommodated in the setting of engineering specifications for 100-year storms or designing best management practices for non-point source water pollution control. Public policy has accepted the inevitability of some inefficiencies when dealing with unpredictable weather systems. Indeed the 'precautionary principle' is based on the notion that when environmental consequences appear likely but their characterization suffers from uncertainty—regulatory paralysis is inappropriate (Kriebel, 2001). Even without stock limits, rangelands will be under or overutilized. Yet, without some clear efforts to make careful and reasoned estimates of carrying capacity, reliance on individual or institutional intuitive adjustments dooms local residents to a certain future of land degradation.

The argument citing increased vulnerability from increased animal density is particularly weak. Concentrating animals into feedlots or limited grazing areas may actually offer livestock a better chance of surviving the inevitable (and perhaps increasingly intense) cycles of drought. The potential to import feed and keep domesticated animals alive during dry periods may actually be greater when they are concentrated in areas that can be reached by roads than if they continue to wander and disperse becoming effectively inaccessible. In any event, during drought years, herds have always condensed. Ignoring the carrying capacity of lands by allowing *laissez faire* grazing policy only

portends greater damage to the rangelands when the dry years arrive or ensures that land degradation will eventually push livestock into reduced and more marginal lands.

There is also no inherent reason why establishment of stocking levels forces land owners to set up fences and to truncate age-old nomadic routes. Stocking rates can be set on public and private lands. In the latter case, corridors can be preserved and incentives created which allow for continued seasonal mobility of herds. For instance, the Republic of Georgia has prohibited the truncation or the privatization of cattle driving routes (State of Georgia, 2005).

Finally, the assumption that enforcement is impossible, making stock limits unwise, is particularly pernicious. The economic incentives associated with poaching are far greater than with exceeding grazing limits yet many African nations have met this challenge and today can boast a highly effective enforcement system (Leader-Williams and Milner-Gulland, 1993; Newmark and Hough, 2000). The same is true for innumerable areas of modern life from foreign currency regulation to tax payment. Technically, enforcement of stock limits is not complicated: inspectors need to be able to read a map and to count. Especially when coupled with public education, international experience suggests there is no reason, *a priori*, to assume that pastoralists will reject these standards. Efforts should be focused on how to better monitor and implement these policies than defeatist absolutism.

If stock limits have failed it is largely because they have not been supported by clear legislation and political will. The United Nations Convention to Combat Desertification anticipates that regulation will be part of overall national strategies. Specifically, the treaty calls on affected countries to 'provide an enabling environment by strengthening, as appropriate, relevant existing legislation and, where they do not exist, enacting new laws and establishing long-term policies and action programmes' (UNCCD, 1994). Environmental legislation is not always popular among the regulated communities and controlling overgrazing is surely no exception. Yet, given the pervasiveness of land degradation in the drylands as a result of overgrazing, an increasing number of countries are meeting this challenge (Tal, 2007).

CONCLUSION

The distinct lack of enthusiasm for regulating grazing is particularly ironic in countries where colonial administrations set such policies in place decades ago. In the mid-1930s, an African Land Development Board was established in Kenya to promote more sustainable agricultural practices in the wake of a period of extended drought. The Board enacted a grazing control programme that included destocking, afforestation of steep slopes and general erosion control (Kenya, National Environmental Secretariat, 2002). The Ministry of Agriculture's Range Management Division, was established to continue these practices, but has not pursued implementation in a meaningful way. The preferred path of least resistance and voluntary participation has meant massive degradation of rangelands (Republic of Kenya, 2004).

India is another country which suffers the results of a lenient approach to overgrazing. Although it has less than 1 per cent of the world's rangelands, these lands have to support 18 per cent of the cattle on the planet. Its National Land Use Policy and Grazing and Livestock Management Policies avoided a clearly legislated regulatory scheme. By its own admission, the result has not attained the desired impact due to diffuse implementation' (India, National Report, 2000).

It is heartening that the international community is beginning to understand the importance of more focused attention to rangeland management. At the UNCCD's bi-annual gathering—the 2005 'Committee for Review of Implementation of the Convention' conducted a hearing on the issue of rangelands in Africa. The final report concluded:

'The generally low priority assigned to tackling range degradation through improved range management has been associated with a lack of awareness of the main issues on the part of both policy makers and resource users, a lack of legal arrangements for community-based organizations, the low level of political influence of pastoral groups, and inappropriate or nonexistent economic and social services and infrastructure. There is an urgent need for rangeland management systems that are productive, environmentally sustainable and socially equitable.' (UNCCD, 2005, pp 3)

There are many reasons why developing nations have not embraced a clear commitment to controlling the intensity of livestock on rangelands. The best explanation of why so many countries hesitate to adopt common sense policies that reflect their land's carrying capacity is that they will be unpopular. Populations have grown used to unlimited access to public lands. Changing this norm will create disgruntled herders—and may harm their short-term profitability, which is often not strong to begin with. Yet, as populations and their flocks grow, the choice is between establishing sustainable stock levels today—or watching the herds eventually dwindle as rangeland systems become truncated, dwindle and collapse. While self-monitoring of lands is of course, a much more palatable policy to implement, when pastoral economies are nomadic, herders cannot be expected to keep a close watch on land conditions. And of course, the dynamics of self-interest and the tragedy of the commons begin to set-in.

Proactive measures to preserve the commons are often synonymous with leadership. Long-term comprehensive solutions for overgrazing will need to include creative responses to the myriad underlying indirect drivers. But the many models of government programmes existing across the planet that successfully impose stock limits and reduce pressures on degraded lands suggest that in countries that contain pastoral economies and suffer from severe desertification, grazing regulations should be an important part of any strategy for sustainability.

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