

# STRATEGIES FOR SUSTAINABLE GRAZING MANAGEMENT IN THE DEVELOPING WORLD

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## ABSTRACT

Subsistence pastoralists in the developing world employ a range of strategies that have enabled them to persist for centuries, and in some cases millennia, by harvesting native vegetation with domestic herbivores. In this paper we compare the grazing management strategies used by pastoralists in temperate and dry tropical ecosystems in Central Asia (Mongolia) and East Africa, discuss threats to the continued sustainability of these systems, and explore the applicability of pastoral management strategies from the developing world to other ecological and socio-economic contexts, such as public land grazing in the Western USA. We found that many of the same strategies are used by pastoralists in these differing environments, and, historically, by ranchers in the Western USA. The sustainability of pastoral systems is threatened largely by the loss of institutions that support sustainable practices. In the Western US, inadequate institutions and economic constraints hinder the implementation of some strategies. We conclude that sustainable grazing practices, in both the developing world and the first world, must be considered together with the institutional framework to support them.

## 1. GRAZING MANAGEMENT IN THE DEVELOPING WORLD

Despite the fact that our earliest examples of managed grazing hail from pastoralist societies in what are today's developing nations, many view "grazing management in the developing world" as an oxymoron, or at best as an unlikely-to-be-attained goal. Management of herds and grazing lands certainly occurred in many, if not most, areas where extensive livestock husbandry was a prevalent livelihood. These graziers, like range managers today, made use of the "principles of range management" to achieve their desired aims by manipulating herd composition (species, age and sex), spatial distribution, and timing of grazing to maximize efficient harvest of available resources, reduce risk, and support an optimum number of individuals. Three main differences between subsistence pastoral systems and market-oriented ranching are 1) producer goals (subsistence vs. profit), 2) the relatively greater emphasis on grazing intensity (stocking rate) as a management tool in ranching, and 3) the institutional arrangements under which grazing occurs (common property in pastoral systems vs. private and/or state property in most modern ranching economies). As a result of the difference in goals, the ratio of people to animals also tends to be much higher in subsistence pastoralist societies than ranching economies.

The objective of this paper is to provide two examples of currently or historically sustainable pastoral management systems from the developing world, highlighting common strategies from two very different ecosystems. We describe threats to the sustainability of these systems and propose lessons offered for pastoral development and grazing management in developed nations. We suggest that grazing management interventions in developing nations be based on historically sustainable strategies that were locally developed and implemented, and that any strategy for the management of animals and rangelands must inevitably address social institutions such as property rights that structure human-environment interactions. In developed countries, implementation of similar strategies for sustainable grazing may require re-thinking social institutions as well as ecological paradigms.

## 2. A FRAMEWORK FOR INVESTIGATING SUSTAINABILITY

Sustainable use of rangelands is a basic goal of most range managers. The role sustainability plays in management decisions depends on the manager's planning horizon. For example, does the manager foresee benefiting from the land for many years or generations to come, or is the future uncertain? Sustainability is also affected by economic, political and social externalities as they interact with individual and collective decision-making. For example, are resources available to implement range improvements? What are the cultural norms surrounding livestock ownership and land use? What are the economic demands on the household?

The Bruntland Report defined sustainability as meeting the needs of the current generation without compromising the ability of future generations to meet their needs (Bruntland 1987). Our definition is more specific: maintaining the

productive and adaptive capacity of ecosystems while providing for the well-being of human communities. Sustainability is commonly thought of as having three interrelated aspects: ecological, economic, and social. The interdependence of these three components of sustainability is especially apparent in pastoral societies of the developing world. Community well-being depends on a healthy economy, which in turn depends on a productive resource base. If social or economic systems break down, the social rules that lead to ecologically sustainable use may disappear or be ignored, leading to ecological degradation. Likewise, if the ecosystem is degraded, it may no longer support the local economy and social system. Economies and social systems can weather and recover from periodic failures and episodic dysfunction, without necessarily leading to permanent degradation. The consequences of ecologically unsustainable use are far more enduring. Once a threshold of irreversible change has been crossed it can permanently undermine the possibility of a sustainable economy and society.

Our framework for investigating the sustainability of pastoral systems poses three questions. 1) What are the ecological dynamics and limits of the system? 2) What are the practices that enable productive use within these limits? 3) What are the institutions (rules, laws, norms, etc.) that are required to promote (or enforce) the implementation of sustainable practices? In the following sections we ask these questions of pastoral systems in two contrasting environments, temperate Central Asia and dry tropical East Africa.

### **3. ECOLOGICAL LIMITS: DYNAMICS OF PASTORAL SYSTEMS IN EAST AFRICA AND CENTRAL ASIA**

#### **3.1 Pastoralists and paradigms**

Advances in ecological theory over the past 15 years have changed our understanding of the ecological dynamics that prevail in many arid and semi-arid ecosystems inhabited by pastoral and ranching populations. The conventional view of rangeland ecosystems, based on Clementsian successional theory and equilibrium plant-herbivore population dynamics, conceptualized the interaction between plants and large herbivores as tightly coupled and mutually responsive such that herbivore populations closely tracked plant biomass, and plant productivity and species composition were highly responsive to increases and decreases in grazing pressure. According to this view, it was possible to identify a stable equilibrium at which plant production and composition, and herbivore densities, were balanced. Stocking rate was taken to be the most important management variable, since according to the conventional view, the density of herbivores and the corresponding rate of forage consumption directly affect plant production and composition (Ellis & Swift 1988, Westoby et al. 1989).

Towards the end of the 1980s it became increasingly apparent to range scientists and managers that plant and herbivore populations in many rangeland ecosystems might not be so closely coupled—or at least not in the way described by the conventional model. First, even long-term removal of grazing pressure in many cases does not result in initiation of secondary succession towards a "climax" plant community, calling into question the application of successional theory to range management. It appears that a single ecological site (climate-soil-topographic context) might support a variety of distinct, but stable, plant communities depending on the sequence, intensity and interactions among various disturbances and stresses (herbivory, fire, drought, etc.) (Westoby et al. 1989). Second, researchers in East Africa observed that livestock populations crashed during extended drought even when livestock consumed only about 10-12% of available forage in a good year, far below the theoretical carrying capacity of the area (Ellis & Swift 1988). Although the amount of forage limited livestock populations in drought years independent of their densities, forage quality rather than quantity was the limiting factor in average years. These observations led Ellis & Swift (1988) to hypothesize that in highly dynamic systems, where conditions for plant growth constantly vary over time and space, plant community dynamics are more affected by climate than herbivores.

One of the implications drawn from the insights of the non-equilibrium paradigm was that mobility and flexibility were more important strategies for sustainable pasture use in such systems than control of stocking rates. Mobility and flexibility, in turn, require large spatial extent for grazing management, and favour heterogeneous environments. The advance of non-equilibrium ecology appears to have influenced the design of pastoral development projects. Although this is generally a positive development, a potential danger of this wholehearted embrace of non-equilibrium theory is the possible misinterpretation of the theory to suggest that stocking rates are completely irrelevant in highly dynamic, non-equilibrium systems—i.e., no level of grazing can damage these systems. In the following sections we review the ecological characteristics of pastoral ecosystems in East Africa and Mongolia, and the management practices pastoralists use in each location. If both systems are characterized by high temporal and spatial variability, we would expect that similar management practices evolved in both areas to cope with high environmental variation in low-productivity environments.

#### **3.2 East Africa: dry tropical ecosystem**

In East African pastoral systems, dynamics are controlled largely by precipitation and the availability of water to support plant growth. A very high degree of intra and inter annual variability in rainfall leads to a high level of (more

or less predictable) seasonality, and to unpredictable, but expected, drought events of a year or longer. Dealing with this sort of variability is the primary challenge of the pastoralists and the livestock that inhabit these regions.

Two patterns of distribution of annual rainfall are found in East Africa and they lead to quite different conditions for pastoralism. Rainy seasons are related to the passage of the intertropical convergence zone as it moves north and south (reviewed in Ellis & Galvin 1994). In areas of East Africa near the equator, the zone passes twice each year, once going north in the early part of the year and again going south, later in the year. As the zone passes, rainfall increases. This leads to a bi-modal distribution of rainfall for much of the East African rangelands, and this bimodality is very well expressed and dependable in Southern Kenya and Northern Tanzania. In Northern Kenya however, the rains associated with the southern passage of the zone are generally very poorly expressed and undependable, resulting in what is effectively a uni-modal distribution of rainfall. The results of these differing rainfall patterns are very significant for pastoralists and their livestock. Where a bi-modal distribution is found, there are two periods of active plant growth each year (typically March – May and October – December, or thereabouts). This results in two periods each year of relatively abundant and nutritious forage, and generally short periods between the growing seasons when grazing animals are restricted to consuming senescent forage of low quality. In uni-modal areas, there is normally a single period of good forage conditions each year, followed by a lengthy period of poor conditions. Livestock production patterns are, of course, controlled by these nutritional differences and result in different patterns of food availability for the pastoralists.

The extent to which shrubs and trees are represented in the ecosystem is also an important feature of East African rangelands. In the drier portions of East Africa, shrubs and trees are poorly represented in areas where the distribution of soil water is relatively uniform in space – in areas such as large extensive plains with little topographic relief for example. In such areas, water may never percolate below the rooting zone of the grasses, and grasses utilize all of the water that enters the system. Where water is strongly redistributed within the system, as in areas with a high degree of small-scale topographic diversity, shrubs and trees are usually better represented. Areas which receive water as a subsidy through run-on or through sub-surface flow are sufficiently well watered that some soil water percolates through the rooting zone of the grasses before it can be transpired, and becomes a resource that can be exploited by the deeper rooted shrubs. This sort of deep percolation and sequestration of water is favoured, too, by the presence of coarse textured soils. These differences in the balance between shrubs and grasses then control the relative balance between browsers and grazers. This balance, in turn affects the flow of nutrients to the pastoralists (reviewed in Swift et al. 1996). Systems based on grass and grazers may demonstrate high rates of production but are often productive only for a shorter period each year – while the limited water resources last. Browse and browser systems tend to attenuate the pulse of rainfall that the system receives and spread out animal productivity and human nutrient capture over a longer period. This effect is particularly important in uni-modal rainfall systems.

A third important consideration in the ecology of East African rangelands is the degree to which they can be characterized as being dominated by equilibrium vs. non-equilibrium dynamics. Current ecological thinking suggests that the two types of systems are inherently very different and that management strategies suitable for one would be inappropriate for the other. If the negative feedback networks responsible for organizing and controlling systems are weakly represented in non-equilibrium systems, we can not expect those feedback mechanisms to assist us with our management. In East African rangelands the transition from the drier, non-equilibrium type of system to the more mesic equilibrium type appears to occur at about 300 to 400 mm of rain per year (Ellis et al. 1993).

### **3.3 Mongolia: temperate ecosystem**

Mongolia's 1.5-million km<sup>2</sup> land area spans six major ecological zones, three of which are dominated by rangeland vegetation: the mountain-steppe, steppe and desert-steppe. The Mongolian climate is temperate with warm, moist, short summers and cold, dry, long winters. Most precipitation falls during the summer months (June-August) with the peak rainfall in July. Mean annual precipitation in the mountain-steppe region reaches 450 mm, in the steppe region 250 mm and the desert-steppe 100 mm. Coefficients of variation in annual precipitation from representative sites in these three regions are: 28%, 30%, and 47-50% respectively (Fernandez-Gimenez & Allen-Diaz 1999).

Mongolia's steppe eco-regions are dominated by perennial grasses with a diverse component of forbs. The steppe and, especially, the desert-steppe regions support significant shrub components. On harder, rockier surfaces in the desert-steppe, as well as some areas of prolonged heavy disturbance, salt-shrub communities are found. These communities are considered excellent foraging habitats for camels. In addition, desert-steppe riparian areas and some areas with higher water tables in the steppe zone are characterized by distinct plant communities in which the coarse grass *Achnatherum splendens* is often dominant.

A two-year study in 1994-1995 examined the effects of historical grazing pressure gradients (from water points) in the three steppe ecosystems on standing biomass, vegetation cover, and species composition, richness and diversity (Fernandez-Gimenez & Allen-Diaz 1999, 2001). Findings from this study suggest that in the more mesic mountain-

steppe and steppe ecological zones, grazing by large herbivores shifts plant community composition from states dominated by highly palatable perennial grasses to states where grazing-tolerant grasses and grass-like plants co-occur with ruderal forbs, several of which are unpalatable to livestock. In the most heavily grazed and trampled sites, grasses may be nearly absent, and the sites are dominated by weedy forbs. In these two ecological zones, standing biomass of grasses and grass cover increased significantly along gradients of declining grazing pressure. These findings conform with the predictions of Clementsian successional theory as applied to rangelands (Dyksterhuis 1949) in the range condition model.

In the desert-steppe, which receives half as much rainfall on average, than the steppe or mountain-steppe, and where the coefficient of variation is significantly higher, our results indicated that there was no discernable relationship between the composition of desert-steppe plant communities and historical grazing pressure (Fernandez-Gimenez & Allen-Diaz 1999, 2001). Rather, in the desert-steppe, vegetation composition appeared to be driven largely by edaphic factors. Grass cover and biomass did not vary along historical grazing pressure gradients, but total vegetative cover did increase significantly with declining grazing pressure. Although shrubs are an important component of desert-steppe flora, there is no indication that heavy grazing pressure leads to increased relative cover of shrubs in desert-steppe communities. This may be due to the fact that herd compositions in the desert-steppe include a high proportion of goats and camels, which browse on shrubs, potentially negating any competitive advantage shrubs might have received with increased grazing pressure on the surrounding grasses.

Unlike some areas of East Africa (Swift et al. 1996), the perennial grasses of the desert-steppe are not replaced by annual grasses under heavy grazing. The greater concern in the desert-steppe zone is simply the loss of total vegetative cover, leaving the sandy soils vulnerable to wind erosion and dune formation that precludes natural reestablishment of native vegetation. At the landscape scale, a recent shift in pastoral land-use patterns from seasonal use in fall and spring to year-round grazing of desert riparian areas appears to be having a negative impact on the vegetation in these areas, leading to increased sandiness, extreme pedestaling, and dune formation. Thus, even if current use levels of the desert-steppe uplands are sustainable, grazing may be having a significant negative impact on key resources within the desert-steppe region.

The limiting factor on livestock production in Mongolia is the availability of winter-spring forage. During the cold and dormant season (Oct-April), livestock rely primarily on standing, dried biomass for forage. In some areas there is sufficient summer growth to harvest, cure and store wild hay to feed confined animals during the worst winter weather. But in most places animals must forage for food under even the harshest conditions. In addition to this yearly bottleneck on production, any given location in Mongolia is subject to a severe winter storm (*dzuud*) every 5-8 years. A bad *dzuud* may easily reduce local stocking rates by 20-25%. Based on an analysis of livestock populations and climate records over 50 years in two study areas, *dzuud* appear to limit populations independent of livestock densities (Fernandez-Gimenez 1997).

The available evidence suggests that Mongolian steppe ecosystems represent a continuum from equilibrium systems in the mountain steppe to predominantly non-equilibrium systems in the desert-steppe. However, each of the ecological zones exhibits characteristics of both equilibrium and non-equilibrium systems. For example, herbivore populations in all systems are subject to density-independent limitations by periodic severe winter storms, a characteristic of non-equilibrium systems, but populations also appear to track productivity, as indexed by precipitation, suggesting a tighter coupling between plant and herbivore populations than non-equilibrium theory predicts. Vegetation dynamics in the desert-steppe appear little influenced by herbivory except in extreme situations and in the desert "oasis" communities, lending support to the assessment of these regions as non-equilibrium systems. Vegetation of the steppe and mountain-steppe zones responds to herbivory to a large extent as predicted by conventional range succession models. However, precipitation remains an important influence in these systems, especially the steppe, and may interact with grazing intensity in its effects on vegetation composition and production. Most existing data suggest that steppe and mountain-steppe pastures are highly resilient and recover rapidly when grazing pressure is relaxed or removed. Similar data are unavailable for the desert-steppe, which may be more resistant to change, but potentially less resilient when a threshold is crossed. The major threat in this system is the loss of soil and creation of sand dunes due to a decline in total vegetative cover - the consequence of both drought and heavy stocking rates.

#### **4. PRACTICES: PASTORAL GRAZING MANAGEMENT STRATEGIES**

In both East Africa and Mongolia, pastoralists use a range of strategies to manage livestock and rangeland resources. It is our aim to describe and compare the ways in which these strategies are implemented in these two contrasting ecological contexts - the strongly non-equilibrium dry tropical rangelands of East Africa, and the temperate Mongolian steppe, characterized by features of both equilibrium and non-equilibrium systems. Both these systems have in common strong seasonality in primary production and limits on livestock population growth.

Management strategies must be understood in the context of management goals (Swift et al. 1996). Whereas the goal of market-oriented livestock production is profit maximization<sup>1</sup>, the goals of subsistence pastoralism are to maximize the probability of survival, and, in many cases, to maximize the number of people that can be supported on the land by livestock (Swift et al. 1996). In contrast, in market economies the number of people per livestock unit needs to be minimized in order to maximize profits per individual.

Range management as a science-based management tradition has articulated four major “principles” or variables that the manager must take into account: stocking rate (grazing intensity); kind and class of animal; timing of grazing; and spatial distribution. Pastoralist strategies tend to focus on the latter three principles rather than the first. In addition, social relationships of reciprocity are an important dimension of many pastoral management systems, since these relationships, and the moral economy that underlies them, help ensure that pastoralists have access to the resources they require to implement mobility, flexibility and diversity.

#### **4.1 Diversity of habitats and livestock species**

Diversity emerges as a strategy both in terms of the kinds and classes of livestock kept, and the range and heterogeneity of habitats exploited by pastoralists. Because different livestock have different forage and habitat preferences, these two diversity strategies are closely related in multi-species systems. Mongolian pastoralists seek habitat diversity at several spatial and temporal scales. First, their entire grazing territory must encompass habitats suitable for use in each of the four seasons. Second, within any given seasonal grazing area, they prefer to have a diversity of habitats and vegetation communities available to match the forage preferences of different livestock species (Fernandez-Gimenez 2000).

Pastoralists in many parts of the world keep a diversity of livestock species. In Mongolia, herders traditionally kept five kinds of livestock: camels, cattle, horses, sheep and goats. Cattle included both Mongolian breeds of *Bos taurus* (European-type cattle), as well as Tibetan yaks (*Bos grunniens*) and yak-cattle hybrids. East African herders often keep sheep, goats and donkeys – and camels where suitable – in addition to cattle. There are several reasons for keeping a multi-species herd. First, different animals have different forage and habitat preferences, and water requirements, allowing for efficient (complete) harvest of the available vegetation resources (Swift et al. 1996). The varied habitat and diet preferences of different species also may minimize competition among species, allowing for a greater number of animal units to inhabit the same landscape than if only one species were used. In East Africa, where drinking water for livestock is often poorly distributed during the dry season, the differential watering requirements of the different species of stock and the differences in mobility among them determine how far from water the animals can be taken to graze. Thus, camels in particular can exploit forage resources at great distances from water, while smaller stock such as sheep and goats have a more restricted grazing radius around a water source.

Second, keeping a diverse herd is a risk-mitigation strategy. Different species have differing susceptibilities to disease and environmental stressors (e.g. extreme cold, heat or drought), increasing the probability that some part of the herd will survive any given disaster or change in the environment. Third, keeping a variety of different animals provides the pastoralist with more different livestock products and services, and in some cases, extends the season for harvesting products such as milk, which can be obtained from several different species that differ in gestation and duration of lactation. In East Africa large stock are used for transport, milk and blood, while small stock are the primary source of meat. In Mongolia, meat is obtained from all types of livestock, though preferentially from small stock. Likewise, all species are milked, and milk is processed into a myriad of dairy products, many of which can be stored for later use. The hair or wool of most Mongolian species is harvested for sale or domestic use (including sheep and camel wool, cashmere, and horse's mane and tail hair). Hides of slaughtered animals are sold or used to manufacture rawhide.

Keeping a diverse herd also provides labour opportunities for a larger cross section of the pastoral population. Small stock can be herded by fairly small children in East Africa, while cattle and camels are generally under the keeping of older boys or young men (and occasionally, women as well). When a herd owner has a mixed herd, all members of his family can contribute labour to the pastoral enterprise (Swift et al. 1996).

#### **4.2 Mobility**

Mobility is a defining characteristic of most pastoral systems. Pastoralists move herds and often households at several spatial and temporal scales. Movements may be nomadic, in which the pattern of movement is opportunistic and varies each year, or transhumant, in which a fairly regular pattern of movement is repeated year to year, with relatively minor variations. Transhumance may be elevational (from low-lying desert areas in winter to high-elevation pastures in summer), latitudinal (in the Northern hemisphere, from southern latitudes in winter to northern in summer), or

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<sup>1</sup> The profit motive among ranchers in the contemporary American West can be debated. Most recent surveys of ranchers indicate that lifestyle factors may play an equally or more important role in the decision to stay in ranching (Liffmann et al. 2000, Rowe et al. 2001)

otherwise driven by the availability of dry and wet season water and forage. Seasonal and interannual movements vary in scope, but in highly variable arid and semi-arid ecosystems historically it was not unusual for pastoralists to migrate hundreds of kilometers over the course of a year. Transhumant movements enable pastoralists to exploit the heterogeneity in their environments at a larger scale, matching the seasonal nutritional and physiological demands of their herds to the available resources. Opportunistic movements are often undertaken to avoid disaster, such as drought, hard winters or wildfires, or to limit exposure to insects or disease. These movements often are not planned and constitute a deviation from the regular pattern of transhumance. In addition to serving as a primary strategy for producing livestock with minimal external inputs, mobility is also undertaken for other reasons, such as accessing markets, avoiding armed conflicts, or maintaining social ties with kin or friends in distant locations (Swift et al. 1996).

Aggregate patterns of mobility of many households over a landscape often result in seasonal patterns of clustering and dispersion of herds and households, as people convene when forage is lush and abundant and disperse when it becomes scarce. This type of pattern is found where water sources are not a limiting factor (for example, in Mongolia during the winter season and in areas of Kenya where dry season water sources are fairly well distributed on the landscape – as in the southern part of Turkana District). In other cases, where dry season water is limited to a few widely scattered sources, - as in the Rendille area on the East side of Lake Turkana - households aggregate during the dry season and disperse in the wet season when ephemeral water sources scattered across the landscape permit greater mobility.

Mobility on a smaller spatial scale is also employed as a strategy by some pastoralists. For example, Mongolian herders traditionally planned out the use of seasonal pasture areas, particularly winter pastures, very carefully, rotating grazing areas nearly daily and allowing recently grazed areas a period of regrowth before returning to graze them. In the winter, it was especially important to plan seasonal grazing and even daily trekking routes so as to limit trampling and destruction of the standing dried forage (Fernandez-Gimenez 1997, 2000). Thus mobility, together with the use of diverse species to harvest diverse habitats, enhances the efficiency of forage harvest and conversion into livestock products. Mobility can also be viewed as a risk avoidance strategy, when moves are undertaken to escape environmental, political or economic conditions that threaten the well-being of herds or people.

### 4.3 Grazing reserves

Many pastoralists, particularly those who repeat the same seasonal movements year after year, set aside areas as grazing reserves to be used during the dry season, or in some cases, for use exclusively during forage availability crises (droughts or extreme winter weather). Reserve areas may be explicitly set aside, or they may be *de facto* reserves that result from minimal use of areas that are difficult to reach or otherwise unappealing to herders.

In Mongolia, pastures surrounding winter and spring campsites are customarily reserved for use during the dormant season and herders collectively refrain from grazing them at other times of year. In addition, during the pre-revolutionary era (before 1921) the noble leaders (princes or Tibetan lamas) of some territories set aside designated grazing reserves that were strictly patrolled during all but the allotted seasons (Fernandez-Gimenez 1999). During the socialist collective period (1960-1990) most districts (*sum*) also designated specific areas as reserve pastures for drought and *dzuud*, and limited access at other times. In Africa, formal grazing reserves are found in the *hema* systems of North Africa and the *kallo* systems among the Ethiopian Boran (Swift et al. 1996).

### 4.4 Flexibility

Flexibility is a general strategy that is manifested in a number of specific ways, such as interannual variation in movement patterns, herd splitting, emigration, and flexible social organization. Pastoralists that practice transhumance may vary the time of seasonal moves or the destination, depending on pasture conditions. Herd splitting is another common tactic that illustrates flexibility. Many pastoralists occasionally split their herds into smaller groups, sometimes by species. Segregating herds by species may enable stock to gain access to more suitable forage for that species. Herd splitting may also reduce risk of losses due to disease, predation, drought or raiding. In Mongolia, several types of herd splitting are practiced. In fall, it is common for a part of the herd, usually small stock and sometimes horses, to be split away from the main herd and trekked some distance to be fattened in special pastures. On these rapid, long-distance moves (called *otor*) usually only a few members of the household accompany the animals and camp in a lightweight tent rather than the traditional felt and wood *ger* (yurt). Herds are also split seasonally, such that animals that are not used much in a particular season (for example, camels in summer or horses in winter) are turned out to graze at will, while others are tended close by. During lactation, the milking stock are kept close to the encampment, as are the young of the year, while mature, dry animals are grazed at greater distances (Fernandez-Gimenez 1997). Similar practices are undertaken by other pastoral peoples (Niamir 1990, Swift et al. 1996).

Emigration is another form of flexibility. During unproductive times, some household members may leave the family to seek employment in settlements, returning when conditions improve. In some societies, including Mongolia, the ebb and flow of people to and from the countryside, and among different districts or communities, is dynamic and constant.

Compositions of households and herding camps change seasonally and annually, depending on economic conditions and social demands. This flexibility in social organization is essential to household survival in many cases.

#### **4.5 Reciprocity**

Reciprocity, like flexibility, is a general strategy that finds expression in a number of pastoral practices and institutions. Reciprocal relationships are not always, and perhaps not often, balanced or simultaneous exchanges and may take the form of patron-client relationships. Reciprocal exchanges are non-monetary and typically consist of the exchange of favours, privileges, services, etc. that are difficult to value or keep accounts on. Reciprocal relationships are important not only in the day-to-day practices that they support. Reciprocal transactions themselves are key to building and maintaining interdependence among individuals and groups and accruing "social capital" (Niamir-Fuller & Turner 1999). Livestock lending and reciprocal pasture access are two examples of reciprocity in action.

Livestock lending is a common practice in many pastoral societies. A household with surplus milking stock may lend a milk cow to a poorer household on a temporary basis, for example. Maasai lend animals to help those in need rebuild their herds (Charnley 1994). In Mongolia, milk stock are seldom lent, but camels are occasionally lent out to help other encampments move. When several households camp together, as commonly occurs in Mongolia, the poorer households receive the benefit of the transportation provided by animals belonging to the wealthier households in the camp, and may occasionally benefit from the milk or meat of other households' animals. In exchange, they provide herding labor out of proportion to the number of stock in their own herd. Typically, the livestock belonging to all the households in the camp are pooled into one herd and each household takes the animals to pasture in turn (Fernandez-Gimenez 1997).

In Mongolia, reciprocal access to pastures in case of disaster is a long-held norm. When an area is struck by deep snows, for example, herders may request access to pastures in a neighboring district or province. Access is seldom, if ever, denied, with the expectation that reciprocal privileges will be provided when the circumstances are reversed. Niamir-Fuller and Turner (1999) report similar interterritorial access rights among pastoralists in several areas of Africa. Without the norm of reciprocity, flexibility in movement would often be much more difficult to implement.

### **5. INSTITUTIONS: CHALLENGES TO SUSTAINABLE GRAZING IN PASTORAL ECONOMIES**

Institutions are the repeated patterns of human behaviour over time that structure human interactions (North 1990). Formal institutions include laws and regulations; informal institutions include social norms and customs. The term "institution" is also used to refer to organizations or social groups with formal structure or informal coherence that devise and implement laws and rules, or serve other social purposes. In this paper we will refer to these entities as organizations, in order to distinguish them from institutions in the first sense defined. Following our framework for understanding sustainability, once ecological limits and ecologically sustainable practices have been identified, the next step is to identify what kinds of institutions and organizations exist or are needed to support implementation of sustainable management practices.

For example, we have described the importance of reciprocity in pastoral societies. In Mongolia, norms of reciprocity for pasture use in times of disaster constitute an institution that enables herders to implement the strategies of mobility and flexibility. Historically, laws and written agreements between adjoining territories codified these customary institutional arrangements, transforming them into formal institutions. In another historical example from Mongolia, prior to socialism, seasonal movements in some territories were governed by a combination of formal institutions and informal, customary institutions. In our study area, formal guidance was imposed through the Tibetan Buddhist Church and a powerful Buddhist leader, who commanded his subjects when and where to move, and set aside strictly guarded grazing reserves (Fernandez-Gimenez 1999). Informal enforcement occurred among communities of herders sharing the same seasonal pastures. These institutions both enabled and enforced the practices of mobility and grazing reserves.

Many of today's challenges to sustainability in subsistence pastoral societies come not in the form of ignorance or poorly informed management practices. Rather they are the result of inadequate institutions to permit or enforce the implementation of the strategies for sustainable management described above. In these contexts it is often impossible to separate the sustainability of grazing management from the sustainability of the institutions that support "good" management. The sustainability of pastoral land-use institutions, in turn, is strongly affected by the larger political and economic settings in which they exist. In particular, economic transitions, from a socialist-command economy to a market economy, or the reverse, or trends towards intensified, agricultural production driven by demographic change, have potentially devastating impacts on the viability of pastoral institutions and the sustainability of the management practices they support (Coppock et al. 2002). Economic transitions and political unrest are also often accompanied by increasing poverty and vulnerability among marginal populations, which may encompass entire pastoral societies, or segments of them.

Thus, rather than “Tragedies of the Commons”, areas in which the prospects for sustainable grazing management seem dim are more accurately characterized as “Tragedies of Open Access” or “Tragedies of Privatization.”

### **5.1 Tragedies of open access**

Open access refers to situations in which there are no rules or institutions to govern the allocation and management of natural resources (Ostrom & Schlager 1996). In contrast to private property and common property, where resources are held and managed by an individual or a group respectively, open access represents the absence of property—that is, the absence of rules that govern access or use. Among pastoralists, tragedies of open access occur most often when traditional institutions are eroded by incremental social change, undermined by immigration of non-pastoral populations, or simply abolished and replaced.

In Mongolia, functional customary and formal institutions were replaced by the collective system in 1960, which also provided formal institutions to guide pasture use and allocation. However, when the collectives were dissolved in 1992, their disappearance left an institutional vacuum which has not been effectively filled by formal or customary institutions (Fernandez-Gimenez 2002, Mearns 1996). This institutional void, together with a sudden increase in herding households, and economic shocks to the pastoral sector from privatization, resulted in increasingly unsustainable land use patterns among pastoralists as many failed to make traditional seasonal movements and occupied the same pastures year-long, in violation of custom. Although not a complete “free for all”, many parts of Mongolia are increasingly taking on the characteristics of open access situations, with negative consequences for community cohesion (i.e. increased conflict over resources) and ecological sustainability.

Charnley (1994) recounts the transformation of common property resource management on Tanzania’s Usangu Plains to open access due to a complex of state interventions and regional problems, including a change in political institutions that abolished native authorities and chiefs with authority to regulate resource access and use, and external pressures that led to increased migration and settlement in the area by different ethnic groups. As a consequence of these changes the original occupants of the area lost authority to regulate settlement, resource allocation and resource use, leading to an open access situation from which some groups benefited and others did not. The ecological consequences of this opening of the commons included increased livestock disease, decrease in wildlife, reduction in pasture quantity and quality, brush encroachment, loss of perennial waterways, and increased crop failure.

### **5.2 Tragedies of privatization**

Privatization refers to the conversion of property rights formerly held by the state, or by groups as communal property, into individual, private property. Policies promoting privatization have several rationales. Prime among these is the belief that individual tenure increases incentives for good stewardship and investments to enhance land productivity, since the individual reaps all the benefits of his investment, rather than sharing it with other resource users. In some cases, privatization may indeed lead to these outcomes. In others, it does not. In arid and semi-arid ecosystems characterized by large spatial and temporal variations in resource quality and quantity, privatization may be counter-productive, and limit pastoralists’ ability to effectively implement strategies such as mobility and flexibility. When pastoral lands are privatized, seldom are the private parcels large enough to incorporate the necessary diversity of habitats required for different seasonal use areas or sufficient area overall to allow for flexible mobility.

In Inner Mongolia, PRC, livestock privatization and policy promoting the “household responsibility” system whereby individual households are allocated plots of pastureland, were intended to promote rational use of grazing land and reduce degradation (Williams 1996). Instead, this land policy led to illicit capture of grazing lands by elites who could afford barbed wire to fence enclosed pastures, and an increase in stocking rates and competition for pasture in the remaining common-use areas, which in turn accelerated degrading processes.

In Kenya, group ranches were established in the 1960s and 1970s, providing title over large areas of pasture to groups of 30-900 Maasai families. The intent of group ranches was to reduce stocking rates and degradation and commercialize livestock production, while increasing the overall productivity of the area and protecting Maasai grazing rights (Kimani & Pickard 1998). Although the ranches succeeded in maintaining exclusive Maasai rights to land, they failed to meet other objectives, and pastoralists continued to manage their livestock in the traditional way, maintaining opportunistic and mobile strategies, crossing boundaries between ranches to access the diverse resources required. For a variety of reasons Maasai began calling for sub-division of the group ranches by the early 1980s, and after initial resistance by the government, subdivision was allowed and has increased dramatically on some ranches. Sub-divided plots are small (usually less than 150 ha) and individually owned, and the owners usually fence them. Increasingly, subdivided plots are being sold to non-Maasai cultivators. Generally wetter, more productive areas (the key resources) are subdivided first, pushing pastoralists onto more marginal and drier areas. This trend towards subdivision of rangelands into small plots with individual tenure threatens the viability of mobile livestock production, reduces the overall carrying capacity of the land, increases exposure to risk for both pastoralists and cultivators, and reduces wildlife habitat and may limit or eliminate wildlife migration routes.

## **6. LESSONS FOR PASTORAL DEVELOPMENT?**

In subsistence pastoral systems, strategies such as mobility may be important even in ecosystems that do not exhibit classic "non-equilibrium" dynamics, such as Mongolia. This is true in part because of the low inputs into the system. Instead of trying to change the basic production system and "sell" pastoralists on a different set of goals, we need to work with the existing goals and traditionally sustainable practices, and focus on ways of shoring up or developing afresh institutions that support these practices. In some cases this means building on the foundation of customary institutions, but adapting and strengthening them for the current context. In others it may mean developing new institutions that creatively protect traditional grazing management strategies, but within a very different political-economic landscape. The development of institutions for sustainable grazing management requires careful attention to local history, geography, politics, economics, and culture. There is no one-size fits all approach, and a complex of diverse property rights over diverse resources, and formal and informal institutions may be needed (Fernandez-Gimenez 2002, Niamir-Fuller & Turner 1999).

## **7. LESSONS FOR FIRST WORLD GRAZING MANAGEMENT?**

What do "first world" rangeland managers have to learn from the practices and institutions of subsistence pastoral societies? We suggest that the same strategies that have been used for millenia by subsistence pastoralists: diversity, mobility, flexibility, reciprocity and grazing reserves, are also applicable in many first world contexts, particularly in nations such as the USA and Australia, where there are extensive arid and semi-arid rangelands, or in other developed nations where elevational or latitudinal transhumance is common. In this section we consider the extent to which these strategies are or could be applied (historically and currently) in the Western USA, and the constraints to implementing them.

### **7.1 Diversity**

In the Western USA, use of multiple-species herds (primarily cattle and sheep) to exploit environmental heterogeneity, distribute risk and diversify income streams was once common. Today, fewer ranchers are pursuing this strategy due to the increased labour and infrastructure costs, decreased returns, and the additional knowledge required to manage another species. Use of diverse habitats continues to take place where transhumance is practiced, primarily the Intermountain West, and parts of California and Arizona. (Constraints to this practice will be discussed later.) Diversity in ranching enterprises now increasingly takes the form of enterprise diversification, including attempts to capture economic value from grazing and non-grazing wildlife through niche and direct marketing, game ranching, fee hunting, and ecotourism, and from other intrinsic values and services provided by rangeland landscapes. Like multi-species herds, these forms of diversification also spread risk, though they may not pertain directly to grazing management. Constraints to innovation of this sort include rapid saturation of niche markets, (over)regulation and monopolies in the meat packing industry, and start-up costs. Increasingly, government programs are subsidizing the cost of conserving grazing lands through incentive programs such as the Conservation and Wetland Reserve Programs, which value the biological diversity of rangelands, or through the purchase of conservation easements. It is not clear whether such programs are economically sustainable over the long term, or who ultimately benefits from them, although they may contribute to the economic viability and ecological sustainability of individual ranch enterprises in the short-term.

### **7.2 Mobility**

Mobility, a defining strategy for many pastoral peoples, also has a place in first world grazing management. The most common way that mobility is implemented today is through some form of rotational grazing or grazing system. Mobility over larger temporal and spatial scales occurs in areas where transhumance continues to be practiced. In the Western US, most transhumance occurs along elevational gradients, where herds winter on desert pasture and summer in mountain pastures. Whereas intensive herding is the most important control over spatial and temporal distribution of livestock (other than the distribution and availability of resources) in most pastoral societies, fencing plays a more important role in the US. Herding is labour intensive and thus prohibitive for many ranchers. Other constraints to implementing mobility over large landscapes in the US include obtaining access to pasture and coordinating use across multiple jurisdictions (e.g., private, state, Bureau of Land Management and US Forest Service lands).

### **7.3 Flexibility**

As in subsistence pastoral societies, flexibility in the timing and location of grazing is also crucial to sustainability in the American West, but is often hindered by lack of access to alternative resources, or by bureaucratic constraints when grazing takes place on federally managed rangelands. The increase in off-ranch income as a proportion of total income indicates another approach to flexibility, not unlike patterns of emigration and return among pastoralists.

## **7.4 Grazing reserves**

Grazing reserves in the form of drought pastures are part of the management plans of many astute ranchers. More recently, “grass banks,” a kind of common grazing reserve, have emerged as a strategy and new institutional arrangement in the West. Grass banks are areas of public or private land that are set aside for use by a community of ranchers, usually in exchange for some type of conservation commitment, or in some cases a grazing fee. Ranchers may access grass banks during a drought, or to implement restorative practices such as burning, resting, and reseeding (Debuys 1999).

## **7.5 Reciprocity**

Reciprocity has long been part of ranching culture in the USA. For example, it was common for neighboring ranchers to help round up and brand each others’ cattle or cut hay. In some cases equipment or livestock were also lent. The demographic changes occurring in many Western communities, particularly those encroached by suburban development, potentially threaten the sense of community that existed in rural, agricultural areas of the USA in the past. By community we mean repeated and multiplex interactions among people over time, that create interdependence and mutual obligation that are mutually sustaining (Singleton & Taylor 1992). In the current climate, reciprocity between people who live in urban areas and ranchers may be increasingly important, as ranching becomes an increasingly marginal livelihood and pressures to sell rangeland for development mount. Such reciprocal relationships may be direct, such as subscription farming or ranching, or more indirect, such as the urban electorate’s support for public funding of purchase of development right programs.

We have sketched out some of the ways that pastoralist management strategies are implemented in first world ranching economies, but the benefits of applying these principles are not realized as fully as they might be in the American West. The obstacles to implementation are largely institutional and economic, and are influenced by demographic and cultural change. The mix of tenures that comprise many western ranches poses obstacles to mobility and flexibility. Similarly, the lack of flexibility in managing federal rangelands hinders use of these strategies. The labour required to implement some strategies makes them prohibitive. It may well be that many of these strategies, particularly mobility and flexibility, are more likely to be implemented by ranchers with the financial resources to undertake them. The situation is similar to that in pastoral societies such as Mongolia, where there is a documented correlation between the degree of mobility and wealth (Fernandez-Gimenez 2001).

Although common property management is unlikely to emerge as the solution to these institutional obstacles in the USA, for both ideological and practical reasons, other approaches to developing institutional arrangements that foster sustainability that are being investigated. Grass banks are among these. Collaborative efforts at resource management, whether they involve groups of adjoining ranches or multiple stakeholders on public lands, have, in some instances, enhanced flexibility and reciprocity without sacrificing accountability. These efforts, in some cases, also help to bridge the cultural divide between new rural residents and traditional ranchers, helping to forge a new “community”. Reform of grazing management policy on public lands is a daunting challenge, but one that should also be examined. In many cases, it may be within the discretion of local managers to allow for the flexibility that will ultimately make grazing more sustainable.

## **8. CONCLUSION**

A closer look at pastoral strategies for grazing management reveals that pastoralists in contrasting environments have employed similar strategies to accomplish their goals. These strategies focus on manipulating the temporal and spatial distribution of grazing, as well as the kind and class of animals used, rather than regulating stocking rates. Successful implementation of these practices requires compatible institutions. In pastoral societies, property institutions are particularly important and some form of common property is often found in these groups, as well as institutions that incorporate the principle of reciprocity. In developed nations where similar environmental conditions prevail, many of the same management strategies may be applied (and often were, historically), but only if the appropriate institutional framework can be devised. In extensive livestock production systems, management practices and management institutions, including resource tenure, must be considered together if sustainability is to be achieved.

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