"The role of ecological perception in indigenous resource management: a case study from the Mongolian forest-steppe"

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Nomadic Peoples, Number 33, 1993

Nomadic Peoples 33:1993, Fernández-Giménez, pp. 31–46

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This paper defines ecological perception and presents a conceptual model summarizing the role of perception in resource management. The model is applied to resource management decisions by Mongolian pastoralists of the forest-steppe, illustrating how herders use ecological and social criteria to make decisions about camp locations and to assess development proposals. The case study also reveals how macro-scale political and economic changes in Mongolia affect local resource management decisions.

Introduction

Ecological perceptions in indigenous resource management are important for three reasons. First, the study of perceptions is essential to understanding and predicting the resource management decisions of local people. Second, an understanding of ecological perceptions, their relation to ecological conditions, and their bearing on behavior is crucial to the design and implementation of development projects and policies. Finally, ecological perceptions provide a potentially useful approach to understanding the interactions between the physical laws that govern the behavior of natural systems and the human experiences that influence how people interpret and interact with these systems. The paper has three parts. It begins with a definition and discussion of ecological perception. Then a conceptual model describing the role of ecological perception in resource management is presented. The paper concludes by applying this model to a case study of ecological perceptions and resource management decisions among Mongolian herders of the forest-steppe zone.

Defining ecological perception

The word perception originates from the Latin *perceptus*, 'the act of taking possession, obtaining, receiving.' (Webster's Third New International Dictionary 1986). Sensory perception is our principal means of obtaining information about the world. Perception also refers to the ways in which the world acquires meaning for us. For our purposes, three levels of environmental perception can be distinguished. Sensory perception is the direct response of senses to external stimuli and determines, literally, how we see the world. Cognition is the transformation of sensory data into empirical knowledge about the world. It is the process of using sensory information to organize and classify the world. Conceptualization is the formation of a broad concept of human and ecological interactions—the construction of a world view. Conceptualization is the process through which landscapes acquire social and cultural meanings, meanings reflected in values and attitudes towards the land.

Sensory perception, which is largely a function of human biology and environ-

ment, will not be discussed here. As for the other two, cognition and conceptualization of the natural world interact and influence one another. However, it is useful to make the distinction between the empirical knowledge of the natural world that is reflected in indigenous systems of classification and resource management practices, and the conceptualization of natural and social order that constitutes the broader cultural and social context in which resource management decisions are made. Both ecological knowledge and the conceptualization of human and ecological systems affect how resources are managed. As Richard K. Nelson (1983) writes of the Koyukon people of Alaska,

> *Koyukon perceptions of nature are aligned on two interconnected levels. The first of these is empirical knowledge ... but their perception of the natural environment extends beyond what Westerners define as the empirical level, into the realm of the spiritual. Koyukon inherit an elaborate system of supernatural concepts for exploring and manipulating the environment... Furthermore, behavior toward nature is governed by an array of supernaturally based rules that ensure the well-being of both humans and the environment.* (p. 15)

This paper explores the nature of ecological perceptions as knowledge and as meaning and examines the ways they affect resource management behavior. Both the cognitive and conceptual realms of perception are structured by rules that determine on one hand how knowledge about the land is ordered and used and on the other what constitutes socially and culturally appropriate behavior with respect to people, land and other organisms. The major tasks are determining what these rules are, how they function, and to what extent and under what circumstances they are violated.

Cognition: ecological perception as ecological knowledge

The study of traditional ecological knowledge originated with ethnoscientific inquiries into indigenous systems of classification and taxonomy (Conklin 1957, Berlin, Breedlove and Raven 1966, Berlin 1992). Ethnoecology emerged from ethnoscience to focus on indigenous perceptions of larger-scale ecological entities (such as plant communities) and ecological processes (Brosius *et al.* 1986, Fowler 1977, Frake 1962, Nabhan *et al.* 1982, Frechione *et al.* 1989). With a few notable exceptions, the behavioral implications of indigenous knowledge have been largely overlooked, and empirical works relating perceptions and resource management behavior are few (Johnson 1974, Conklin 1957, Alcorn 1981 and 1989, Brush 1980, Martin 1982). Those that do exist examine predominantly agricultural societies, with only a several works addressing local knowledge or decision-making among pastoralists (Niamir 1990, Agrawal 1993, de Boer and Prins 1989, Scoones 1992, Martin 1982). Recently, the increasing recognition that existing local knowledge and management systems are the appropriate starting point for development has led to greater interest in indigenous resource management from an applied perspective (Brokensha and Werner 1980, Inglis 1993, Johannes 1989, Toledo 1990, Oldfield and Alcorn 1991, Berkes 1993).

Traditional ecological knowledge is local and indigenous people's knowledge about the physical and biological world, including climate, soils, water, vegetation, wildlife, and domestic livestock. Such knowledge can take several forms: taxonomic and structural knowledge of individual organisms and entities; knowledge of the spatial and temporal distribution and dynamics of organisms and physical phenomena; knowledge about interactions among organisms and about physical processes; practical skills and methods for the management and use of natural materials;

and social institutions that allocate and regulate resource use, and provide for the transfer of knowledge and skills (Johannes 1993, Toledo 1990, Niamir 1990).

Traditional ecological knowledge includes inherited cultural knowledge and knowledge acquired from direct personal experience and experimentation. Knowledge and technology are also obtained from other cultural groups and subsequently modified (Niamir 1990, Brosius *et al.* 1986, Alcorn 1981). A number of authors have pointed out that traditional ecological knowledge cannot be separated from the social context in which it is created and transmitted (Niamir 1990, Alcorn 1981, Wilken 1989, Berkes 1993, Hutterer 1985). Indeed social institutions constitute an important facet of indigenous knowledge. Many significant resource management practices are based on social relationships rather than particular technologies. For example, the timing and location of grazing among nomadic pastoralists often depends upon systems of land and labor allocation and reciprocity among and within social groups. Thus, as Alcorn (1981) points out, resource management entails the maintenance of social and well as ecological relationships.

Knowledge is rarely uniformly shared within a community, yet variations in ecological knowledge have seldom been studied (Hays 1974, Alcorn 1981). Alcorn (1981) identified a number of factors, biological and physical, economic, cultural, social and personal, that affected how Huastec individuals perceived plant resources. For example, perception of the resource value of plants depended on economic factors such as the allocation of time and space needed for propagation and processing, the opportunity cost and risk of adopting use, the labor requirement for collection and processing, and the potential for income generation. Alcorn contends that perception of plants and their resource value depends on who uses them and what they are used for. Thus, perceptions of natural resources depend upon the resource management objectives of the perceiver.

When several distinct cultural or social groups share the same resource base, differences in perceptions may be even more dramatic. Not only do these groups possess different conceptualizations of the natural world, they also perceive the 'facts of nature' differently. Such differences frequently lead to conflicts over the management of resources (Spooner 1987, Laksono 1988, Alcorn 1989, Huntsinger 1994), often to the detriment of the land as well as its inhabitants. Experts whose 'scientific' knowledge opposes local custom and practice often play key roles in these conflicts. As is well known, a great deal has been written about the ecological and economic irrationality of pastoralists and, more recently, their rationality (Herskovits 1926, Harris 1966, Hardin 1968, Widstrand 1975, Sandford 1983, Western and Finch 1986, Coppock *et al.* 1986, Livingstone 1991). Such scientific and bureaucratic interpretations of traditional subsistence systems underwrite the development of natural resource policies in the Third World. It is important recognize that differences in ecological perceptions stem not only from divergent ideologies and world views, but also from radically different epistemologies. Somewhat humbled by the failures of past development projects many rangeland scientists are now giving greater credence to the 'rationality' underlying traditional management practices (Sandford 1983, Coppock *et al.* 1986, Ellis and Swift 1988).

Conceptualization: ecological perception as world view

Empirical knowledge of the environment is one aspect of ecological perception. Another is the symbolic significance of the landscape. What does the land mean, what values are attributed to it and how are human-nature relationships conceived? The answers to these questions have important implications for resource management de-

cisions. A vast philosophical, historical and anthropological literature addresses these issues (White 1967, Tuan 1974, Nash 1967, Cronon 1983, Merchant 1989, Everendon 1992, Oelschlaeger 1991, Toelken 1976) and its review is beyond the scope of this paper. However, I will briefly outline the significance of this cultural and ideological component of ecological perception and offer two examples of its relationship to resource management.

Dove (1992) argues that the meaning of a landscape is created and transformed through a dynamic and dialectic interaction between natural and cultural systems. Ecological perception and resource management behavior are neither entirely socially and culturally constructed nor are they products of simple environmental determinism. Rather, the dynamic interaction among ecological conditions, patterns of human use of the landscape, social relations and cultural interpretations is driven by political, economic, social, demographic and environmental trends and events. Dove (and others: Peters 1984, Moore 1993) use careful historical accounts to elucidate the ways in which the definition of resources affects and is affected by their use. Struggles over the use of land, they argue, are struggles over its meaning. Two examples of this dialectic are Dove's account of the transformation of the meaning of 'jungle' in Pakistan, and Huntsinger's study of conflict over the use and meaning of parklands in California.

Dove recounts how the original term *jangala* referred to a savannah maintained and used primarily by pastoralists who prevented secondary growth of dense brush and forest by grazing their livestock, burning and logging the forest (p.235). In the cultural geography of ancient India, the dry *jangala* was equated with purity, civilization and the union of nature and culture, while moist areas called *anupa* represented filth and barbarism. The contemporary term *jangal* has a nearly opposite meaning, denoting true forests (as opposed to open savannah), and is perceived as a wild, dangerous and uncivilized place. Dove attributes the change in meaning to the change in how the landscape is used. Where once *jangala* encompassed all of society when the Aryans practiced an extensive agro-pastoral lifestyle, the 'wild' jungle now lies outside and on the fringes of an intensively cultivated and managed agricultural landscape.

> *Whereas extensive, long-cycle use of the land obliged society to view agriculture and civilization within the bounds of nature, intensive, short-cycle uses do not. Whereas society once depended upon the natural dynamics of vegetative succession to restore the productivity of the land during fallow periods, society now views these dynamics as a threat. Whereas extensive practices caused society to honor nature and natural processes, intensive practices lead society to suspect and disparage natural processes—as implied in the contemporary use of the term junglees 'forest [people]' in derogatory fashion.* (p. 242)

Dove argues that this change in the use of the landscape, reinforced by the change in the meaning of jungle, furthered the interests of the colonial British government, which could more easily govern a sedentary population.

The second example comes from the rapidly developing suburban landscape of central California, where 18,000-acre Mt. Diablo State Park is quickly becoming an island of undeveloped open space in a sea of upscale subdivisions (Huntsinger *et al.* 1994). A struggle has developed over the meaning and management of parklands as the state park administration interprets its mandate to manage the park as a 'native environmental complex' in which natural processes dominate (p. 14). The administration's decision to eliminate livestock grazing in the park conflicts with local ranchers' perceptions of the landscape and the role of livestock in it. Environmental groups support the state park's decision, while local homeowners whose property abuts the park boundary side with the ranchers because they fear that the removal

of livestock will increase the risk of wildfires that threaten their land. Each interest group is responding to its own image of the park and what it represents. To park scientists it is a 'natural system', that should be allowed to function with as little human interference as possible. Environmentalists share this perception but imbue the park with wilderness values, viewing it as a refuge for nature and naturalists from the encroaching tide of urbanization. Ranchers see the park as a forage resource and view livestock as an appropriate and historic feature of the California landscape. For local homeowners the park represents both an asset and a threat to the value of their property and their ability to enjoy it. Ironically, with the removal of cattle grazing at Mt. Diablo, the park will be obliged to bulldoze fire breaks mechanically to compensate for the fire-abating role of cattle grazing. The park administration has also considered developing a living history ranch featuring costumed Hispano vaqueros in place of the existing working ranch that leases park land for grazing.

These two cases illustrate how changing political-economic, social and demographic trends affect how land is used and perceived. As Dove asserts, the link between cultural and natural systems is dialectical in nature, "as changes take place in culture or nature, they provoke related changes in the other, and so on". (p. 232) These transformations of meanings and uses of landscapes over time highlight the importance of historical analyses of ecological perceptions and resource management practices.

The role of ecological perceptions in resource management: a conceptual model

The notion that ecological perceptions are crucial to understanding resource management behavior is not novel. In 1962 Frake wrote:

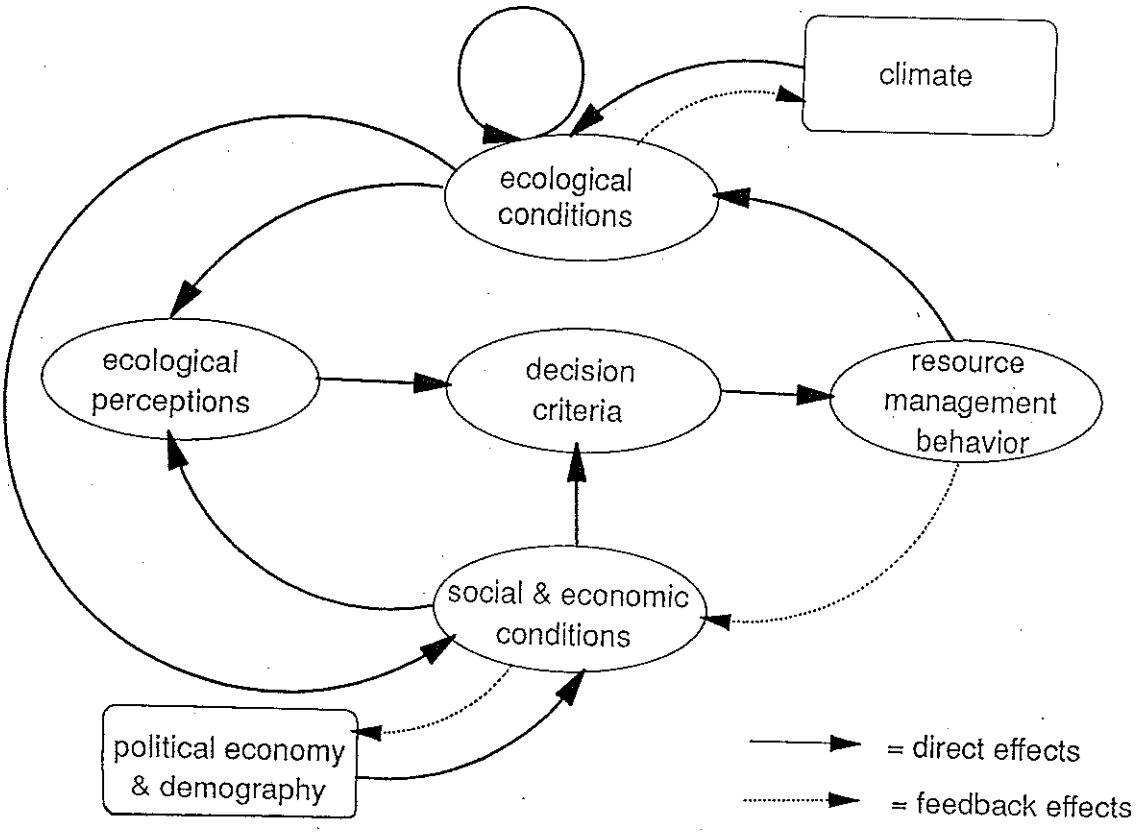
> *An ethnographer, then, cannot be satisfied with a mere cataloguing of the components of a cultural ecosystem according to the categories of Western science. He must also describe the environment as people themselves construe it according to the categories of their ethnoscience. From a presentation of the rules by which people decide upon the category memberships of objects in their experience, an ethnographic ecology can proceed to rules for more complex kinds of behavior, killing game, clearing fields, building houses etc. Determining the requisite knowledge for such behavior shows the ethnographer the extent to which ecological considerations, in contrast, say, to sociological ones, enter into a person's decision of what to do. The ethnographer learns, in a rather meaningful and precise sense, what role the environment in fact plays in the cultural behavior of the members of a particular society.* (p. 55)

An understanding of ecological change must incorporate lived human experience of the world, and show how this experience translates into behavior that in turn influences ecological conditions. The nexus of these interrelationships is human perception, which affects ecology through its influence on resource management. Ecological perceptions in the forms of knowledge and values constitute sets of decision criteria and behavioral rules with respect to land, people and other organisms. The role of ecological perceptions in resource management can be evaluated by the 'goodness of fit' between an individual's perceptions and her resource management behavior. To what extent and under what circumstances do people follow the 'rules' encompassed by their cognition and conceptualization of the natural world? When and why do they fail to behave according to these rules? One obvious response to the latter question is that ecological criteria are not the only criteria that enter into resource management decisions. Nevertheless, by examining the relationship between perception and decision we can gain a better and more explicit understanding of the diverse factors underlying resource management decisions and the ten-

sion between competing decision criteria. Such understanding may, in turn, help to predict resource management decisions as well as contribute to the design of policies and projects that enable local people to make full use of their traditional ecological knowledge and values.

The simple model offered here (Figure 1) summarizes how ecological perceptions are shaped by both ecological and social interactions. Decision criteria consist of the behavioral norms and cognitive rules that derive from knowledge about and conceptualizations of the world, as well as criteria based on social and economic considerations. Local social and economic conditions are driven in part by events and trends external to the local or even regional ecosystem, such as commodity prices, political strife, immigration and emigration. Social and economic conditions are also affected by the consequences of local resource management decisions (indicated by a dashed feedback arrow in the illustration). Decision factors are weighted according to ecological and social criteria and a decision is made resulting in a particular resource management action, such as planting a particular crop, applying fertilizer or selling livestock, among others. Such activity may or may not eventually affect ecological conditions. Ecological conditions are affected both by abiotic and climatic events and trends and by anthropogenic and non-anthropogenic ecological interactions. Ecological conditions may have feedback effects on climate as well as on local socio-economic conditions and, indirectly, the larger political economy.

Figure 1. *Conceptual model of the role of ecological perceptions in indigenous resource management*



The model is not intended to supply the actual decision-making rules, which are specific to people and place. The model does serve as a heuristic tool with which to generate testable hypotheses about the complex interactions of perception, behavior and ecology in specific cultural and ecological systems. The utility of this approach is that it attempts to explain resource management from the local person's—the actor's—point of view, taking into account both ecological and socio-economic inputs to decision-making.

The case study: ecological perception in resource management decisions of Mongolian pastoralists

Introduction

Mongolian nomads have had a nomadic pastoral subsistence strategy for at least one thousand and possibly as many as four thousand years. Nomadic pastoralism continues to be a dominant facet of Mongolia's culture and economy in the late twentieth century. Mongolia's pastoral economy has adapted to a number of political and social changes through the centuries, including two major transitions in the past seventy years. The first, in 1921, was a communist revolution that eventually led all Mongolian herders to join herding collectives. In the collectives, herders tended state-owned animals for a salary, while keeping a limited number of private livestock for subsistence use and trade. The second, in 1990, was a democratic revolution and economic liberalization program that led to the privatization of 70 percent of livestock and the dismantling of the herding collectives.

Mongolia's long history of nomadic pastoralism and the pervasiveness of a nomadic pastoral ideology in Mongolian culture suggest that Mongolian herders possess a rich store of traditional technical and ecological knowledge that enables them to persist, if not thrive, in the harsh conditions of the Central Asian steppe. The work of Mongolian researchers who have documented traditional herding practices supports this conjecture (Bazargür *et al.* 1993, Tumurjav nd 1989, FAO 1991). Their research has examined the ecological basis for nomadic patterns of mobility and pasture use (Bazargür *et al.* 1993, Purev 1991, Tumurjav nd), traditional grazing and livestock management practices (Purev 1991), selection and breeding of native livestock (Tumurjav 1989), and traditional veterinary science (Dash 1991) and weather forecasting (Bataa 1991). Less is known about herders' ecological perceptions and the effects of this century's economic and political transformations on perceptions and traditional practices. It is unclear, for example, how collectivization affected the social relationships through which knowledge was conveyed and acquired, and the customary social institutions through which pasture use was allocated and regulated (Mearns 1993, Humphrey 1978, Sokolewicz 1981).

In this section, I apply the perception and decision model to the herders of Tsagaan Nuur *bag*. First, I describe the ecological and social conditions in Tsagaan Nuur and the climatic, demographic and political economic forces that influence them. Second, I discuss herders' ecological perceptions. Last, I show how ecological perceptions and socio-economic conditions establish the decision criteria that herders use to make specific resource management decisions.

Methods

Research was conducted during June and July 1993. Herder perceptions of pasture resources were elicited by requesting eight informants to draw maps of their pastures and then asking them to distinguish between pastures stating the criteria used to differentiate them. Herders' perceptions of ecological processes and accounts of decisions were elicited in 20 individual and group interviews. Some of these data were

collected in the context of requesting herders' responses to proposed livestock production improvement projects.

Study site and ecological conditions

Tsagaan Nuur *bag* (sub-district) in Tariat *sum* (district), Arkhangai *aimag* (province) is located in the broad river valley of the Hoyt Terkhyn and Tariat Rivers and Tsagaan Lake on the northern slope of the Hangai Mountains. The 2100-meter valley floor is flanked by 2500–3000-meter mountains that lie roughly perpendicular to the river. The north slopes of the mountains are dominated by patches of Larix sibirica forest, while the river's flood plain supports a sedge-dominated plant community. Between the flood plain and the mountains stretches a broad expanse of steppe. Moist north-facing mountain hillslopes support lush mountain meadows and some mountain valleys contain wet sedge-dominated meadows. Tariat *sum* lies within the permafrost zone, and the valley bottom and north-facing slopes show evidence of thermokarst processes. There is little evidence of major soil erosion except for the cryogenic land slumps, which leave bare scarps of soil on the upslope, and streambank failures also probably associated with undercutting of permafrost.

Some evidence of changes in species composition was observed in the heavily grazed areas surrounding the *sum* and *bag* centers and in the immediate vicinity of winter shelters and herding camps. Species such as Artemesia frigida, Potentilla acaulis and Carex duriuscula, which are considered indicators of heavy grazing pressure (Li and Jargalsaikhan 1993, Lhagjab 1993), and Chenopodium album, Draba numerosa and Plantago depressa, which are associated with other types of anthropogenic disturbance (Pacyna 1986), were more abundant at these locations (Fernandez-Gimenez 1993).

The mean annual rainfall in Tariat *sum* is 266 millimeters with a coefficient of variation of 41 percent. Snow covers the ground an average of 131 days per year (PALD 1993). These data suggest that Tariat lies on the cusp between more arid and highly variable ecosystems that exhibit non-equilibrium plant-herbivore dynamics, and moist and productive ecosystems that tend towards a stable equilibrium in plant and herbivore populations (Ellis and Swift 1988, Ellis and Togtokhyn 1993, Cincotta *et al.* 1992). Deep snows and frozen snow (*dzud*) present significant problems for Tsagaan Nuur herders. When supplementary fodder is not available severe weather conditions limit livestock populations. Storm losses may prevent livestock numbers from reaching a level at which density-dependent processes might regulate populations, thus pushing the plant-herbivore system towards uncoupled, non-equilibrium dynamics.

Tsagaan Nuur herders keep cattle, yaks, sheep, horses and goats in their herds. Herding households make a minimum of four to six seasonal movements per year over distances of 3 to 20 kilometers. Rapid long-distance (30–200 kilometer) migrations (*otor*) may be undertaken under severe weather conditions. Herds graze the river's flood plain in summer, the intermediate elevation steppe in spring and autumn, and spend the winter months in the higher mountain valleys.

Social and economic conditions

The *bag* is the smallest administrative unit of government. The next largest administrative unit is the *sum*, the equivalent of a county or district, contiguous with the jurisdiction of the now defunct collective. Tsagaan Nuur *bag* supports approximately two hundred herding households (835 individuals). In Tsagaan Nuur most households join with one or more other households, usually relatives, to form herding camps of two to twelve households called *khot ail*. *Khot ail* often change in size and composition seasonally. Usually households of one *khot ail* work cooperatively, herding their animals in common by turns,

taking turns delivering the milk of all households to the local dairy station, and cutting hay together in autumn. Formal leaders of *khot ail* are not designated but often one elder or experienced herder assumes this role. Several herders reported that herding and movement decisions are made on the basis of discussions among the herders of a *khot ail*. Tsagaan Nuur herders did not recognize any intermediate forms of social organization in between the *khot ail* and the *bag*; however herders from neighboring *khot ail* were observed to engage in some collective activities, including training their horses together for the races on the national holiday, and, in one case, agreeing to set aside a portion of the flood plain as an emergency winter forage reserve.

Most herders belonged to the Gerelt Zam collective (*negdel*) until the *negdel* was dissolved in 1991 and reformed into a cooperative *khorshoo*. There are also a number of new herding households that acquired livestock during privatization and have only recently begun using Tsagaan Nuur's pastures. Herders received livestock and individual ownership of winter shelter structures through privatization, although there were not enough winter shelters for all livestock owners to receive one. The remaining pasture and fodder resources are state owned *de facto* common property. *Khot ail* usually have customary rights to specific winter, spring and autumn pasture areas and wild hay cutting places. These 'customary' rights are sometimes based on traditional use by a family extending back to pre-collective times, and other times are based on use during the collective era. Summer pastures on the flood plain function as an open access resource. Herders establish their summer camps on a first-come, first-serve basis.

Customary claims to pasture resources, regardless of their origins, are somewhat tenuous due to a lack of any formal legal structure or local authority for settling land disputes. Herders perceive there to be no local authority for settling land and pasture disputes, and the proposed national land law has yet to be passed by Mongolia's legislature. Together these circumstances provide no security for current tenurial arrangements. Several herders interviewed complained that their winter pasture was being trespassed during summer by other herders. The most common sources of complaint were new herders and households camped nearby the district center.

Tsagaan Nuur herders have several avenues for selling livestock products, including two cooperatives (*khorshoo*), a trading *khorshoo*, a broker company and occasional private traders. The district as a whole suffers from a lack of liquidity, and herders are often unable to get cash for their products, or to pay in cash for goods (PALD 1993). Petrol is in very short supply in all Mongolia, raising transport costs. Consequently consumer goods, including staples such as flour, rice, tea, and other essentials such as cloth, have increased in price and are frequently unavailable. Unemployment and high prices in the city have contributed to an urban-to-rural migration, which has been intensified by the lure of acquiring livestock through privatization.

Under the collective system, elementary education was mandatory for all children and health care was provided through regular home visits by physicians and other clinicians. Since 1991 some herders have stopped sending their children to school because they cannot afford to pay their keep as boarders or to maintain two households (one near the school and one moving with the livestock). Hospital and clinic budgets have been drastically cut and medicines are difficult to obtain.

Ecological perceptions

Herders classify pasture resources in two ways, by season of use and by the nutritional characteristics of forage. Forage resources are divided into two broad categories, the 'thick' or 'hard' grass found on the flood plain and in wet montane meadows, and the 'thin' grass characteristic of the

steppe and hillsides. The 'thick' grasses (sedges) were perceived as poor quality forage most suitable for yaks, cattle and horses. The thin grasses of the hillslopes and steppe are preferred by small stock, such as sheep and goats, and are believed to be more 'tasteful,' nutritious, and higher in energy content. Pasture resources classified by season of use are summer, autumn, winter and spring pastures, reserve areas, and distant emergency pastures (*otor* places). summer pastures were considered to have higher density and lower quality forage, while forage in winter and spring pastures was of lower density and higher quality.

Two types of reserve areas were mentioned by herders. First, within the winter pasture used by one herding camp (*khotail*), herders may deliberately save certain areas for emergency use. One herder pointed out that he reserved the steep, rocky south-facing slope above his winter shelter for last-resort use since it offered protection to the animals and some green growth could nearly always be found there in the crevices between rocks. Second, neighboring camps may agree to reserve certain common pasture areas for emergencies. On the north side of the river, herders traditionally set aside a portion of the summer floodplain pasture for emergency use during the winter.

Finally, distant, emergency pastures are used in severe weather, such as deep or frozen snow. The rapid, long-distance moves to these pastures are known as *otor*. In Tsagaan Nuur *bag*, herders typically move 180–200 kilometers to a neighboring district (*sum*) during winter *otor*. In 1992–1993 some herders moved their stock shorter distances, from the north to the south side of the river (approximately 40 kilometers).

Although several officials, including the local zootechnician, perceived degradation in Tsagaan Nuur's riverside pastures, herders did not perceive degradation or permanent changes in pasture productivity or species composition in Tsagaan Nuur *bag*. Year-to-year changes in pasture productivity were attributed to climatic factors rather than livestock effects.

When asked to define degradation, herders distinguished between 'eaten' areas and degraded areas. 'Eaten' places are caused by a concentration of people and livestock in one place at one time. Herders sometimes described these places as having 'too many livestock' or being 'over-eaten'. However, eaten places regrow, usually within one year, without permanent changes in species composition or productivity.

Degraded areas were defined as permanently altered in species composition and productivity and characterized by soil loss and sandiness. Many herders equate degradation with desertification and attribute degradation to human activities other than livestock grazing, most notably driving trucks and tractors across pasture areas. One group of herders offered a sophisticated explanation for the difference between the effects of grazing and the impact of machinery on steppe vegetation: livestock do not damage plant root systems by grazing, whereas heavy machinery compacts the soil and damages roots, thereby inhibiting regrowth. Similarly, some herders said that horses and sheep were the livestock most likely to contribute to degradation because they damage the soil surface by pawing the ground. Root herbivory by the steppe mouse and grubbing by wild pigs were also mentioned as causes of degradation, although neither was said to be a problem in Tsagaan Nuur *bag*. In addition, some herders considered abandoned fodder fields to be degraded due to invasion of weedy species.

Although the herders interviewed did not perceive long-term changes in pasture productivity or species composition, a number of them reported changes in wildlife populations over the years. In particular, they believed that elk, antelope and marmots are becoming more scarce. One older herder had this to say about the changes of the last seventy years:

There has been much damage to nature in the past 70 years. Before then people understood to love nature and protect the rivers and trees. We Mongols have a tradition of keeping the water and forest clean. In the last forty years people have done things like killing animals on the ice of the river [getting blood in the water], and cutting trees wherever they want. After worshiping the oboo [a spirit represented by a sacred pile of rocks or wood] the last three years [i.e. since democratization and the decriminalization of religion] the river and lake are getting bigger and the grass is growing better...In the 1960s we had wild animals like big horn and antelopes which we can't find now. The animals are afraid now. People are hunting wild animals because through development Mongols got many guns from Russia. Yes, Mongolia was very rich with wild animals. For example in summertime we were not allowed to kill sheep or wild animals...I am against killing all wolves. When there are too many it is alright to kill them. Old Mongols say wolves must be involved in herding places. When we kill all wolves, we can't keep our animals. When there are too many wolves, we can push them away. But mostly people can't kill them. Wolves are too clever. (Myagmarjav June 29, 1993).

Other evidence of a Mongolian 'environmental ethic' can be found in the ancient Buddhist prohibition against disturbing the soil (which contributes to Mongols' aversion to cultivation), and in the Great Yassa, Chinggis Khan's legal code, which contains prohibitions against wasting and polluting water (Raisanovsky 1965, Jagchid and Hyer 1979).

Resource management decisions

Two types of decisions will be examined to see how ecological perceptions and social conditions influence choices of action. The first is the decision where to locate a *khot ail* in a given season. The second is the hypothetical decision implicit in herders' responses to specific livestock feed improvement proposals.

The choice of where to camp for the summer is based on ecological criteria including availability of water for livestock and domestic use, avoidance of flooded areas, and availability of optimal forage types (both thick and thin grasses) for the different kinds of livestock. Social and economic criteria used to make the location decision include proximity to the dairy station where herders sell their milk and the degree of crowding on the summer common pastures. summer camp sites do not appear to be allocated or regulated based on customary use. One herder recounted how he hoped to camp alongside the river but while he was waiting for his preferred site to dry, another camp appropriated the spot. This happened again at his second choice spot, and he was finally forced to choose a site that was farther from the main river, although it was about the same distance to the dairy station. In this case the herder had to forfeit proximity to the best water source in order to ensure that he would have an adequate amount of pasture and be within a reasonable distance of the dairy station.

In the winter, location of camps depends largely on ownership of winter shelters and customary rights to winter pasture areas. However, these rights are increasingly difficult to enforce. Competition is greatest for winter pastures and shelters close to the administrative centers of the *sum* and *bag*, but these pastures also are at greatest risk of trespass during summer, the trespassers effectively 'robbing' the winter users of their winter forage. Herders who use unoccupied pastures and shelters in more remote locations are assured of sufficient pasture, but must sacrifice proximity to schools, shops and health services in order to obtain this security.

While herders consider use of another's winter pasture during summer to be an infringement on the right of the winter user, without exception they express willingness to share their winter forage *during winter* with other herders displaced by storms or

other disasters. This reciprocity, which is universally accepted and valued in Tsagaan Nuur *bag*, constitutes a facet of Mongolian traditional ecological knowledge expressed through the perpetuation of a social convention.

The second class of decisions are the hypothetical choices indicated by herders' responses to proposed livestock and feed development proposals. In individual and group interviews herders were asked to respond to several such proposals. Some proposals stimulated a range of different reactions from herders ranging from approval to condemnation, while others received more uniform responses. In each case herders' discussion of the proposal suggested the criteria and reasoning underlying their responses.

Most herders responded negatively to a proposal to implement rotational grazing. Their reasons were both ecological and economic. From an ecological standpoint herders perceived rotational grazing as unnecessary and potentially detrimental, since they perceive that even pastures overused in one year usually recover in the next. Some went on to say that pastures that are left ungrazed for many years decrease in productivity. From an economic standpoint, herders felt there was not enough pasture available to allow large areas to rest each year.

Similarly, herders were not in favor of introducing foreign genes into their local livestock breeding pool. They evaluated this proposal from an ecological perspective by saying that their native Mongolian livestock are better adapted to the harsh conditions of the steppe. They weighed economic factors by stating that they were nevertheless interested in increased wool and milk production, if this could be achieved by careful selection of native stock. In addition they needed breeds of cattle or yaks suitable for drought now that mechanized transportation is unavailable.

When asked to respond to the proposal to implement a formal system of pasture leases, herders responded differently. Their responses illustrate the tension between ecological considerations and socio-economic ones. On one hand, the variability in climate and the consequent need for flexibility discourage leases of fixed pasture areas to individuals. This perspective is reflected in herder comments such as "Ownership by individuals is difficult. Every year is different and animals need big pasture places," and "Privatization of pastureland is very dangerous because of the variability in the climate and the need for flexibility...Also, people don't respect the idea of private ownership." On the other hand, increasing competition for and trespass on pastures leads many herders to desire the greater security of tenure that a formal lease would provide. A number of herders suggested that different tenure arrangements were needed for summer pastures and pastures used in the other seasons. A herder explained this need through ecological reasoning; summer pastures are 'growing places', grazed during the period of continuous plant growth, while autumn, winter and spring pastures are 'not growing places,' where the forage resource is preserved dried grass purposefully saved for use during these seasons. Because of their regrowth, summer pastures are viewed as a near limitless resource, while autumn, winter, and spring pastures are much more finite resources. This explanation suggests that the 'limitless' resource of summer 'growing places' can withstand a less regulated, more open system of allocation, while the finite winter, spring and autumn pastures require a more elaborate and enforced system of rights. Some herders explain the recent difficulties with trespass as the result of new and inexperienced herders acquiring livestock under privatization. These new herders lack the traditional ecological knowledge and personal experience that instill the importance of and the reasoning behind saving all winter pastures for the hardest months.

Discussion

Earlier on I stated that the role of ecological perception in resource management could be measured by comparing perceptions with behavior. In this section I have attempted to illustrate the role that ecological perceptions play in reported and hypothetical decisions of Mongolian herders. The descriptive analysis offered here suggests several hypotheses to be tested, including the following: 1) Inexperienced herders place greater emphasis on economic and social criteria rather than ecological criteria in deciding where and when to graze; 2) Herders in more remote areas give more weight to ecological criteria; 3) The weight given to ecological criteria increases with increasing aridity and variability in the environment. These questions will be further examined in research planned for 1994–1995. Equally as important as evaluating specific hypotheses is obtaining a greater understanding of the historic social, political, economic and ecological contexts in which decisions are made. Many decisions made by Tsagaan Nuur herders are clearly driven by the recent national, political and economic events that have led to shifting rural demographics and the breakdown in the local institutional structure of pasture allocation, not to mention the opportunity for herders to make certain decisions in an independent and decentralized, rather than a centralized, fashion.

Summary and conclusion

This paper has defined ecological perception as having two components directly relevant to resource management: cognition or ecological knowledge and conceptualization or world view. Both are products of human ecological and social interactions and consist of sets of cognitive and behavioral rules. These rules and the resource management activities that follow from them apply not only to human interactions with soil, water, animals and plants, but also to social interactions with other humans, which comprise a crucial dimension of ecological knowledge and resource management. The model presented places ecological perceptions and decision making at the nexus of the relationship between ecological and socio-economic conditions. Ecological perceptions reflect the way in which humans experience the world, and it is this lived experience, grounded in ecological and social interactions, that is brought to bear when decisions are taken. The model also accounts for the external forces—climate, demography and political economy—that affect ecological and socio-economic conditions. The role of ecological perceptions in resource management can be evaluated by comparing ecological perceptions with resource management behavior. The lack of correspondence between stated knowledge and values, and observed behavior, may be attributable to alternative factors and criteria, such as social and economic considerations, used in decision-making.

A case study from the Mongolian forest-steppe illustrates how herders use ecological and social criteria to make decisions about camp locations and to assess development proposals. The case study also demonstrates how the macro-scale political and economic changes in Mongolia affect local resource management decisions. How will these historic changes affect the ecology and sustainability of Mongolia's rangelands? I suggest that one key to predicting and directing these effects is a careful examination of ecological perceptions, social and economic criteria and the roles each play in local resource management decisions.

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Acknowledgements

This research was supported by a National Science Foundation Graduate Fellowship and summer Travel Grant, the Berkeley Chapter of Sigma Xi and by the University of California, Berkeley. Dr. Barbara Allen-Diaz and Dr. Lynn Huntsinger provided intellectual and financial support. The Research and Teaching Institute for Animal Husbandry in Ulaanbaatar, Mongolia, the PALD project and the Institute of Development Studies in Brighton, England provided invaluable technical and logistic support. Emery Roe and Lynn Huntsinger furnished extensive comments on a draft.

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