

Commission on Nomadic Peoples

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Human Responses to Environmental and Social Uncertainty”

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Nomadic Peoples, Number 28, 1991

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Transhumant Goat Pastoralism in the High Sierra of the South Central Andes: Human Responses to Environmental and Social Uncertainty

Lawrence A. Kuznar

Uncertainty in the physical and social environment is an important consideration of pastoralists in deciding how to manage their herds. The responses to uncertainty are examined in the case of Andean goat herders who live in the high sierra of the Department of Moquegua, Peru. Droughts, theft, and predation are the primary risks faced by these herders. Mobility, and particular slaughter strategies are used to respond to random climatic events. Dogs and vigilance are the primary means of protecting herds from thieves and predators.

An important issue which concerns Andean pastoralists, and pastoralists in general, is the management of uncertainty. Random fluctuations in forage availability, theft, and predation are thought to condition pastoral behavior in the Andes (Browman 1984, 1987; Flannery et al 1989; Kuznar 1991). Pastoral families who live in the high sierra environmental zone (2500 m to 3800 m amsl) in the Department of Moquegua, Peru (Figure 1) were studied in 1987 and 1989 in order to address the effects of risk on pastoral behavior. These pastoralists represent an important but little described population in the Andes. High sierra pastoralism varies between household production by primarily agricultural families (cf. Isbell 1978; McCorkle 1987), to full time economic specialization on herding (Kuznar 1990). All pastoralists in the Andes must respond to the same opportunities and limitations presented by the availability of forage, the growth potential of their flocks, and random fluctuations in herd size due to environmental and social hazards. A detailed description of environmental parameters for the high sierra, and production parameters (i.e. birth rates, meat/wool yields, forage

requirements) for high sierra herd animals are presented here in order to provide an empirical basis for an understanding how uncertainty affects pastoral behavior in the south central Andean high sierra. Then, the strategies employed to mitigate risk and to take advantage of opportunities in the environment are discussed.

High Sierra Environments

Most researchers agree that there are four basic environmental zones on the western flank of the south central Andes (Molina and Little 1981; Weberbauer 1945; ONERN 1976). These are the coast, the low sierra, the high sierra, and the altiplano, or puna (Figure 2). The high sierra is found between 2500 m and 3800 m. This zone is characterized by large mountains, deep valleys, and seasonal rains between November and April (Molina and Little 1981). The rains, although not great (200 to 800 mm/year), support shrub vegetation and some pastures of Andean bunch grasses (Weberbauer 1945; Troll 1968). People cultivate wheat, barley, Andean grains such as quinoa (*Chenopodium quinoa*), and potatoes (Brush 1982; Dollfus 1981;

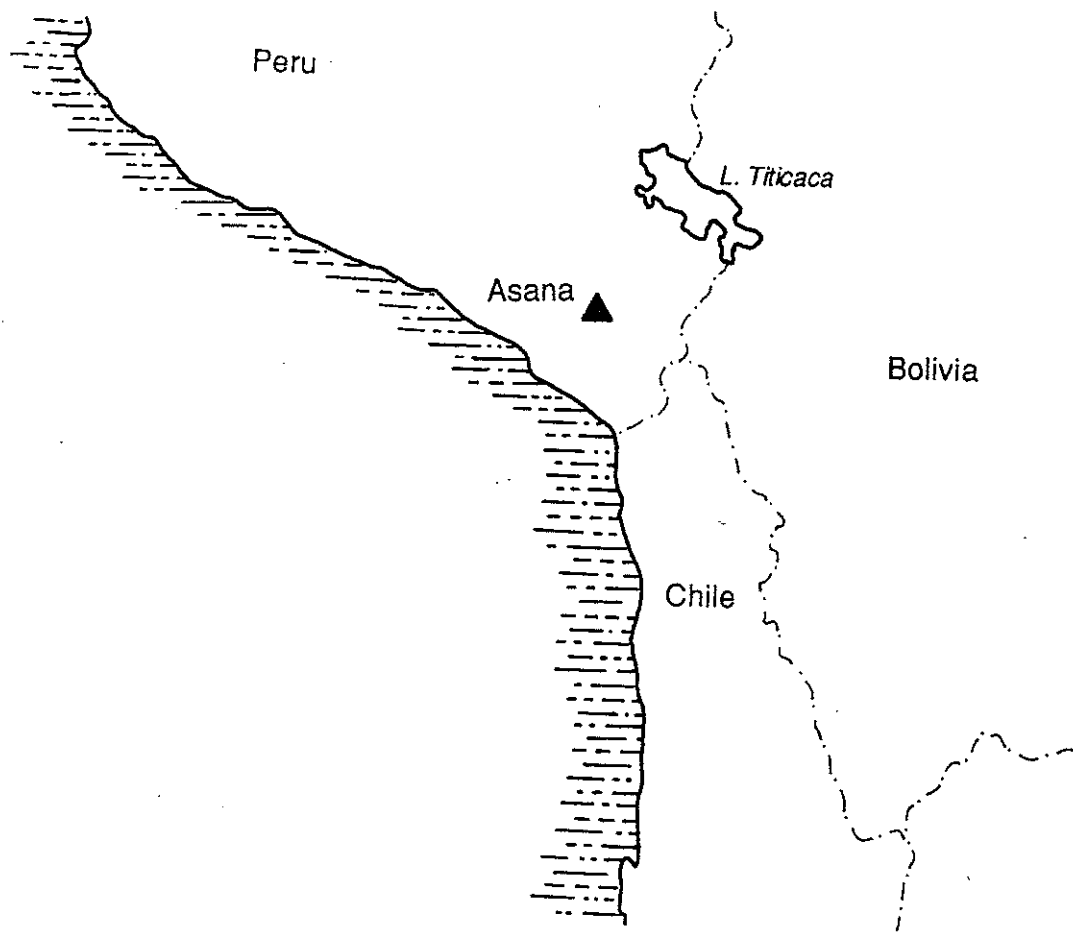


Figure 1.

Orlove and Godoy 1986) and raises sheep, goats, and cattle (Kuznar 1990; Isbell 1978; McCorkle 1987) in this zone.

This study investigated the drainages of the Coscori, Asana, and Charaque rivers in the Department of Moquegua, Peru (Figure 3). The high sierra in these valleys can be subdivided into upper and lower zones based on precipitation and vegetational differences (Kuznar 1990; Weberbauer 1945; ONERN 1976). The lower high sierra receives low seasonal rainfall, and has very sparse perennial vegetation, warm days, and cool, but not freezing, nights (Table 1). The primary plant species are *Franseria meyeniana* along with various cactuses and annual grasses. Mean annual temperature is about 10°C, and major droughts occur in two out of nine years (ONERN 1976). During the wet season, the normally arid landscape becomes green with annual grasses which, in some cases, can support dense populations of animals (Kuznar 1990).

The upper high sierra has higher seasonal rainfall, more diverse vegetation, and cooler temperatures than the lower high sierra (Table 1). The dominant plant species in this zone include shrubs such as *Fabiana weberbauerii*, *Parastrephia lepidophyllum*, *Adesmia arborea*, *Baccharis odorata*, *Baccharis latifolia*, *Baccharis boliviensis*, *Balbisia meyenii*, *Verbena juniperina*, perennial grasses such as *Calamagrostis brevifolia*, *Calamagrostis amoena*, *Stipa ichu*, annual herbs such as *Gilia glutinosa*, *Tagetes multiflora*, and various cacti. Mean annual temperature is about 9°C, and precipitation is less variable than the lower high sierra, with major droughts occurring in about year in ten (ONERN 1976).

This is the environmental context in which high sierra pastoralism exists. Its main features are the seasonal and spatial differential availability of forage, altitudinally stratified zonation, and periodic drought. The adaptations exhibited by Andean herd animals to these features are described next.

Table 1. Environmental Zones within the High Sierra

Elevation	Zone	Characteristics
3800 m	Upper High Sierra	Seasonal rainfall (250mm) Matorral Shrub Forest Warm Days, Cold Nights
3400 m		
2500 m	Lower high Sierra	Seasonal Rainfall (40 mm) Sparse Vegetation Warm Days, Coll Nights

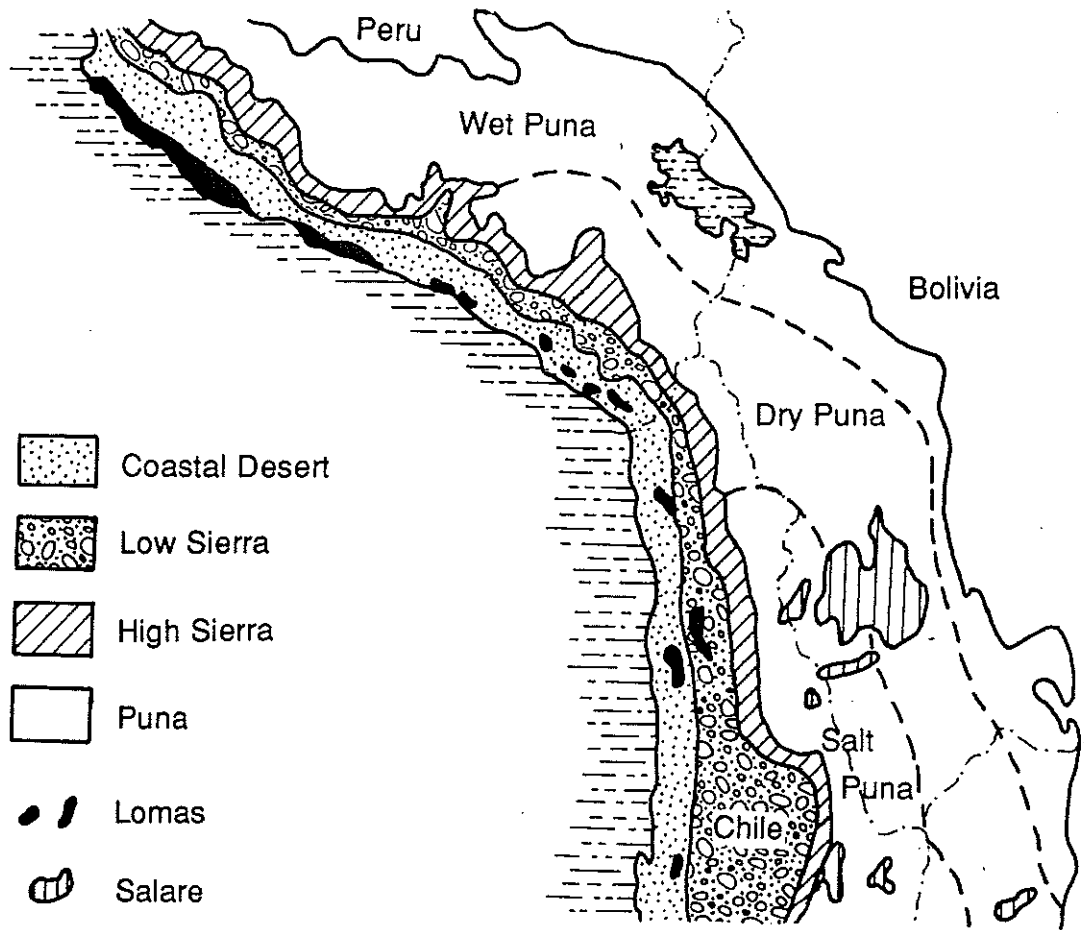


Figure 2.

Animals Herded in the High Sierra

The primary domestic animals used by high sierra pastoralists in the Department of Moquegua are goats, sheep, and cows. All animals are local, unimproved criollo breeds. The average herd has 350 (range 120-900) goats, 30 sheep, and 5-10 cows. Basic parameters for each of these animals are listed in Table 2. Most of this information was collected through observations of herding behavior and interviews as little has been reported for Andean herd animals, especially goats and cows.

Herders raise criollo goats primarily for their meat in the Asana valley. Criollo goats weigh about 20 kg, and goat dressing percentages are about 50 percent (Devendra 1978). Goats are driven to a market for slaughter where goat meat brought a price of 4500 intis/kg (approximately \$1.12 U.S.) in August of 1989. The milk of females who have lost young that year is used to make butter, cheese, and for cooking. Otherwise, people do not purposefully milk goats in the Asana valley. Herders sell some of the cheese, although the family uses most of the milk products from the goats.

Goats consume approximately 3.5% of their body weight in dry matter (DM) per day (Devendra 1978), which consists of 60% browse and 40% graze in the Asana valley (Kuznar 1990). However, the goats demonstrated an ability to consume a great variety of plants, and their dietary composition could easily change depending on the time of year and the availability of forage. Because of this dietary flexibility, goats are able to use the high sierra landscape more extensively than all the other animal species. In addition, goats are the most prolific herd animals in the Andean high sierra. Goats typically twin, and they give birth twice a year; once during the wet season and once during the dry

season. However, pastoralists usually kill one of the twins at birth during the dry season in order to ensure that the female will have enough milk to feed the other twin during this lean time of the year. Therefore, goats have a fecundity rate of about 3 births/female/year. The primary predator of goats is the Andean fox (*Dusicyon culpaeus*) which attacks both adult and young animals at night. Informants report that between 4% and 8% of a flock will be lost to predators each year. Kid mortality is reported at roughly 10%, caused by frosts and predation by Andean fox.

Criollo sheep provide meat and wool. Most lambs are born between January and May. Fecundity rates for highland Andean sheep range from 1.14 to 1.43 births/female/year (Choque and Cardozo 1974). The breeding age of sheep at this altitude is two years, and animals are weaned at 8 to 9 months. Herders allow ewes to live a maximum of 5 to 6 years. At two years of age, most males are slaughtered, and young "fat" ones may be slaughtered as well. Mutton commands a high price of 6500 intis (\$1.62) per kg. Herders report that sheep in the high sierra may be sheared at any time of the year when a family needs money, or wool for household consumption. Sheep are sheared every one or two years with annually most common.

Sheep face the same hazards as goats. Because few sheep are herded in the high sierra, it is difficult to estimate hazard rates. However, in a particular herd with eight lambs, a fox killed one in the month of February, when foxes are particularly bothersome. Lambs are also known to die from exposure to frosts. Some diseases afflict sheep, especially one carried by a parasite which lodges in their liver. They have a diet of 100% graze, and prefer the wetland vegetation which grows in marshes known as bofedales. Because of their narrow diet,

Table 2. Characteristics of Domestic Animals in the High Sierra

Character	Goats	Sheep	Cows
% Bodywt. DM*	3.5	3.5	2.5
H. S. stock rate**	1.7	4.8	22.6
L. S. stock rate**	0.4	0.46	3.6
Diet (%grze/%brze)	40/60	100/0	80/20
Herd Sizes	100-900	20-40	0-10
% Herds	90%	10%	1%
Slaughter rate	8%-10%	15% ?***	+
Infant mortality	10%	12.5%	+
Adult mortality	4%-8%	4%-8%	N/A
Fecundity	3	1.14-1.43****	0.50****
Birth season	Aug./Jan.	Jan.-May	All Year
Wool yield	N/A	2 kg	N/A
Weight	20 kg	25 kg	250 kg
Dressing %	50%	50%	50%
Dung kg/day*****	0.3	0.3	4

*from figures in Devendra 1978; Gatenby 1986; Iannelli 1984

**from figures in Kuznar 1990

***Sheep slaughter rates taken from Thomas 1973

****Fecundity rates for Sheep were taken from Choque and Cardoza 1974. Rates for cows taken from Sal-Paz 1975

*****Winterhalder, Larsen and Thomas 1974

they are the least efficient grazers per unit live weight in the high sierra.

Criollo cows are raised for meat and milk, and attain an average size of 200 kg to 250 kg. Cattle live about ten years, but pastoralists slaughter males when they need cash. Beef brought 4000 intis (\$1.00) per kg in the Moquegua market during August of 1989. Women milk cows each morning and make the milk into cheese, or leave it raw; the family sells some and consumes some. Cows have a mixed diet (roughly 80% graze, 20% browse) and prefer to graze in *bofedales*; they appear to have few natural enemies and most survive to be slaughtered.

High Sierra Pastoral Social Structure

The basic social unit is the nuclear family composed of a couple and their unmarried children. Extended families, composed of a core of siblings and their families, are also common. Families recognize a household head (usually male) who has most of the apparent responsibility for herd management decisions. All family members engage herding activities. Children are especially important for the day-to-day maintenance of animals. The family head takes care of the more valued species (such as cows), and is often away negotiating barter arrangements with agriculturalists, or conducting market transactions in the nearest large town of Moquegua.

Relationships between families vary, and there is little community identification among the pastoralists, owing to their mobility and nuclear family focus. One persistent social problem for high sierra pastoralists is theft. Because herd animals are docile and mobile, they are easily stolen (Irons 1965; Flannery et al 1989; Orlove 1977). Informants cited figures of 10% to 20% losses to their herd from theft alone. Initially, I was skeptical of these high

figures, but then I observed one thief who, when confronted with his crime, admitted to a third party, that he alone had stolen five goats, representing about four percent of a particular family's flock. Since only a few instances of thefts such as this are necessary to achieve a 10% to 20% loss of a family's herd, I am now inclined to accept this figure tentatively. Pastoralists stated that both Aymara camelid herders from the *puna* and other high sierra pastoralists will steal animals from high sierra herds. However, the main source of thieves are the agriculturalists and townsfolk from lowland towns and villages. This is interesting since Flannery et al (1989) describe precisely the same pattern of theft on *puna*/high sierra llama herds in Ayacucho. Other researchers have noted that high theft rates are also common among Andean agriculturalists (Gade 1970; Tschopik 1944). Strategies employed by pastoral families to control this loss will be discussed below.

During the wet season (November to April), animals graze in the lower high sierra zone between 2500 m and 3200 m. Animals remain in this zone until they consume all of the grasses, usually through May or June/July. When the animals deplete these resources, herders move them into the upper high sierra zone to exploit perennial vegetation. Each family retains land-use rights in each environmental zone. Families retain these rights primarily through use. Although all families claim to have legal title to land, legal documents to land are rare, and tensions can arise when two families arrive on the same pastures. Informants admitted that the best way to prove one's right to grazing land was simply to be present there before anyone else arrived.

Tensions are exacerbated by the variable mobility strategies employed by high sierra pastoralists. Although all families follow a lower zone/wet season and a higher zone/dry season mobility

pattern, families differ in their degree of residential permanence, and in the frequency with which they use certain parcels of land. The mobility patterns and herd sizes of four families who use the Asana/Charaque drainage will be described to illustrate this variability.

Family A consists of three brothers and two sisters who have a flock of approximately 80 sheep. This family typically lives in the adjacent Capilune valley, about 20 km away. But in drought years they move into the Asana valley, and live in a large cave known as Cueva Quellaveco between August and January. This family's residence pattern can be described as fully transhumant. They change residence seasonally, and move into a different valley during the poor years (Figure 3).

Family B lives year-round in the community of Tala, at the confluence of the Asana and Charaque rivers. The family consists of a couple and their four sons and five daughters. Only two of these sons and two to three of these daughters live with the family year-round, the others having moved away. The family herd consists of 150 goats, 37 sheep, and 11 cows and it remains in the lower high sierra near Coscori from January through April. During the dry season, the animals graze in the Asana valley (Figure 3). Small, temporary pastoral camps are used during these seasonal forays, although the family uses a permanent residence in Tala as a hub for their pastoral activities.

Family C is a nuclear family and owns a herd of about 400 goats. These animals graze in the lower Capilune valley during the wet season, and in the Asana valley during the dry season (Figure 3). This family is fully transhumant, changing their residence at least once during the wet season, and twice during the dry season. Their two dry season habitations are located at 3500 m and at 3800 m at Cueva Quellaveco. During drought years, when Family A invades Family

C's territory, relations are tense, yet the families come to an agreement about grazing territory.

Family E is one of the wealthier families in the region. They maintain a diversified economy having agricultural plots (*chacras*) in the community of Tala and a large herd. This herd grazes along the Coscori in the lower high sierra during the wet season. During the dry season, their herd of 900 goats, 30 cows, and 25 sheep moves to the Charaque drainage, which they almost entirely control (Figure 3). The family maintains seasonal habitations in the Charaque valley during the dry season.

These descriptions illustrate both the variability in wealth which occurs and the variability in mobility and residential pattern which is based on a common wet season/low zone and dry season/high zone mobility pattern. These differences are in response to the seasonal shift in resource location, and to the particular quality and quantity of pastures that each family has available to themselves. Next, the responses of pastoralists to uncertain fluctuations in the availability of these resources and theft will be described.

Responding to Uncertainty: Drought, Theft, Mobility and Vigilance

The primary forms of uncertainty that affect herds in the high sierra are fluctuations in precipitation, theft of livestock, and predation. Precipitation in the upper high sierra Asana valley averages 250 mm/year, and in the lower high sierra it averages 40 mm/year. The herders define a drought year as a year in which precipitation levels are not high enough to maintain the natural forage on which their animals depend. This corresponds to levels of precipitation below 100 mm/year in the upper high sierra, and below 10 mm/year in the lower high sierra. Droughts occur

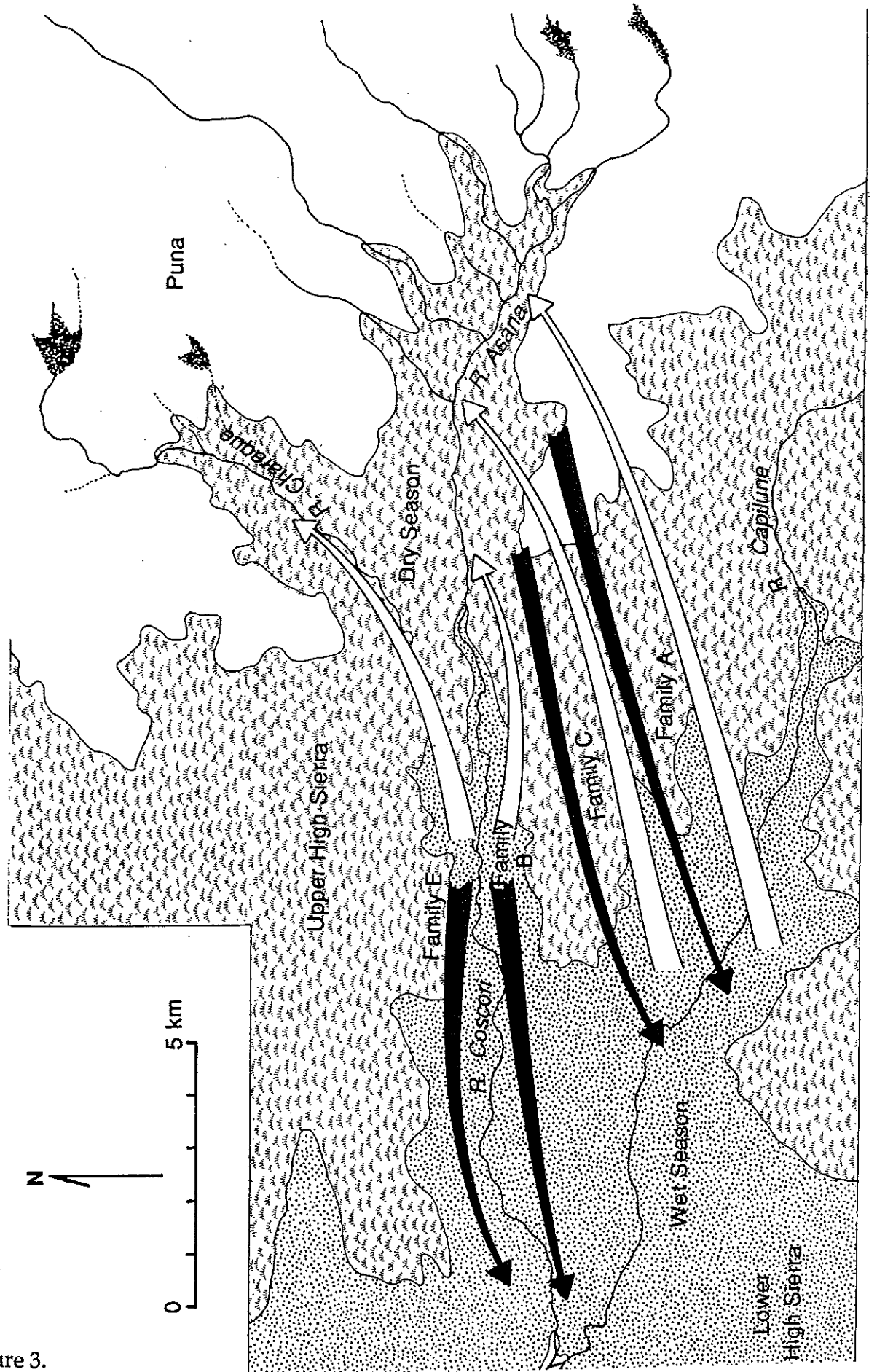


Figure 3.

roughly in one year out of ten. A severe drought limits the ability of females to produce enough milk for their young, and decreases the amount of forage available for all animals, resulting in starvation. Local pastoralists noted that a bad drought year can result in the loss of an entire generation of kids and lambs, and up to 60% of an adult herd.

Pastoralists use three strategies to mitigate the effects of drought years. These include a herd composition which favors goats, mobility, and a specialized slaughter strategy. Goats usually constitute the majority of a family's herd, and generally are preferred to other animals because they reproduce twice as rapidly as sheep, and are able to eat many kinds of forage, which improves their ability to survive a severe drought when preferred forage species (especially grasses) may not be available.

Mobility enables pastoralists to utilize areas where grazing lands may be available. The mobility patterns of Family A described above are an example of this. In years of drought, Family A moves from the Capilune valley to the Asana. However, this strategy cannot be widely used since most regions have already been claimed as grazing territories, and access will not be open. The tensions between Family A and C illustrate this point. Furthermore, since drought affects the entire region, most areas will experience depressed availability of forage, and moving from one impoverished area to another will not solve a family's problems.

Another response to periodic drought is the use of a specialized slaughter strategy determined by the following algorithm. If precipitation is normal for the year, slaughter only those animals needed for the family's immediate food and cash needs. This allows herds to be maintained at maximum levels with respect to available forage during normal years. If the year is a drought year, slaughter as many animals as necessary

to adjust herd levels to the amount of forage available in the family's grazing territory. This strategy results in the slaughter of 30% to 50% of a herd in a drought year and maintains the largest possible herds at all times, thereby ensuring, as far as possible, the family's welfare by maintaining a large herd which can withstand periodic reductions due to droughts. The only time herds are not using all available forage resources is when a herd is rebounding from a drought year.

Herds are not only valued for their monetary worth in consumption, but also for the prestige conveyed by owning a large herd. Therefore, each herder's overall satisfaction level is maximized by maintaining as large a living herd as possible, rather than through consuming the animals of the herd. The maximization of a herder's satisfaction through maximizing herd size makes the slaughter strategy described above attractive to high sierra pastoralists.

Uncertainty need not always imply deleterious effects on resource levels and herd growth. Very occasionally (roughly every generation) a major climatic event known as an *El Niño* occurs in the south central Andean coast (Dillon 1985; Molina and Little 1981). The waters off the Pacific coast of South America are normally cold, and north-flowing. Approximately every generation or so, this current reverses, and warm, equatorial waters flow south along the Andean coast. This results in torrential rains on the normally arid coast, and a virtual blooming of the coastal environment (Dillon 1985). When this occurs, high sierra pastoralists will travel approximately 100 km to the coast to graze their herds on the desert vegetation. The effect of this temporary windfall in forage is to increase the fertility of the herd and allow a spurt of herd growth during that year. However, the last *El Niño* was in 1982-83, and this strategy is not a normal part of yearly

pastoral activity.

Environmental fluctuations are stochastic phenomena which operate on the scale of years, or decades. Other stochastic phenomena such as theft and predation operate on a daily scale. The rate of theft suggested above for high sierra herds is roughly 10% to 20%. This high rate is a threat to herd growth, and high sierra pastoralists are reasonably concerned about thieves, generally known as *mala gente*. Although local pastoralists express a fear of violence from the *mala gente*, overt violence in thievery does not appear to be common. The primary means of protecting herds from theft and family members from thieves, is through personal vigilance and the use of dogs. Dogs bark and warn herders of approaching strangers and may even attack and thwart thieves. Dogs are an important link in the vigilance network since, when several hundred goats are spread over several hectares of rugged terrain, or when people are asleep in the middle of the night, the dogs are able to keep watch where herders cannot.

Dogs provide another important service to pastoralists in the Andean high sierra. Predation from Andean fox, mentioned above, is a hazard which can claim between 4% and 8% of a herd per year. Although not as serious as theft, this still represents an important source of loss, and one about which pastoralists are very concerned. The response is again through the use of dogs and personal vigilance. Foxes usually attack at night, so dogs are more useful than humans for chasing away these predators. Dogs will also actually hunt and kill foxes, thereby supplying some degree of predator control.

Summary

Pastoralism in the south central Andes focusses on the herding of goats with minor contributions from sheep and

cows. Owing to the aridity of the environment, the steep altitudinal gradient, and the differential availability of resources along this gradient, most pure pastoral families maintain a seasonally transhumant pattern of mobility between wet season camps (2500 m to 3200 m amsl) and dry season camps (3400 m to 4000 m amsl). Important sources of stochastic variation involve fluctuations in precipitation, theft, and predation. Fluctuations in precipitation involve random droughts (10% of the years), and major rainfalls on the distant coast (approximately every generation). Mobility, preference for goats, and a specialized slaughter strategy were seen to mitigate and take advantage of these stochastic variations in rainfall and forage. Dogs and personal vigilance were used to mitigate the day-to-day hazards of theft and predation. Owing to the ranging abilities, ferocity (perceived or real), and hunting capabilities of dogs, these animals are extremely important in preventing theft and predation. High sierra pastoralists express a desire to maximize the size of their herds, and the strategies described above help them to attain this goal. In sum, high sierra pastoralists are presented with various opportunities and hazards in their environmental and social environments, and successful adaptation to these aspects of their environment is necessary for the successful maintenance of the family herd, and therefore of the family's livelihood.

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Acknowledgements

I would like to extend my gratitude to Mark S. Aldenderfer for making this work possible. The research was supported by National Science Foundation grant BNS88-22261.

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