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Source: Mountain Research and Development, 27(2) : 138-145

Published By: International Mountain Society

URL: https://doi.org/10.1659/mrd.0832

Mountain Research and Development Vol 27 No 2 May 2007: 138–145 doi:10.1659/mrd.0832

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Changes in Livestock Migration Patterns in a Tibetan-style Agropastoral System

A Study in the Three-Parallel-Rivers Region of Yunnan, China

The present paper analyzes the changes in migration patterns of a Tibetan-style transhumance livelihood system for a period of 20 years in northwest Yunnan, China. Between 1984 and 2005, the average number of pastures for rotational use in the 12 investigated villages decreased from 6.2 to 3.9, and the average number of stops on the annual migration route decreased from 8.3 to 5.8. The number of days during which the animals depend on stall feeding and low-elevation shrubs increased from 231.3 to 270, while those spent in forest belts decreased by 32.6% and those in alpine rangelands by 25.5%. These changes have intensified the pressure on low-elevation ecosystems and grazing resources. Winter fodder supply, rather than carrying capacity based on overall grazing resources at all elevations, should be used to determine the scale of pastoral development. Encroachment of woody plants is a major cause of alpine rangeland degradation, which used to be unjustifiably attributed to a growing livestock population. Reintroduction of traditional management tools such as burning can effectively increase the area of available rangeland resources and curb localized degradation processes by evening out grazing pressure.

Keywords: *Transhumance; alpine rangeland; pasture management; fodder; land cover change; livelihoods; Yunnan; China.*

Peer reviewed: *November 2006* ***Accepted:*** *January 2007*

Introduction

The Three-Parallel-Rivers Region on the eastern Tibetan Plateau has been attracting the attention of the world because of its unique geological history on the Asian continent, rich biodiversity, and fascinating ethnic cultures. Vertical agropastoral transhumance is a traditional livelihood strategy for Tibetans who inhabit the region. This complementary exploitation of resources at different elevations through a combination of pastoral management and crop cultivation can be found in many mountainous regions of the world (Uhlig 1995). A vast body of literature on a wide range of issues concerning this form of livelihood has been produced (Uhlig 1995; Miller 1997; Tulachan 2001; Nautiyal et al 2003; Preston et al 2003; Wu 2004; Duncan et al 2006). However, research on the eastern Tibetan Plateau using case-based studies of local livelihood strategies is still very rare. This undermines many conservation and development initiatives. The present study makes a quantitative analysis of the current status of and changes in the seasonal migration of animals in an agropastoral system on the eastern Tibetan Plateau, examines the causes and consequences of such changes, and investigates the causes of alpine rangeland degradation.

Study area and methods

Our study focused on 12 Tibetan villages (28°20'8.5"–28°39'9.5" N, 98°44'43.6"–99°06'54.8" E) within the Three-Parallel-Rivers World Heritage Site that lies at the heart of a topographically complex area known as the Hengduan Ranges—a major arc of mountains curving into Indochina from the eastern end of the Himalayas. Administratively, these villages belong to Deqin County of northwest Yunnan, China (Figure 1). They are all located within the watershed of the Lancang (Mekong) River and differ in terms of elevation of permanent settlements, demographic context, infrastructure development, and alternative livelihood opportunities. The topography of the broad region where these villages are located is characterized by high mountains and deep gorges. As the elevation rises from 2140 m near the Lancang River to 6740 m on the Kawagarpo Peak, a distinctive stratification of biophysical factors—climate, soils, and vegetation—and natural resources occurs along the altitudinal gradient. The dry river valley belt reaches to 2600–2700 m, where it is replaced by forests that usually extend to 4200 m.

Traditionally, local farmers depended on agropastoral transhumance—a combination of activities at different elevations—for a basic livelihood, relying heavily on forest resources and on livestock to maintain a highly self-sufficient economy with little exchange with the outside world. However, since the early 1980s, when China adopted a more open policy and ushered in a market-oriented economic system, this region has been increasingly linked to and impacted by overall economic conditions. Economic restructuring driven by market demand, government programs, and NGO development initiatives has caused local land use changes, redistribution of the labor force, and livelihood diversification. Between 1996 and 2005, the average contribution of agropastoralism to total income in the villages studied dropped from 41.7% (range: 13.6%–64%) to 25.9% (range: 6.3%–55.2%).

The main animals kept by local people include yellow cattle (*Bos Taurus domesticus*), yak (*Bos grunniens*), *pianniu* (a crossbreed of yak and yellow cattle), mules, horses (*Equus cabalus*), donkeys (*Equus asinus*), sheep (*Ovis aries*), and goats (*Capra hircus*). These animals are raised for different purposes. For simplicity in this study, they are analyzed in functional groups:

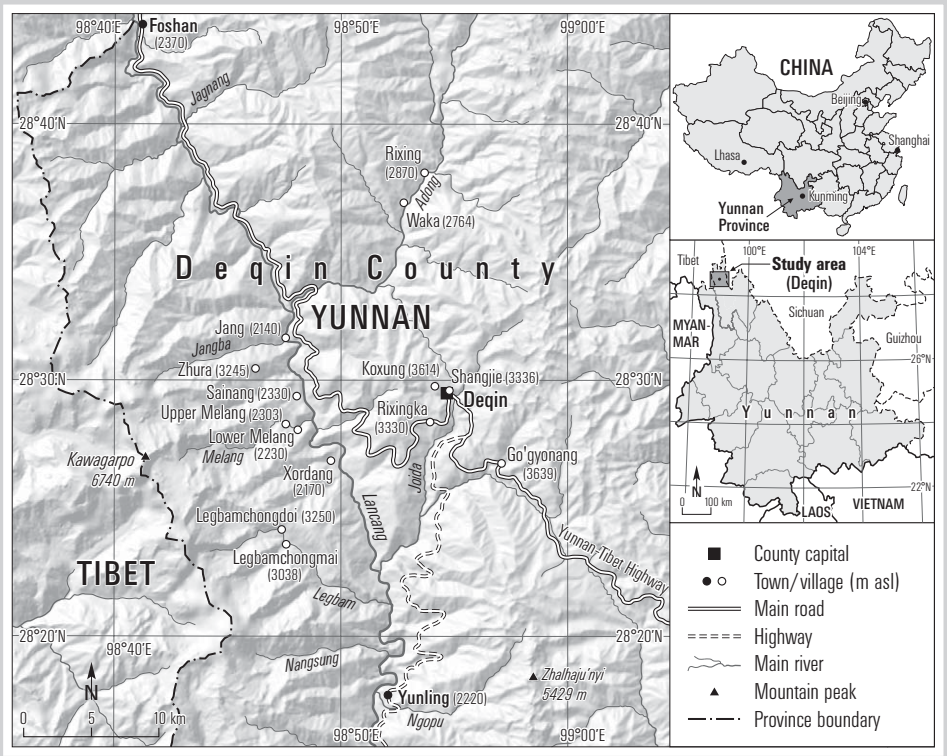

FIGURE 1 Location of Deqin County and the villages studied. (Map by Andreas Brodbeck)

1. MDA: milking and draft animals (yak, *pianniu*, and yellow cattle);
2. PA: pack animals (horses, donkeys, and mules); and
3. GS: goats and sheep.

As PA and GS are mainly kept near the village center during the day and in stables at night, only MDA are engaged in annual migration from low- to high-elevation rangelands. The number of animals and herd composition for each village surveyed are presented in Table 1.

Our methodology employed semi-structured interviews, village meetings, participatory observation, and questionnaires. These participatory rural appraisal tools proved to be very useful. Villagers, especially elderly herders, often provided reliable information on historical changes in pasture use and their underlying causes. Moreover, annual reports from each village for a period of 10 years (1996–2005) were collected from local governments. These proved to be a good source of information on herd size and structure, and the output of livestock production.

Results

Rangeland resources

Land resources for livestock production in the study area include farmland around village centers and in winter-residence areas, shrubland at all elevations, forests, and alpine meadows. Farmland supports livestock production by supplying crops in the form of concentrates, stalks, and silage plants as a winter fodder supplement. Shrubland close to village centers is usually the chief location for animal activities in winter and early spring. Alpine meadows are the principal rangelands in summertime (July and August), while resources in forest belts are used mostly in transition by animals on their way up to and back from village centers.

Types of migration

Depending on the location of permanent settlements and the distribution range of a village's land resources, three basic migration patterns can be distinguished (Figures 2A–2C).

In the first type (Type A, eg Rixing), permanent village settlements are at low elevations, mostly in valley bottom areas near the Lancang River, but their land resources extend from the river bank to the alpine area. They have access to resources across the whole span of the vertical vegetation spectrum and their annual migration routes usually start from and end in their area of permanent settlement (Figure 2A).

The second type (Type B) involves villages where permanent settlement is at high elevations (above 3000 m), but with resources extending up to the alpine area and down to valleys at low elevations (eg Zhura). These villages enjoy resource availability similar to Type A villages. But they have special winter houses at lower elevations (around 2500 m) where people keep their animals in wintertime (Figure 2B).

Type C villages are characterized by permanent settlements at high elevations (above 3000 m). Their resources do not extend to the valley bottom (eg Koxung; Figure 2C). By contrast with the other 2 types, people

TABLE 1 Households, population, and herd composition in the 12 villages in 2005. LU = livestock unit; MDA = milking and draft animals; PA = pack animals; GS = goats and sheep. Conversion factor: 1 head of cattle = 1 LU; one sheep or goat = 0.125 LU (Sere et al 1995). (Source: annual reports of the villages)

Villages	Households	Population	Total LU	% of different animal types		
				MDA	PA	GS
Upper Melang	26	152	126	19.1	62.0	18.9
Lower Melang	25	136	123	20.4	61.2	18.4
Jang	19	102	93	55.8	10.7	33.5
Zhura	15	81	194	81.0	17.0	1.9
Legbamchongdoi	15	84	174	76.5	17.3	6.3
Legbamchongmai	16	84	196	70.3	29.6	3.2
Rixing	20	140	375	89.9	10.1	0.0
Waka	16	86	226	81.4	18.6	0.0
Rixingka	30	145	333	90.6	0.0	9.4
Go'gyonang	5	44	193	90.4	5.2	4.4
Koxung	28	131	248	100.0	0.0	0.0
Shangjie	50	188	90	100.0	0.0	0.0

in villages of this type must keep their animals in stables for a longer time, with a greater risk of fodder shortage in winter. The annual migration distance is shorter; animals are often driven directly to alpine pastures and migrate only between alpine pastures and permanently settled areas of the villages.

In each village, the date for the start of summer migration depends on the availability of fodder resources at higher elevations, and coincides with the time for planting corn, buckwheat, and potatoes that falls between May and early June. The time for returning from summer pastures is regulated so that the animals do not return to the village center before the end of the autumn harvest in September and early October. The herders usually determine the number of days for each stay, based on the availability of fodder resources at each specific site.

Changes in migration patterns

Changes in animal migration patterns are most visibly reflected in: 1) the number of pastures in rotational use; 2) the number of stops made during annual migration; 3) the distance of the migration route; 4) the proportion of time spent at different elevations; 5) the number of households actually engaged in migratory pastoralism; and 6) the location of summer houses.

As illustrated in Table 2 and Figures 3A–3D, between 1984 and 2005, 9 villages (75% of the total) experienced a reduction in the number of pastures in use and 10 villages (83.3% of the total) experienced a decrease in the number of stops made during the annual migration. The average number of pastures used in rotation in the villages investigated decreased from 6.2 to only 3.9, and the average number of stops made during annual migration decreased from 8.3 to 5.8. In 3 villages, ie Upper Melang (Figure 3A), Lower Melang, and Shangjie, traditional vertical transhumance has ceased completely and been replaced by sedentary husbandry. In 7 of the 12 villages surveyed, villagers no longer travel to the same high elevations they used to.

Accompanying these changes in animal mobility is a shift in the length of time spent at each of the 3 major grazing venues (Table 3). Taken as a whole, the length of time that livestock depend on stall-feeding and low-elevation shrubs increased by 16.76%, from 231.3 days in 1984 to 270 days in 2005. By contrast, the number of days spent in forest belts dropped by 32.6% and in alpine rangelands by 25.3%, from 71.7 days and 62.5 days in 1984 to 48.3 days and 46.7 days in 2005.

At the same time, the number of households with people actually engaged in vertical migration is declining, as reflected in the number of byres on the pastures. For instance, in Jang there were 11 summer houses at Yongnong (Figures 3C and 3D) in the 1980s, but only 8 in 1997, 5 in 2004, and 4 in 2005. Similarly, at Nagzhog in Melang (Figure 2A), there were 10 byres in 1984, 8 in 1997, 4 in 1999, 2 in 2002, and none in 2003. This trend is observed in almost all the villages. Families with a limited labor force or with herds whose size is not large enough for one person to take care of will entrust their animals to others, on either a paid or a free-of-charge basis.

The location of summer houses is also changing. In particular, the construction of road networks has

caused redistribution of the summer houses which, when possible, are now mostly concentrated along highways where transport of cattle and goods and sale of dairy products are more convenient. In recent years, the government has encouraged and financed the construction of iron-roofed summer houses with stone walls. This has greatly reduced the flexibility of animal movement and encouraged the concentration of animals along roads, where construction is convenient.

Discussion

Causes and consequences of changes in migration patterns

Change in herd size and structure: From 1996 to 2005, the number of livestock fluctuated, but the general trend was one of decline, accompanied by a shift in herd structure. Of the 12 villages, 10 experienced a decrease (from 1% to 60%) in the total number of livestock units (LU). When all villages are taken into account, the total number of LU, MDA, and GS dropped by 18%, 14%, and 71% respectively, while the number of PA increased by 48%. As mentioned above, livestock production in the study area serves a wide range of purposes pertinent to local ecogeographical and socioeconomic conditions—changes in which often cause a shift in herd size and structure, which is bound to bring about changes in animal migration patterns. In both Upper Melang and Lower Melang, for example, tourism activities (horseback riding in particular) began in 1998 and caused a shift in major animal groups from MDA to PA. At the same time, the adoption of tractors for land tillage has reduced the need for draft animals. This shift in functional animal groups has led directly to the collapse of transhumant pastoralism in these villages. In many households, herd size has been reduced to such a level that it is no longer sensible to have one person take care of the animals, so annual migration simply ceases.

Lack of laborers: The seasonal rhythm of livelihood activities means that many important cash-earning opportunities, such as tourism and gathering of mushrooms and caterpillar fungus, all occur during May and October, which overlaps with the time when animals must be taken to summer pastures. Furthermore, outmigration of laborers, economic restructuring initiated by governmental or development agencies, and new opportunities for alternative income all induce shifts in the demand for labor. Even though livestock production is still the pillar of the local subsistence economy, cash-earning activities are always given top priority. Households short of labor often respond by abandoning summer migration, reducing herd size, shortening the migration route, or reducing the number of stops.

Land use change: Tibetan-style transhumance in the study area is based on rotational use of resources at dif-

FIGURES 2A–2C Animal migration patterns. (Sketch by authors)

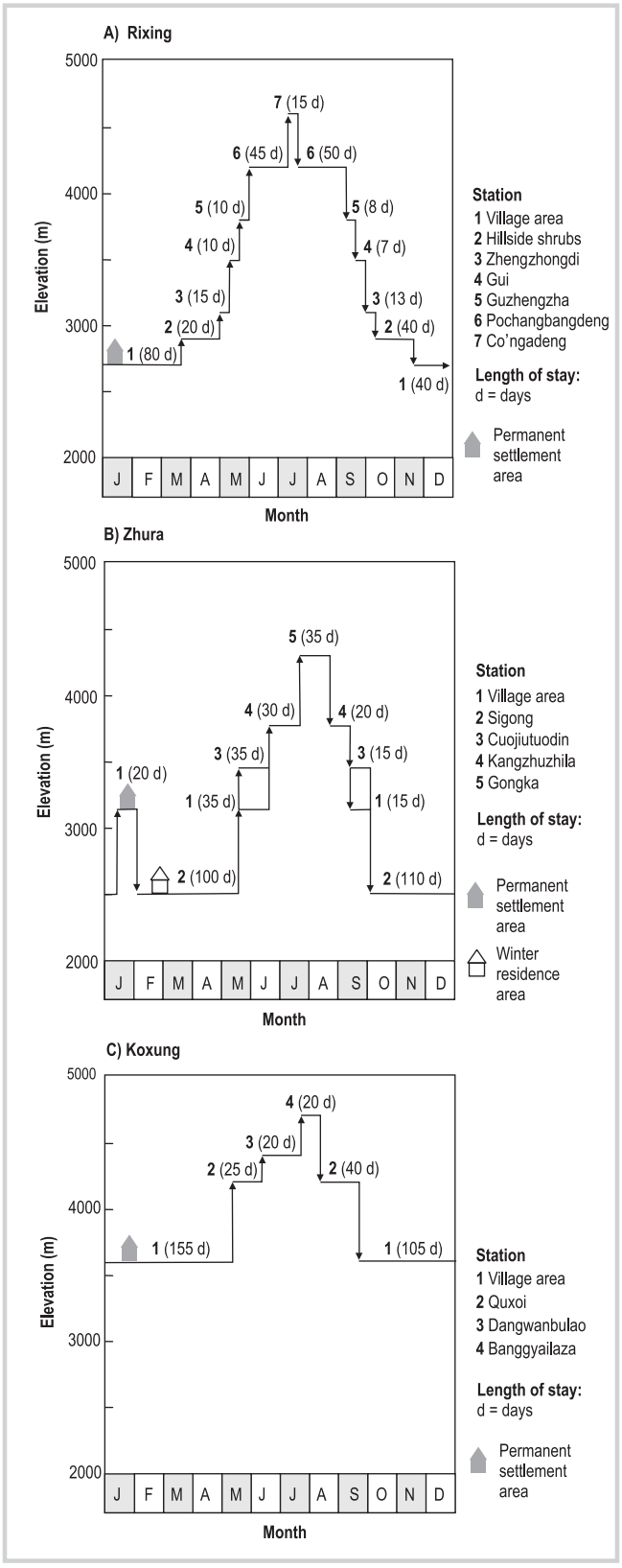

TABLE 2 Changes in animal mobility between 1984 and 2005.

Villages	Number of pastures used		Number of stops made		Highest place reached (m)	
	1984	2005	1984	2005	1984	2005
Jang	7	3	10	6	4400	3222
Lower Melang	5	1	8	1	4314	2500
Upper Melang	5	1	8	1	4314	2500
Waka	9	9	11	10	4500	4500
Rixing	7	7	12	12	4525	4525
Legbamchongmai	8	5	10	9	4200	3887
Legbamchongdoi	8	5	10	9	4200	3887
Zhura	7	5	9	8	4224	4224
Rixingka	4	2	4	2	4450	4400
Shangjie	5	1	6	1	4700	3330
Koxung	5	4	6	5	4700	4700
Go'gyonang	4	4	6	6	4600	4600

ferent elevations. Therefore, changes in land use at any elevation will definitely result in changes in animal migration patterns. In Jang, for example, the local government's advocacy of cultivation of grapes and other cash crops in lowland agricultural areas caused an immediate reduction in the number of animals and changed their migratory patterns. In Shangjie, implementing the nation-wide "grain for green" project on agricultural slopes at low elevations led to a complete cessation of transhumant pastoralism.

However, due to the mountainous nature of the area, not every village or household is exposed to identical opportunities or influences. Factors such as the distance to transport lines and market centers, relative location of tourist destinations, and access to non-timber forest products often make a great difference in terms of advantages and disadvantages. As a result, great inter-village and intra-village differences exist in relation to external impacts and changes in indigenous systems. For example, in out-of-the-way villages such as Waka, Rixing, and Go'gyonang, which are less affected by development programs or market forces, animal migration patterns have remained basically unchanged over the past 2 decades (Table 3).

Changes in animal migration patterns have multiple consequences. Ecologically, these changes have usually intensified pressure on rangeland resources at lower elevations where ecological systems are the most vulnerable. As shown above, the average length of time for animals to feed on stored fodder and graze on low-elevation shrubs increased by about 39 days in 2005 compared to 1984. The impacts of such changes on alpine areas are still hard to predict. The role of domestic animals in creating and maintaining biological diversity, from the genetic level to the landscape level, has been gaining increasing recognition (Molinillo and Monasterio 1997; Wu and Liu 1998; Finck et al 2002; Lasanta-Martinez et al 2005). It is generally agreed that cessation of grazing activities does not always benefit nature conservation.

Changes that have taken place have aggravated the already common and serious shortage of winter fodder and at the same time resulted in under-use of high-elevation rangeland resources. This is quite risky, since at current technological levels and under current socioeconomic conditions, combining transhumant pastoralism and crop cultivation is still the most efficient form of resource use in the study area. Abandonment of such practices would easily expose local people to market-driven macroeconomic conditions and make their lives more unstable and unpredictable.

How many animals can local resources support?

Local pastoral management departments have been using total rangeland resources as a reference point for pastoral planning. This is problematic, as it can easily be determined that, due to the seasonality of livestock activities in the study area, rangeland resources in forest belts and alpine areas are not used to their full capacity, while low-elevation areas are generally overused. In terms of area, low-elevation shrubs accounted for only 21% of the total rangeland resources of the county, but for 75.8% (range: 54.8%–100%) of the grazing days in 2005. This clearly indicated that winter fodder resources—not total resources at all elevations—were the bottleneck factor that should be used as a basis

FIGURES 3A–3D Changes in migration patterns between 1984 and 2005. (Sketch by authors)

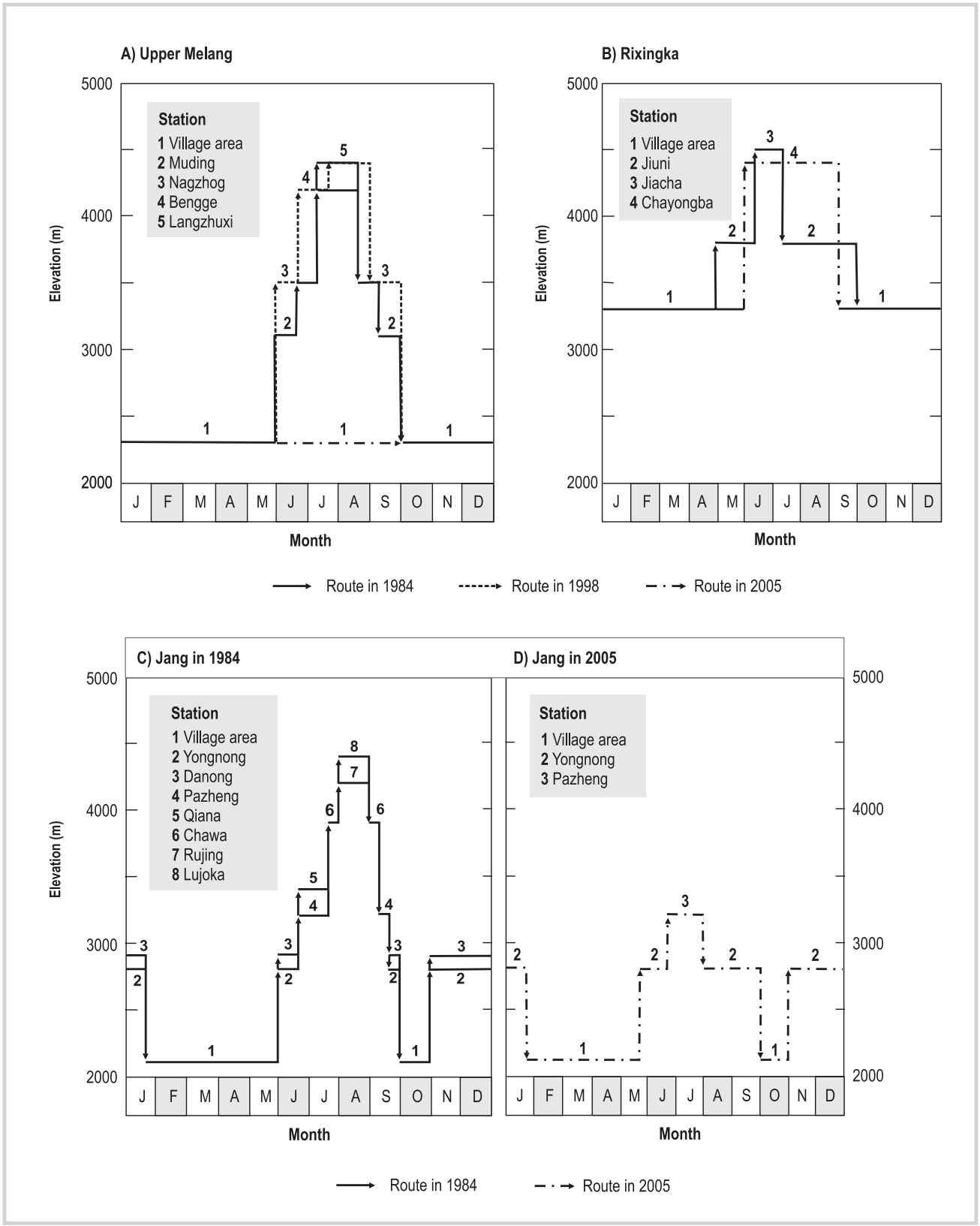

TABLE 3 Changes in duration of stay (number of days) at different elevations between 1984 and 2005.

	Shrubs and stall-feeding		Forest belts		Alpine meadows	
Villages	1984	2005	1984	2005	1984	2005
Jang	265	315	70	50	30	–
Lower Melang	240	365	95	–	30	–
Upper Melang	240	365	95	–	30	–
Waka	200	200	60	60	105	105
Rixing	200	200	60	60	105	105
Legbamchongmai	245	245	90	120	30	–
Legbamchongdoi	245	245	90	120	30	–
Zhura	220	210	125	120	25	35
Rixingka	210	260	125	–	30	105
Shangjie	240	365	–	–	125	–
Koxung	240	240	–	–	125	125
Go'gyonang	230	230	50	50	85	85

for calculating livestock production. What is more, recent implementation of ecological restoration programs and an increase in pack animals, mainly as a result of the boom in tourism, have further increased the pressure on low-elevation rangelands.

Is a growing animal population the cause of alpine rangeland degradation?

Degradation of alpine rangelands has been repeatedly reported by pastoralists, management staff, and researchers. The most frequently mentioned indicators of degradation are encroachment of woody species, reduction of palatable plants, and gradual denudation of rangelands. In almost all cases, people regularly attributed this change in rangelands to overgrazing owing to a growing animal population. However, careful studies of animal population dynamics would probably show that this is not always true. As already mentioned, there was a decrease rather than an increase in the total number of LU and MDA in the villages between 1996 and 2005. What is more, the annual period during which animals use alpine meadows decreased by 25.3%, from 62.5 days in 1984 to 46.7 days in 2005, a reduction of about 16 days. Therefore, overall grazing pressure on alpine rangelands has been decreasing in the past decade. However, rangeland degradation processes still continue (Figure 4).

To probe the fundamental causes of this problem, one must be aware that most of the seemingly natural rangelands in the alpine areas of northwest Yunnan were created and maintained by human use, especially through periodic burning, which is a cheap and time-saving form of rangeland management that was once popular in most of the mountainous regions on the eastern Tibetan Plateau. Villagers used to clear trees and shrubs in the treeline ecotone and above (mostly by burning) in order to encourage the development of rangelands.

However, this traditional form of rangeland management has been halted in the past 2 decades in order to prevent forest fires. At the same time, pastoral man-

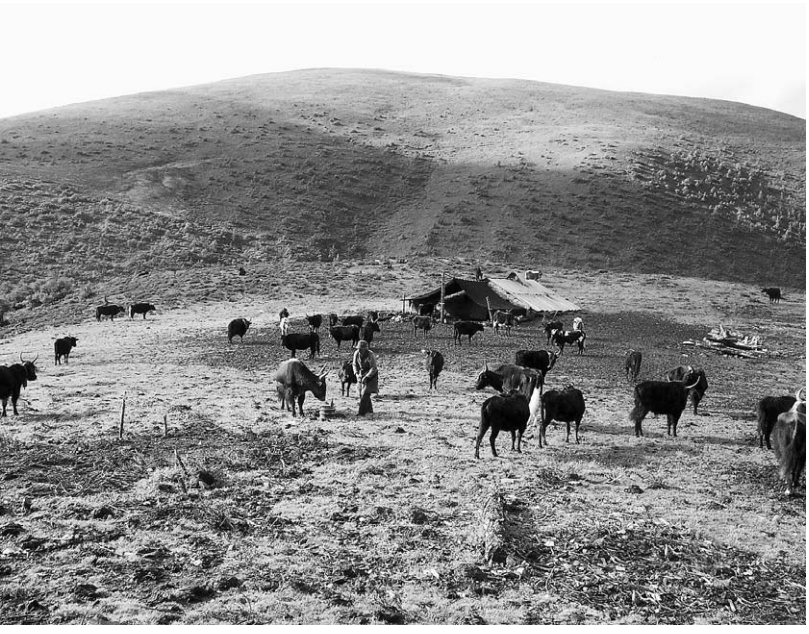

FIGURE 4 Traditional transhumant summer pasturing at 4200 m, at the pass near Baimaxueshan Mountain, Deqin County. Land is severely degraded close to the summer house; encroachment of shrubs and trees can be seen in the background. Previously, encroachment of shrubs on pastures was prevented through periodic burning, which maintained good-quality grass cover. (Photo by Yi Shaoliang, 15 August 2005)

agement departments and pastoralists lack affordable, effective, and easy-to-use alternative techniques to control the encroachment of woody plants. Consequently, rangelands maintained by people are left unmanaged, resulting in increased woody plant cover through natural succession. This usually causes a decrease in the area with palatable fodder plants, as well as changes in vegetation types. Areas where woody plants encroach are avoided by animals; this has increased grazing intensity on less-encroached areas and led to local overgrazing and degradation. Continuation of this process often ends with the whole rangeland being degraded. It has thus been argued that in many cases it is the cessation of traditional management measures, rather than the increase in animals, that is to blame for rangeland degradation.

Conclusions

Seasonal migration to make use of natural resources at different altitudinal belts is a basic feature of Tibetan-style transhumance in the Hengduan Ranges of China. In this production system, resources in alpine areas are often underused, while low-elevation resources are seriously overused. Carrying capacity calculated according to resources available at different elevations is often misleading. Instead, low-elevation shrubs and the capacity to provide supplements in wintertime are the bottleneck in successful livestock production.

In recent decades, migration patterns have undergone drastic change. Factors causing changes in herd size and structure, local land use, availability of labor, and infrastructure can all lead to changes in animal migration patterns. A shift in grazing activities to areas at low elevations has increased the pressure on already fragile ecosystems and intensified shortages of fodder in winter. The ecological and socioeconomic consequences of such changes need to be closely monitored.

Overall grazing pressure on alpine rangelands has been decreasing in the past decade. There is a need to reassess the placing of blame for degradation of alpine rangeland resources on the growing animal population. In fact, encroachment by woody species, resulting from the exclusion of traditional controlling measures such as burning, may often be the primary cause of alpine rangeland degradation. Increasing winter fodder supply or regulating annual migration patterns could be suitable ways of improving livestock production management in the study area.

ACKNOWLEDGMENTS

This research was financed by Project 40671181 of the National Natural Science Foundation of China, Project KSCX2-SW-123-5 of the Chinese Academy of Sciences, and Project 03ZQ026-043 of the Sichuan Department of Science and Technology.

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