Chapter 3
Maintaining the Human–Natural Systems of Pastoralism in the Himalayas of South Asia and China

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Abstract This chapter presents an overview of pastoralism in the Himalayas and summarizes the current situation and trends of human–natural systems of pastoralism in the Nepalese Himalaya, in the Indian Himalaya, and on the Qinghai–Tibetan Plateau of China. The human–natural system of pastoralism has lasted in a relatively stable manner for centuries in the Himalayas, especially through flexible responses to the variability of climate conditions in the short term. However, a great number of external and internal driving forces are currently threatening the sustainability of the long-term nature of pastoralism. They complicate interactions and feedbacks between human and natural components of pastoralism in coping with the stresses, and the integration of various tools and strategies from the ecological and social sciences as well as other disciplines in sustainable pastoral development. In the Himalayan region of northern Nepal, local institutions of collective action and indigenous property right systems for pastoral resource management are the key adaptive strategies to overcome the difficulties in pastoral management associated with poor cooperation and collaboration between the government and the pastoral society. In the Indian Himalaya, well-organized local institutions and commonly agreed norms and rules among the pastoral societies have promoted the sustainable use of pastoral resources in coping with pressures and threats of climatic, socioeconomic, and political changes. On the Qinghai–Tibetan Plateau of China, local pastoralists have developed adaptive actions of mobility, specificity, preparedness, diversification, exchange, collaboration, and partnership based on their knowledge and wisdom to cope with rangeland degradation driven by climate change and human overexploitation.

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3.1 An Overview of Pastoralism in the Himalayas

The Himalayas range across eight Asian countries, from Afghanistan in the west to Myanmar in the east, and from the Qinghai-Tibetan Plateau of China in the north to the Ganges Basin in the south. The latitude range is some 11°, from about 38°N in Pakistan and Afghanistan to 27°N in Bhutan. This vast distance obviously involves considerable changes in climate and vegetation. More than 60 % of the total area of 4.3 million square kilometers in the Himalaya is covered by rangelands which are primarily or directly used for pastoral livestock grazing. Mobile grazing guided by customary rules and institutions has been practiced in the Himalaya since early human civilization and is considered to be one of the important livelihood activities, especially for people living in high-altitude areas. For centuries, the alpine meadows, the major type of rangelands in the high Himalayas, have been used as grazing grounds by livestock of local communities and the animals from adjacent lower valleys during summer (Farooquee 1994). The grazing zones go further northwest to the Karakoram foothills and the Hindu Kush. Animal husbandry has been an integral part of the subsistence economy in the Himalaya, and livelihood's dependence on livestock increases with increasing elevation (Sundriyal 1995). Although the amount of animal husbandry in the Himalaya is not exactly documented, livestock grazing at the upper levels of mountains is dominated by mobile pastoral communities; for example, in Bhutan, fewer than 14,000 yak herder households with fewer than 50,000 yaks contribute about 3 % to the national products (Derville and Bonnemaire 2010). Pastoralism sustains about 150 million people, who are mostly ethnic minorities with a unique culture and tradition in the region, and impacts three times as many people living in downstream regions of the Himalaya. With rich diversities from both the cultural perspective and the biological perspective, pastoralism in the Himalayas is characterized as a typical human–natural system (social–ecological system). Similarly to the other human–natural systems of pastoralism in the world, the Himalaya's pastoralism is critically important in this region for the human populations it supports, the food and ecological services it provides, the economic contributions it makes to some of the world's poorest regions, and the long-standing civilizations it helps to maintain (Dong et al. 2011).

In the western Himalaya, which includes the Himalayan ranges in northwest India to the west of the Nepalese border, the Himalayan ranges in northern Pakistan, the Hindu Kush in northern Afghanistan, and other mountain ranges where they run down to the plain, transhumant or nomadic grazing systems are widely practiced to locate the best herbage resources from pastures and rangelands (predominantly *Artemisia* steppe). These grazing systems are particularly prevalent in the ethnic herder groups such as the Gujjars, Bakarwals, Gaddis, and Changpas in India, the Gujjars and Bakarwals in Pakistan, and the Kuchis (who are part of the Pushtun majority) in Afghanistan. Throughout the region, these herders adopt almost the same grazing pattern of vertical migration, in which they graze their livestock during winter in warmer zones such as the plains, foothills, and the desert fringe,

and move upward as when the weather becomes warm until they reach mountain or alpine pastures in the summer. Nomadic pastoralism is practiced by the unsettled herders, who follow a migratory cycle between high pastures and lowlands throughout the year, and transhumant pastoralism is practiced by the lowland-settled herders, who send their livestock in summer to within reach of high pastures. Lowland overwintering can give herders access to both pastoral markets and opportunities for seasonal employment. The dates of migration have traditionally been fixed on the basis of herders' perceptions of seasonal changes. Although the migratory herders have the grazing rights for most of the rangelands as the traditional way of use and can access the lowland pastures on oral agreement with local residents, they do not normally own the grazing lands. Small livestock such as sheep and goats are normally the basis of the herding systems in this region, although buffalo and cattle are grazed by the migratory Gujjars in Pakistan and India, camels are herded by the Balochistan in Pakistan and Afghanistan, and yaks are grazed by ethnic minority herding groups in some high-elevation areas of Afghanistan, Pakistan, and India (Fig. 3.1). In most cases, selling wool and live animals for meat (a small portion is usually reserved for home consumption on special occasions) is the only source of income for the herders to trade for the daily necessities and food (mainly cereals).

In the eastern Himalaya, pastoralism is very important in rangeland areas of northern Nepal, northern Bhutan, and Sikkim in India, whereas the extreme east is forest rather than rangeland. This region is generally wetter than the western

Fig. 3.1 Mobile grazing goats in Himachal Pradesh, India. (Photo by Shikui Dong, 2012)

Himalaya and there large grazing livestock such as yaks and chauri (cattle and yak hybrids) are much more important than small grazing animals such as goats and sheep. Migratory herding has been well adopted by the ethnic groups, such as the Bhotias and Sherpas in middle Nepal, the Tamangs and Kirats in eastern Nepal, the Bhutias in Lachen and Lachung of Sikkim, India, and the Brokpas in northern Bhutan. Herding systems in the eastern Himalaya are more stratified altitudinally, and herders keep the animal species according to their preferences for the altitude. The migratory herding of yaks and chauri dominates in the alpine–cool–temperate areas at relatively higher altitude, and the mobile grazing of cattle and buffalo is very important in the temperate–subtropical areas at relatively lower elevation (Fig. 3.2). The same grazing pasture may be shared by different livestock species and different herding groups in different seasons of the year; that is, subalpine meadow dominated by sedges may be the summer pastures of the chauri and the winter grazing lands of the yaks, and the temperate rangelands associated with oak or mixed forest of oak and ble pine may be the winter pastures of the chauri and the summer grazing lands of buffalo and cattle. In these mixed herding systems, some herder families remain relatively stationary to engage in agricultural farming as agropastoralists and they entrust their grazing livestock to others for part of the year. These pastoral systems take advantage of the variations in climate, vegetation, and labor. In most cases, selling diary products and live animals for family

Fig. 3.2 Herders moving yaks from subalpine shrublands to alpine meadows in Langtang of Rasuwa District, northern Nepal, in summer. (Photo by Shikui Dong 2007)

income is the major purpose of herding livestock, in addition to home consumption.

In the northern Himalaya, the Qinghai–Tibetan Plateau (QTP) appears as a huge geographical unit where most land territories are covered by rangelands, which have been utilized by ethnic Tibetans in China as grazing pastures for centuries. Because of the diverse climate and landscapes across the vast region of the QTP, the herding systems differ greatly between the east and the west. In the western part of the QTP, where the climate is arid or semiarid and the landscapes are dominated by alpine steppe or alpine desert, the nomadic or transhumant herders generally graze their yaks, sheep, and sometimes goats in a migration cycle between the high-elevation pastures in summer and the low-elevation pastures in winter, which is similar to what the herders do in the western Himalaya. However, the herders have to move their livestock on the plateau throughout year and have no access to low plains or valleys because of geographical barriers. In the central and northern parts of the QTP, especially the headwater areas of three rivers (the Yellow, the Yangtze, and the Mekong), where the climate is semiarid and semihumid and the landscapes are dominated by alpine steppe or alpine meadow and alpine shrub meadow, the herders similarly graze their yaks and sheep in a nomadic or transhumant migration cycle between the summer pastures at high elevation and the winter pastures at low elevation (Fig. 3.3). In the far eastern region of the QTP (e.g., the Hengduan Mountains), where climate is much wetter and

Fig. 3.3 Tibetan nomads transporting goods and living materials with yaks to a camp on the higher summer pasture (above 4000 m) on the Qinghai–Tibetan Plateau in the warm season (Photos by James Lassoie, 2012)

the landscapes are more diverse, the herders use the migratory herding system which is similar to that adopted by the herders in the eastern Himalaya; that is, they graze their yaks and sheep on the pasture of alpine meadow at the highest elevation in summer and on the pasture of subalpine meadow at high elevation in winter; they graze the chauri on the pasture of subalpine meadow at high elevation in summer and on the temperate rangelands associated with oak or mixed forest of oak and ble pine at low elevation in winter. In these mixed herding systems, some herders also practice agricultural farming as agropastoralists in low-altitude valleys near their residential areas for part of the year.

It is clear that mobile pastoralism characterized by the vertical movement of livestock in a cyclic manner is common throughout the Himalayas, where the pastoral communities make full use of rangeland resources in different ways, ranging from mountain nomadism through transhumance to combined mountain agriculture (agropastoralism). Over centuries, the stability of pastoralism across the Himalayas has been maintained through the balance among pastures, livestock, and pastoralists/herders, but the balance is not simple. The pastoral groups have applied diverse strategies such as livestock and human mobility and dispersal to overcome the problem of overgrazing rangelands. Herders' movement in the Himalayas is heavily focused toward obtaining specific production or other functions with featured socioeconomic organization and property rights. However, Himalayan pastoralism is not solely bonded with a certain kind of economic system (i.e., consumption-oriented or market-oriented production). Moreover, it is not tied to a specific type of land tenure: some pastoral communities have control over the land territory within which they migrate for mobile livestock grazing, whereas others have to graze their livestock with a formally or informally contracted migration route on public or private lands, of which they do not have political or legal ownership. Pastoral groups are also very diverse in their political structure, ranging from state-controlled peasants, to community-based collectives, to individualized households. In most cases, the permanent and essential resources such as grazing pastures and drinking water are shared by different pastoral groups, whereas the livestock herds are owned privately by individual pastoralists.

Mobile pastoralism in the Himalayas is not only a subsistence pattern, but also an effective means of exploiting marginal environments. Different types of pastoralism in the Himalayas can be understood as different adaptation strategies, which are closely associated with the geography, ecology, and socioeconomic development levels in the locality. It is only through pastoral mobility that the local people can efficiently use all potential resources in the large ecological zones, especially to convert the low values of plant resources in remote areas into high values of animal products through migratory grazing. Low energy and transportation availability is generally associated with low population density and high mobility of a pastoral society. Pastoralists can increase the reproduction and survival rates of livestock through good investments in animal breeding and health care and can make more profit by investing more human labor in milk and wool production than in meat production. The pastoral production systems rarely focus on a single product, whereas they make full uses of both "continuing" (calves, lambs, and kids; milk,

butter, and cheese; transport and traction; manure; hair and wool) and "final" (meat, wool, hides, and skins) products (Bhasin 2011). This is the way that pastoralists can make the most profit from use of resources in marginal areas of the Himalayas where farming is not feasible.

Within a pastoral ecosystem, there is ecological diversity represented by various ecological habitats, flora, and fauna, and cultural diversity reflected by different ethnicities, religions, and customs. These two components are interrelated and interact in the various pastoral production systems across the Himalayas. Culturally, pastoral populations living in the harsh environments of the Himalayas have developed many adaptive resource use strategies to overcome the problems of water and land limitations depending on the sociocultural characteristics of the local population. As a key form of an adaptive natural resource use strategy, pastoralism is a long-lasting livelihood option for many indigenous people living in the Himalayas to balance the relationships among pastures, livestock, and people. The pastoral technologies require that the herders' daily life practices be in line with the requisites of the grazing livestock (i.e., pasture, water, salt, and protection from predators). Pastoralists remain mobile all year round to sustainably use the permanent rangelands, which are essential sources for grazing livestock, so that they cannot make large investments in other assets such as personal goods, houses, and land. The social structures, functional groups, and administrative institutions of pastoral society in the mobile way of life have been developed on the basis of the needs demanded in the migratory production mode.

As a coupled human–natural system, traditional pastoralism has lasted in a relatively stable matter for centuries in the Himalayas, especially through flexible responses to the variability of climate conditions in the short term. However, a great number of external and internal driving forces are currently threatening the sustainability of the long-term nature of pastoralism, and are triggering adaption strategies possibly to transform this system. With the increasing trend of globalization of the marketing system, the pasturelands have been increasingly commercialized and/or turned into national parks, resulting in many problems for the pastoral groups. With the expansion of agriculture and forestry into rangeland areas, the herders have been forced by political marginalization to abandon their traditional and customary rights to these grazing lands. With the advent of socioeconomic reforms and economic development, the pastoral economy and marketing systems have been significantly changed, leading to breakage of traditional trade relationships between highland pastoral communities and lowland agricultural communities. With more avenues for earning, opportunities for waged labor, and the attraction of a better life in urban areas, outmigration is a growing trend in the pastoral areas of the Himalaya. Rangeland degradation associated with climate change and overexploitation are resulting in a decline in pastoral production in the Himalayan ranges. However, current policies and strategies related to pastoral production in the Himalaya have overlooked the integration of social, economic, and environmental factors, which will likely intensify social–ecological problems. On the basis of case studies from the QTP of China, the Nepalese Himalaya, and the Indian Himalaya, we summarize the current situations and trends of human–natural systems of pastoralism in the

Himalayas and new approaches that would promote better management, enhance the security of local environments, and mitigate the regional environmental problems.

3.2 Case Study from the Nepalese Himalaya: Importance of Indigenous Knowledge and Institutions in Sustainable Pastoral Management

3.2.1 Background

Nepal is situated in the southern Himalaya, bordering China in the north, India in the west and south, and Bhutan in the east. Around 12 % of the nation's territory is defined as either rangelands, or pasturelands or "grazing lands" (Land Resource Mapping Project 1986; Rajbhandary and Pradhan 1990; Rai and Thapa 1993; Shrestha 2001), which are mostly located in the hilly and mountainous areas of the Himalaya in northern Nepal (Table 3.1). These rangelands play critically important roles in economic development and human well-being in the Nepalese Himalaya. Pastoralism of buffalo, zebus, yaks, chauri, sheep, and goats based on rangeland grazing is a relatively small but important part of the farming practices among ethnic populations living in the Himalayan areas of northern Nepal (Rai and Thapa 1993). Pastoralists are involved in milk, wool, hair, hide, abd blood production or keeping live animals as transportation tools or work energy sources.

For a long time, rangeland livestock grazing has been the dominant land use by indigenous communities in remote mountains and valleys of northern Nepal (Alirol 1979). Some scholars (Chand et al. 1991; Dong et al. 2007) have stressed that livestock grazing and pastureland management in this region have continuously suc-

Table 3.1 General information about case study sites

Information	Dhunche	Gatlang	Langtang
Location (elevation)	Lowland (1900 m)	Middle land (2200 m)	High mountain (3300 m)
Climatic zone	Subtropical-Temperate zone transition zone	Temperate zone	Subalpine zone
Farming systems	Multiple farming of livestock, crops, fodder, and vegetables	Crop–livestock mixture farming	Livestock farming (tourism)
Total households	164	223	61
Livestock composition in individual households	1–2 cattle, 2–3 buffalo, 4–5 sheep and goats, 10–15 yaks and chauri (only 10 % of households engage in yak farming)	1–2 cattle, 10–20 sheep and goats, 10–15 yaks and chauri (half of households engage in yak farming)	20–30 sheep, 2–3 horses, 10–15 yaks and chauri (80 % of households engage in yak farming)

ceeded in exploring the indigenous knowledge of local people, which is rooted in the geographical, physical, climatic, and ecological characteristic of the Nepalese Himalaya. With all of this indigenous knowledge, local people have converted many constraints into opportunities (Tamang 1993; Dong et al. 2007). Moreover, sustainable utilization of natural resources and improvement of local livelihood are generally highly related to the pastoral institutions that govern the natural resource utilization, particularly property rights and collective action, which shape the local people's natural resource use patterns, which in turn impact the outcomes of the pastoral production systems in the region, as stressed by Dong et al. (2007), who stated that "together, mechanisms of collective action and property rights define the incentives people face for undertaking sustainable and productive management strategies, and they affect the level and distribution of benefits from the use of the natural resources", and Meinzen-Dick and Gregorio (2004), who state that "the close linkages between property rights, collective action, and natural resource management are critically important for technology adoption, economic growth, food security, poverty reduction, and environmental sustainability."

Although indigenous knowledge and local institutions have played very important roles in sustaining the rangeland management and livestock production in pastoral systems of the Nepalese Himalaya over centuries (Dong et al. 2009), traditional resource management practices have been ignored or overlooked by centralized governments in the past, and there is a huge gap between local people's traditional practices and the knowledge of professionals and practitioners (researchers, planners, and policymakers; Tamang 1993). These problems and gaps have resulted in significant resource degradation and social conflicts over natural resource use (Shrestha 2001). Hence, it is essential to understand indigenous practices of natural resource management, local institutions for property rights and policy formulation, and the collective decision-making processes and to build on this knowledge and information to achieve sustainable development of pastoral systems in the Nepalese Himalaya. We conducted and updated this case study to investigate and document the indigenous knowledge, local institutions, and their roles in sustaining pastoral resource management and enhancing the resilience of human–natural systems of pastoralism in the Himalayan region of northern Nepal.

3.2.2 Methods

This case study was conducted in Rasuwa District (Fig. 3.4), a high Himalayan and mountainous district of Nepal, whose name means "grazing land for sheep and cattle." This district represents the pastoral areas of the Nepalese Himalaya very well in the indigenous pastoral production systems, the historical traditions of pastoralism, and the socioeconomic importance of pastoral systems to local livelihoods. This district is located in the northwest of Nepal's Central Development Region (one of four regions in Nepal), bordering the Tibet Autonomous Region of China in north and the Sindhupalchowk, Nuwakot, and Dhading districts of Nepal in the southeast, south, and

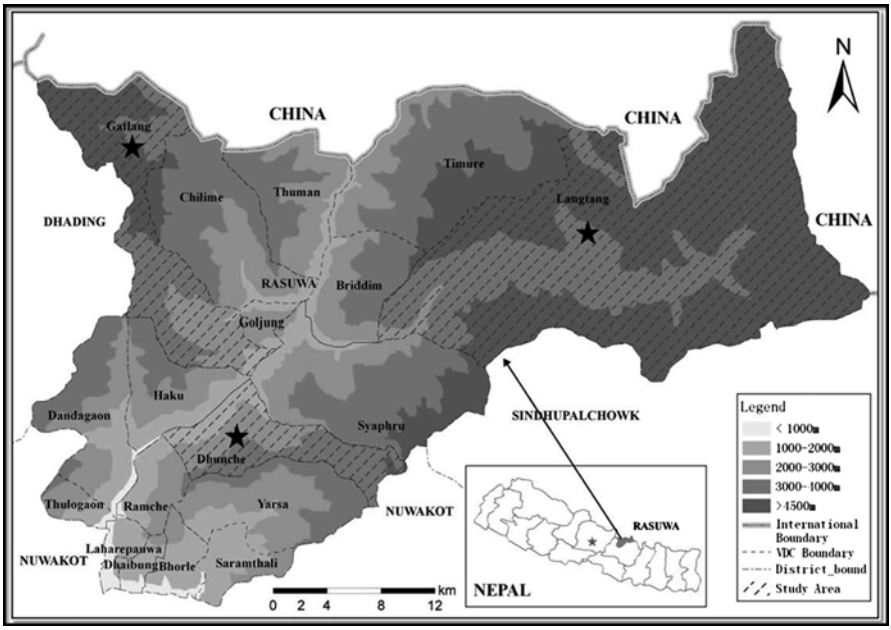

Fig. 3.4 Location of case study sites in Rasuwa District, Nepal

west respectively. The total population of the 18 village development communities (VDCs) in this district is about 44,000 from around 8700 households with a mean size of 5.05 people (Tourism for Rural Poverty Alleviation Program 2005). Most of the population (65 %) in this district belongs to the Tamang ethnic group, with evident Tibetan origin, whose major production system is extensive livestock grazing on native rangelands. Dhunche, Gatlang, and Langtang were selected as the representative VDCs in this district for the field investigation after consideration of the spatial variations of the geographical locations, climate conditions, and farming systems (Fig. 3.4, Table 3.1).

All the data in this case study were collected and updated with use of various data sources, including research publications, reports, newsletters, and a field investigation between 2006 and 2007. Integrated approaches including participatory rural appraisal, open-ended questions and pretested questionnaires (10, 14, and 11 households in Dhunche, Gatlang and Langtang respectively), key-person interviews (6, 6, and 8 individuals in Dhunche, Gatlang and Langtang respectively), and group discussion (21, 14, and 12 participants in Dhunche, Gatlang and Langtang respectively) were used in the investigation. Information and knowledge about indigenous pastoral practices, traditional herding management strategies, pastoral land tenure and resource property systems, and pastoral institution and governance arrangement were gathered in the investigation. Supplementary information about problems, constraints, challenges, opportunities, and changes in pastoral management systems, external public support, and partnerships were collected and recorded from both primary sources through group discussion and personal communications and secondary sources through desk study and literature review. The data quality was

controlled by careful investigation and cross-checks with different sources. Systematic qualitative techniques recommended by Patton (1990) and Miles and Huberman (1994) were used to analyze all the data.

3.2.3 Results

3.2.3.1 Indigenous Practices

The information collected from three case study sites shows that local pastoralists have been continuously applying a vertical transhumant gazing system, a recurrent feature of indigenous grazing management systems across the Nepalese Himalaya. This grazing system is characterized by the moving of livestock toward high alpine pastures in the monsoon season and to lower pastures or forests during the winter (Fig. 3.5) so as to make good use of climate conditions and feed availability between different ecoclimatic zones along altitudinal gradients. Through the seasonal movement in a yearly

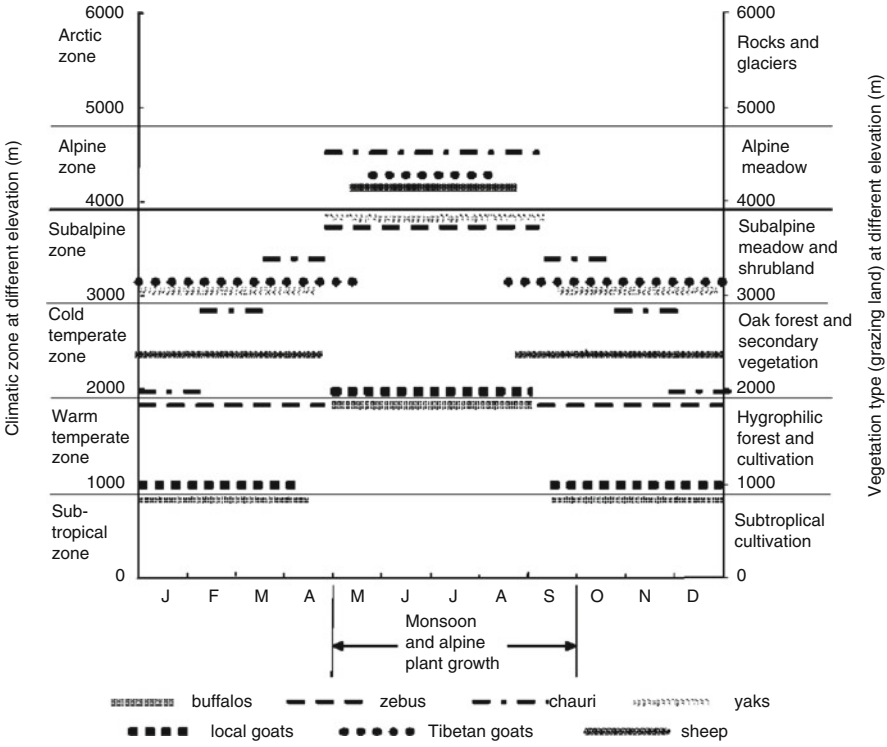

Fig. 3.5 Herding systems along altitudinal gradients characterized by different climate and vegetation in the eastern Himalaya (e.g., Rasuwa District of northern Nepal). (From Dong et al. 2007)

cycle, the pastoralists can secure consistent feed requirements by grazing livestock for maintenance, movement, growth, production, and reproduction.

Herding different livestock species according to their ecological and niche requirements for climate, vegetation, and altitude is a key practice in this indigenous transhumant grazing system; for example, the local pastoralists move their chauri from subalpine meadows at an altitude of about 3000–4000 m in summer gradually down to oak forests at an altitude of about 2000 m in winter, and they move their yaks from the alpine meadows at an altitude of about 4000–5000 in summer gradually down to subalpine meadows or shrublands at an altitude of about 3000–4000 m. To overcome the problems of feed deficit in the winter season, most herders in the case study sites maintained only the number of livestock that could be fed adequately using rangelands forages with a small amount of fodder supplements. In such a way, the local pastoralists can efficiently use the rangeland resources at the different altitudes and well maintain the production of different types of livestock with different habitat preference in different seasons.

Rotational grazing of the livestock between different plots of the same pasturelands (summer, winter, or transitional pastures) on the basis of feed availability is another key indigenous practice adopted by local pastoralists over centuries. The movement of livestock from one plot to another normally occurs every 10–15 days depending on the herders' judgments of grass cover and height. The carrying capacity of pastureland is estimated annually on the basis of climatic variability through a well-defined method among the herder groups to ensure the stability of each plot for a fixed number of animals. The same plot can be repeatedly used in the same grazing season if the grass cover and height have recovered very well. The campsites are protected with stone or reseeded with the native grasses to reduce the risk of soil erosion when the livestock are moved to another grazing plot. In such a way, as stated by local pastoralists, the relationship between the grazing pressure of livestock and the carrying capacity of pasturelands can been balanced and the pasturelands can be protected from overgrazing. Moreover, the local pastoralists stressed that this rotational grazing practice is helpful to reduce the potential spread of external and internal parasites.

3.2.3.2 Collective Actions

Local people have developed their own institutional arrangements for shared use of pastoral resources in a collective way over a long time. There are basically two sets of local organizations: an elected community committee composed of 11–12 people, which acts as the leader and decision maker at a community level; and a couple of civil associations, which are self-identified groups of households with common interests or with the same resource pools (e.g., livestock, vegetables, crops, and forest) at a group level. In some cases, five to seven people are elected from same type of associations to form a subcommittee, which acts as a representative for each type of association to deal with other associations (Fig. 3.6). The community committee is mostly responsible for controlling and regulating the access to pasturelands and fodder resources through enforcement of

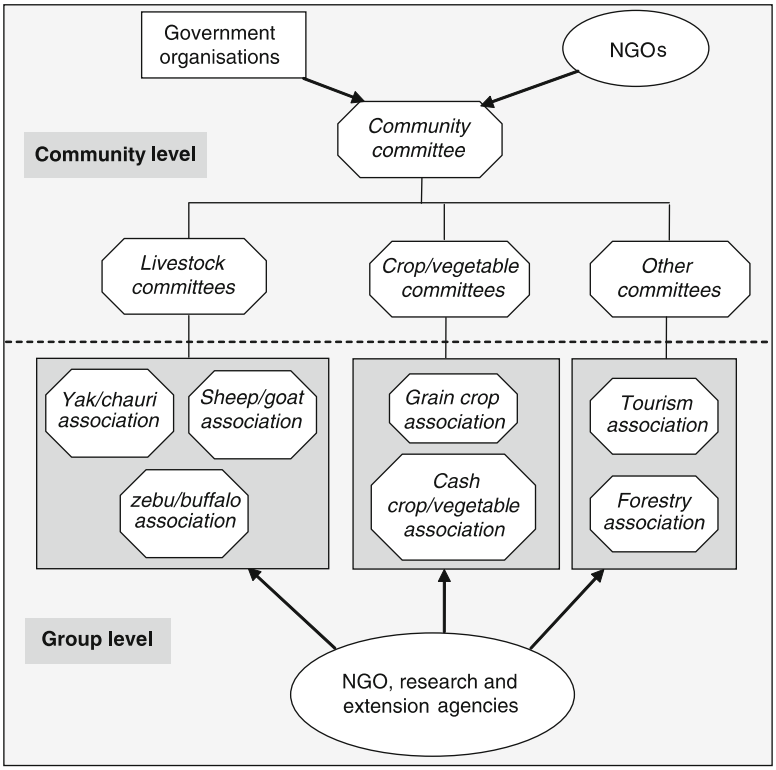

Fig. 3.6 Local pastoral institution arrangements and their linkage with other institutions

well-defined and mutually agreed rights and rules, backed by various social norms and sanctions. In such a way, the community committee can ensure that all community members (including poor and sociopolitically weaker individuals) have relatively equitable access to the pastoral resources. The community committee can also promote the collective actions of livestock grazing and feed collection by enforcing the primary rules and regulations regarding when and for how long the livestock are grazed on certain pasturelands, and when and where hay may be cut for winter feed. The association of livestock keepers such as yak/chauri associations establish rotational grazing rules, regulate herd movements, and make other decisions specific to shared uses of pastoral resources among herders' groups through negotiation and discussion. It is also responsible for mitigating conflicts arising over shared used of pastoral resources within the same herders' group or among different herders' groups with support from the community committee. The coordination and cooperation of the livestock association with other associations such as a crop association, a forestry association, and a lodging (tourism) association can ensure the collective use of different resources related to pastoral management. These grassroots organizations work much better in social functions than the external administrative and political organizations in sustaining pastoral resource management (Dong et al. 2009).

The collective actions of the pastoral society in the case study sites can be well understood in the grazing management. The length of grazing time and the livestock populations grazing alpine pastures in the summer (monsoon season) are strictly controlled by the herder committees, and the grazing time and the livestock populations in low-elevation forests in the winter (dry season) are decided by the forestry committees. The stocking rate is normally controlled by the herder community itself cooperatively according to the carrying capacity, which is estimated by experienced herders on the basis of grass height and cover. Several herders work in a group to herd a certain type of the whole community's livestock, including sheep, goats, buffalo, yaks, zebus, and chauri separately and rotationally to balance the utilization of different grazing plots and to promote the regrowth of grazed grasses. Although the cultivation of forages for hay is not popular, the pastoralists' communities have developed practices to harvest indigenous grasses or fence patches of land with shrubs or stones to protect winter grazing areas and hay fields. Collection and use of medicinal and aromatic plants are strictly regulated by the community committee to reduce the risk of rangeland degradation, although the local herders' households are permitted to harvest small quantities of such plants from grazing pastures for personal use and as a minor family income source. The collection of medicinal and aromatic plants by outsiders is not allowed, unless they pay a very high tax to the whole community. Timber harvesting for shed construction and the cutting of fuelwood in forest areas are strictly regulated by the forestry community committee, and only a small amount of timber can be harvested with permission of the committee or by payment of a high tax to the forestry community. In such a way, grazing sites in forests can be well protected from damage. The development of ecotourism in recent decades has initiated new uses for livestock as pack animals and jobs for local inhabitants as porters, hotel managers, and grocers for foreign mountaineers approaching the Himalaya, resulting in the diversification of local livelihoods. Therefore, pastoral communities collaborate with tourist communities in a collective way to share the benefits of selling livestock products and serving as guides, porters, restaurant managers, and grocers.

3.2.3.3 Property Rights

In a pastoral society, the property rights are mainly related to the pastureland and livestock resources. In the case study sites, the management of pasturelands depends mostly on resource use rights and land tenure systems. Primary pasture resources in these areas, as in other parts of northern Nepal, were previously recognized as either private assets or communal properties owned by the community. However, the central government (i.e., Ministry of Forests and Soil Conservation) took over the management of natural resources as a public property as a result of the Nepal Nationalization Act of 1957. In most cases, some pastoralist households owned small areas of land for crop and hay production and for house and corral buildings in scattered subsidiary settlements. Although

the local people lost ownership of pasture resources, they owned use rights to these resources according to the grazing tradition and administrative domains. In this case, the local pastoral communities had to regulate their access and guard against entry of other communities to the natural resources, including rangelands, and strongly resented infringements. Herders from the same community usually negotiate with each other or depend on the community committee's decision for the sharing of grazing pastures, and they normally mitigate conflicts arising from sharing pastures through self-negotiation. Sometimes, conflicts between different communities over use rights of grazing lands happen because of different interpretations of traditional arrangements of grazing areas and administrative boundaries. For example, herders from Gatlang once fought with herders from Chilime, another Tamang VDC in Rasuwa District, over the sharing of a large grazing pasture, Sanjen pastureland, which has been used by herders from Gatlang for a long time but recently had been grouped into Chilime's administrative domain. Recently, both VDCs claimed use rights for this pasture, and they cannot reach an agreement about sharing this pasture through negotiation. Gatlang herders stated that this problem has negatively affected their pastoral production levels and livelihoods. In this case, the local herders had to depend on district or regional governments to make decisions about the pasture resource utilization.

Livestock and their products are privately owned by the individual household, although the livestock from a community or an association are collectively herded on the basis of oral or written agreements of pasture sharing. However, there are some differences in herding management among these three case study sites because of different geographical locations and herding traditions. In Dunche, there are three types of grazing lands: "high-altitude pastures" used normally for summer grazing; "village pasture area" set aside by the community for grazing livestock kept at home for draft and manure production; and "forest edge pasture" for National Park buffer-zone residents to graze a small number of livestock for short periods of time or to collect fodders after paying a fee. In Gatlang, there are two major grazing lands for livestock: summer pastures at high altitude and winter grazing lands in lowland community forests. A group of households (community or association) share the same grazing lands at both locations on the basis of standard animal numbers and specific grazing periods as fixed by the group. In Langtang, seasonal movement between summer and winter grazing lands is regulated by the grazing rights, which are inherited permanently through matrilineal relations or are obtained trough a temporary contract or agreement. Movement to the summer grazing lands involves all livestock owners as a group, and an individual livestock keeper is not allowed to break up grazing lands and make a separate camp. Comparatively, the access to and use of winter grazing lands near their settlements are more flexible; that is, the individual livestock owner in a community can freely graze animals on communal meadow–shrub pastures surrounding the community's settlements.

3.2.4 Implications of the Case Study

These cases testified the importance of indigenous practices and local institutions for natural resource management in northern Nepal. Similar results have been reported across the world (Chapagain 1986; Gilmour 1990; Gadgil et al. 1993; Gill 1993; Rai and Thapa 1993; Farooquee and Saxena 1994; Wu 1997; Chan 2002; Farooquee et al. 2004; Tesfay and Tafere 2004). Although indigenous natural resource management systems may have some shortcomings, the flexibility of these systems to changes and the ability of these systems to adapt demonstrate a major strength in Nepal (Gill 1993), where public support from the government for pastoral development is lacking (Dong et al. 2009). Local pastoralists have extensive experience and knowledge of the local conditions and natural resource use history in this area (Tamang 1993), so they can overcome the physical, climatic, and biological difficulties and utilize the rangeland resources efficiently (Dong et al. 2007). Therefore, effective and appropriate strategies for developing sustainable pastoral management systems in this region require both a clear recognition of indigenous knowledge of pastoral resource management, which has been practiced by local pastoralists for centuries, and integration of the indigenous knowledge with modern technologies.

As mentioned earlier, the strong linkages between property rights, collective action, and natural resource management are very important for technology adoption, economic growth, and environmental sustainability. Although it was previously believed that a resource held under a common property resource regime was inherently inefficient since individuals could not have proper incentives to act in a efficient way (Gordon 1954; Scott 1955; Hardin 1968), it is evident from the case study that clearly recognized pasture use rights and grazing land tenure in traditional pastoral management systems, together with well-defined rules within local institutions, promote the efficient utilization and sustainable development of pastoral resources in northern Nepal. The efficiency of resource utilization under common property resource regimes has been debated for a long time, but it is generally agreed that until collective management under common property institutions is the most viable option for long-term economic and ecological sustainability of the common pool resources. Many studies on the foundation of common property resource regimes in the developing world have shown that local institution arrangements, including customs and social norms, designed to induce cooperative solutions can overcome the collective action problem and help achieve efficient use of common pool resources such as pastoral resources (Gibbs and Bromley 1989; Ostrom 1990). Therefore, local institutions of collective action and indigenous property right systems for pastoral resource management need to be highlighted in the facilitation of rangeland legislation covering traditional rights and customary tenure and cooperation and collaboration between the government and the pastoral society in northern Nepal.

3.3 Case Study from the Indian Himalaya: Importance of Local Adaptations to Climate and Social Changes

3.3.1 Background

Pastoralism contributes a big share to Indian livestock production, which accounts for 25 % of the nation's agricultural GDP and makes India one of the world's largest livestock producers (Bhasin 2011). Pastoralists rear indigenous animal breeds, maintaining the rich genetic variety of livestock. As a result of historical and cultural influences as well as resource availability, various types of pastoral systems, from nomadic to transhumant to agropastoral, can be found across the nation. India's pastoralism is often combined with sociopolitical forms of organization that can be considered tribal (Bhasin 2011). It is estimated that more than 200 tribes with about 6 % of the nation's population are involved in pastoralism in the whole of India (Sharma et al. 2003). Pastoralism exists prevalently among the ethnic tribes living in the drylands of western India, the Deccan Plateau, and in high-altitude regions of the Indian Himalaya (Bhasin 2011): the Gollas and Kurumas of Andhra Pradesh are mostly involved in cattle and sheep rearing; the Rabaris and Bharwads from Gujarat are normally engaged in raising sheep, goats, cattle, and small livestock; the Kurubas and Dhangars from Karnataka usually raise sheep; the Raikas/Rabaris and Gujjars from Rajasthan and western India generally raise camels, sheep and goats; the Gaddis, Gujjars, and Bakarwals from Himachal Pradesh and the western Himalaya normally herd sheep, goats, and buffalo; the Bhutias of Sikkim in the eastern Himalaya and the Changpas of Ladakh in the western Himalaya usually raise yaks (Table 3.2).

The Himalaya cover only 18 % of the territorial lands of India, but they accounts for 50 % of India's forest cover (including rangelands) and 40 % of the species endemic to the Indian subcontinent (Maikhuri et al. 2000). In the Indian Himalaya, the rangelands are represented by warm temperate grasslands, subalpine and cool temperate grassy slopes, alpine meadows of the high mountains and the alpine steppe, cold arid regions, or alpine dry scrub, occupying nearly 35 % of its geographical area (Rawat 1998). These rangelands differ in their climatic and geographical features, as well as in the supporting pastoral communities. Livestock rearing on the rangelands is an integral component of the economy in the Indian Himalaya, and dependence on livestock rearing increases with an increase in altitude (Sundriyal 1995). Over centuries, the alpine grasslands at high elevation have been used as the grazing pastures by migratory livestock of nomads as well as animals from lower valleys during summer (Farooquee 1994). Although the livestock grazing in the upper mountains is dominated in mobile pastoral societies, scholars argued that nobody really knows the exact extent of animal husbandry in the Indian Himalaya (Sharma et al. 2003). On the basis of the estimation from an overview publication, the Indian Himalaya are home to about 50 million domesticated animals, which are mostly kept in systems of combined mountain agriculture (Kreutzmann 2012). The pastoral communities of the Indian Himalaya use the pastoral resources efficiently

Table 3.2 General information about major pastoral groups in the Indian Himalaya (*Source*: Singh 1996)

Pastoral groups	Size	Location and species	Ethnic identities	Outline migration pattern
Bakarwals	NA	Kashmir (mainly goats)	Muslims. Speak Kashmiri and sometimes Hindi	They move to Jammu and Punjab plains in winter and to Kishtwar and other higher alpine valleys of the Kashmir Himalaya in summer months
Gujjars	2,038,692 (1931 census)	Jammu, Himachal Pradesh, and Uttarakhand (mainly buffalo)	Hindu and Muslim. Speak a mix of Gujarati, Urdu, Dogri, and broken Hindi with a Perso-Arabic script	Winters are spent in the regions of Jammu, Punjab, and lower districts of Himachal Pradesh and Uttar Pradesh, Saharanpur regions, and in the areas adjoining Rajaji National Park. They migrate to higher (nonalpine) regions of Himachal Pradesh and Uttarakhand in summer
Changpas	NA	Southeast Ladakh (yaks)	Follow a primitive form of Buddhism. Speak a mix of Ladakhi and Tibetan, with a Tibetan script	Their migration cycle is around the various high-altitude pastures of Rupshu plains in the Changthand region of Ladakh
Gaddis	1,26,300 (2001 census)	Kangra and Dharamsala regions of Himachal Pradesh, parts of Uttar Pradesh and Punjab (sheep and goats)	Hindu Rajputs. Speak Hindi with a Devangri script, and Pahari	Punjab plains and lower districts of Himachal Pradesh during winter months and occupy Lahaul and Dhauladhar pastures in summer months
Bhotias	NA	Upper regions of Garhwal and Kumaon of Uttarakhand (sheep, goats, cattle)	Hindu. Speak the Pahari group of languages with a Devanagiri script	They occupy lower districts of Uttarakhand such as Dehradun and the Bhabhar valley in winter months and move to higher pastures of the Garhwal and Kumaon Himalaya toward Nanda Devi, Gwaldam, Mana pastures, and adjoining regions

(continued)

Table 3.2 (continued)

Pastoral groups	Size	Location and species	Ethnic identities	Outline migration pattern
Bhuttias	21,259 (1981 censu)	North district of Sikkim	Buddhists. Speak a Tibetan dialect	Alpine regions of Lachung and Lachen valleys of the north district of Sikkim and move to lower forest below Mangan in summer
Monpas	34,469 (1981 censu)	Tawang and West Kameng districts of Arunachal Pradesh	Buddhists: their language belongs to the Bodic group of the Tibeto-Burman family	Higher reaches of East Kameng and Tawang districts of Arunachal Pradesh in the summer season and migrate to lowlands around Tawang in the winter months
Kinnauras	59,547 (1981 census)	Kinnaur district of Himachal Pradesh	Rajputs or Khosias and the Berus include both Hindus and Buddhists	In summer, sheep and goat flocks are driven to higher parts of Himachal Pradesh and in winter the flocks are driven to foothills of Uttarakhand and Himachal Pradesh

NA not available

by different means of mobility patterns, socioeconomic organizations, and property rights (Table 3.2). All forms of pastoralism may be considered as different forms of adaptation determined by ecological conditions and technological development levels, making pastoralism critically important in the Indian Himalaya from social, economic, cultural, and environmental dimensions.

Unfortunately, threats and pressures associated with climate change, economic development, and political marginalization have been challenging the sustainability of the traditional pastoral system, including migratory cycles, local economy, and social organization (Bhasin 2011). Some studies showed a decrease in rainfall and unpredictable onset of the monsoon, longer dry spells, higher temperatures linked to decreased water availability, and warmer winters with significantly less snowfall are the major features of climate change in the rural Himalaya (Macchi et al. 2011). The ecosystem services provided by the Himalayan rangelands such as rich biodiversity and food production may become vulnerable to climate change and the large-scale socioeconomic forces (Dong et al. 2010a, b). Extreme weather conditions, drought, epidemics, and predators associated with climate change can result in reduction of animal production (Bhasin 2011). As a result of new threats emerging to water and food security, pastoral production, nutrition, and public health in vulnerable areas such as the Himalaya, hard-fought progress has been made in achieving the Millennium Development Goals on development and poverty alleviation but this

may be slowed down or even reversed by climate change (El-Ashry 2009). Social, political, and economic changes are also challenging the sustainability of Indian pastoralism, one of the important human–natural systems in India. As stated by Bhasin (2011): "Currently, the trend towards globalization of the market, with pastoral lands increasingly being commercialized and/or turned in to national parks has created problems for the pastoralists. Due to neglect by officials and policy makers, pastoralists face deprivation from their traditional and customary rights to these grazing areas. The political marginalization of pastoral communities paved the way for forcible eviction from their land and/or restriction of their movements. Many of them left their traditional transhumant way of life and settled along valleys. Some have settled in urban areas others stick to the pastoral activities by changing the composition of livestock by increasing number of goats and decreasing number of yaks. State policies regarding forests, agriculture, irrigation, fodder, famine, pastoral rights and migration are some of the mechanisms that contribute to the alteration of pastoral life-style. Likewise, social crisis, such as phases in domestic developmental cycle and work force shortage in herding groups cause concern in the community." This is not the solely specific case in any Indian districts, and almost all pastoral groups in the Indian Himalaya are facing similar constraints and problems (Bhasin 2011). Therefore, it is necessary to conduct a case study to examine the challenges and problems faced by pastoral communities in the India Himalaya and their adaptation strategies to cope with these difficulties.

3.3.2 Methods

The case study was conducted in the Indian state of Himachal Pradesh (Fig. 3.7), which is located between latitude 30°23′02″N to 33°15′34″N and longitude 75°36′41″E to 79°01′51″E with the altitude ranging from 350 m at its boundary along the Punjab plains to 6816 m at Reo Purgyal in the Zanskar Range (Singh et al. 2009). In the light of regional variations in rainfall, temperature, and humidity, the state can be divided into five climatic zones (Singh et al. 2009): a subtropical zone (below 900 m), a warm temperature zone (900–1800 m), a cool temperature zone (1800–2400 m), a cold high mountain zone (2400–4000 m), and a snow frigid zone (above 4000 m). There are 12 districts, 115 tehsil/subtehsil (similar to VDCs in Nepal), and more than 20,000 villages. According to a recent population census report, the human population of Himachal Pradesh is 6,077,248, with a decadal growth rate of 17.53 %. About 90 % of the population in Himachal Pradesh is rural and belongs to three sociological population groups: the Rajputs and Brahmins, the Scheduled Tribes, and the Scheduled Castes. The Scheduled Tribes include the Gaddis, the Gujjars, and the Bholts, which are mainly engaged in animal husbandry, with many of them practicing migratory grazing (Singh et al. 2009), although livestock rearing is an integral component of the economy, and is inseparable from the agricultural component of every household in rural areas of Himachal Pradesh.

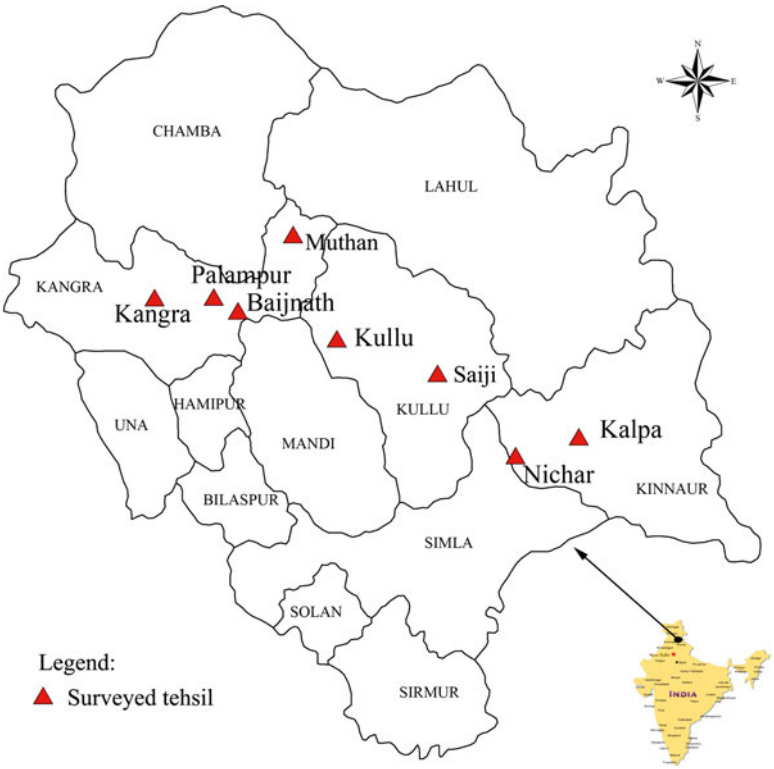

Fig. 3.7 Map of surveyed tehsils/subtehsils in Himachal Pradesh, India

In this study, eight tehsil/subtehsils were selected for the field survey on the basis of information collected from the on-the-desk work (Table 3.3). Sixty-six households were randomly sampled from the selected tehsil/subtehsils for the survey, which was conducted between December 2010 and February 2011. These households represent the general situations of pastoral groups in Himachal Pradesh (Table 3.3). Methods similar to those used in the Nepalese case study, including the collection toolkit of participatory rural appraisal, open-ended questions and pretested questionnaires, key-person interviews, and group discussion, were applied in this survey. Herders/farmers were interviewed by face-to-face survey based on a questionnaire mainly on rural animal husbandry practices and problems faced by them. The quality of the results of the questionnaires was controlled through careful checks on the errors in the completed questionnaires. Supplementary information was collected and updated with use of various data sources, including research publications, reports, newsletters, and personal communications. Systematic qualitative techniques recommended by Patton (1990) and Miles and Huberman (1994) were used to analyze all the data.

Table 3.3 Information about rangeland and livestock in the case study sites (data from Singh et al. 2009)

Name of tehsil/ subtehsil	Land area (ha)	Rangeland area (ha)	Grazing livestock numbers (ACU)				
			Cattle	Buffalo	Sheep	Goats	Total
Baijnath	21,325.19	1529.77	21,154	2028	2488	2235	27,904
Kangra	28,429.39	5803.18	30,729	12,810	920	3560	48,020
Multhan	94,693.05	74.17	4458	0	3241	2132	9831
Palampur	44,426.40	5946.24	39,192	6225	3378	3136	51,931
Kalpa	32,678.59	11,062.68	2540	5	1181	361	4087
Nichar	104,414.55	25,804.37	8112	0	4488	2331	14,931
Kullu	290,046.43	29,143.83	67,474	172	13,516	7669	88,831
Saini	27,192.94	3999.74	13,162	19	1496	1357	16,033

ACU adult cattle unit

3.3.3 Results

3.3.3.1 Indigenous Practices

The survey indicates that the Gaddi, Kanet, Kauli, and Kinnaura pastoralists in Himachal Pradesh have adopted transhumant grazing practices, which involve cyclical movements from lowlands in winter to highlands in summer to take advantage of the availability of pasture resources varying with seasonal climate change at different elevations. Unlike the nomadic Changpa pastoralists in Changthang of southeast Ladakh, the Gaddi, Kanet, Kauli, and Kinnaura pastoralists in Himachal Pradesh are transhumant shepherd groups who have dwellings in the valleys between mountains and practice long-distance herding of livestock. The pastoralists herd small livestock such as sheep and goats in a vertical migration, in addition to keeping a small number of nonmigratory large livestock such as bulls and cows in their dwellings. They raise sheep for the production of wool, which is woven into rain-resistant blankets, snowshoes for the shepherds, and carpets for family use or sale. They raise goats for the production of milk, which is the staple diet of the shepherd's during migration, and meat, which is mostly sold for family income. Bulls and cows are kept for draft power of plowing cultivated croplands or family drinking milk during the time of year when they stay at home. There are many fixed migratory routes from the highland peaks to the lowland plains, with numerous passes in the Himalayan ranges (Fig. 3.8). Through a year-round movement, the herders can obtain a consistent supply of feed for maintenance, movement, growth, production, and reproduction of the livestock. This traditional transhumant grazing system has capitalized on the physical and climatic characters and the plant communities, and has converted many constraints into opportunities in the fragile environments of the highlands of the Indian Himalaya.

Balance between availability of water and fodders and the requirement of the livestock in different seasons is indispensable to pastoral groups for adaption to migratory grazing in Himachal Pradesh. In early April, the pastoralists begin to

Fig. 3.8 Migratory routes of herding groups in Himachal Pradesh, India

move their flocks of sheep and goats upward (northward) along the low mountain ranges to their dwelling villages by early May. Then they graze their livestock in village forests and middle hill forests in May and June, and harvest the winter crop and prepare the crop fields for the monsoon. Moreover, they pen the sheep and goats on the newly harvested fields for a couple of nights to provide manure as fertilizer for the next crop. By late June, the partial melting of the snow allows the pastoralists to cross over mountain passes into the alpine meadows at high altitude to feed their livestock on the nutritious forages throughout the summer (July, August, and September). By middle-late September, decreased forage availability forces the pastoralists to move their flocks of sheep and goats downward (southward) by recrossing high mountain passes to their own dwelling villages. In the next 2 months, they graze their animals in village forests and middle hill forests, and plow the land and cultivate the winter crops. By the middle of November, the pastoralists start to move down to the winter grazing lands in the lowland forests or the plain pastures within

1 month. By the end of December, the pastoralists reach the winter grazing lands, where they spend 3 months herding their flocks. Along the winter migration routes and on the winter grazing grounds, the pastoralists can obtain forages in various places, such as village pastures, which tend to be public scrublands, private grasslands from which cultivator communities have harvested grass to feed their animals, in stalls, or the streambeds and roadsides where grass grows well.

3.3.3.2 Collective Actions

At the household level, a family acts a social group (unit) to herd its livestock by combining the seasonal movement of livestock with seasonal cultivation. When most of the family members depart to herd their large flocks of livestock on high-altitude meadow pastures in summer and low-altitude silvopastures in winter, a small percentage of the population (mostly the elders and women) are left behind to look after the draft cattle (which subsist mainly on corn stalks) and fields and to process the woolen products such as blankets and carpets. This coordination is very important for maintaining the herding unit as a viable social unit. Some pastoralists live in tents and move with their animals and families along fixed routes, whereas other pastoral families do not use tents during migration and they prefer to move lightly. For those pastoralists who do not use tents and bring tings with them, they normally obtain livestock products directly or they barter animal products for grain with agriculturalists and for other daily necessities with retailers.

At the community level, the village appears as a clear social division. The members of the villages/hamlets consist of a clearly bounded social group. An *al*-association is a form of cooperation and mutual insurance through which a pastoralist can maintain significant interpersonal relations within a broader society. The *al*-association is divided into the *khinds,* named after the ancestors where the split is supposed to have taken place. A *khind is* composed of numbers of *tols*, which are two to three generations in depth and may consist of one or more brothers and share a common hearth. Normally, all the families of a *tol* herd their livestock together under the supervision of two hired shepherds and two *tol* members (belonging to any family who can spare two male members at that time). As labor cannot be purchased in a pastoral community, the pastoralists ensure a stable labor supply through *barton* (obligatory assistance) and cooperation between families. Local governing bodies are necessary to control ownership and transfer of property as well as to adjudicate conflicts. The *Pradhan* (representatives from a group of households) is in charge of settling local disputes within a village, whereas the *Panchayat* (representatives from a group of villages) is responsible for settling disputes between villages. These local institutions are also responsible for serving the social, economic, security, and development needs of all member pastoralists. Besides, local institutions make norms or rules for all the pastoralists to regulate herd movement, information sharing, risk pooling, aggregation, and dispersal of herders across the region. On the other hand, a variety of social and cultural mechanisms, such as religion, folklore, and traditions, support the local institutions to regulate the sustainable migratory herding in Himachal Pradesh.

3.3.3.3 Local Adaptations

Climate change, growing human population, increased infrastructure and economic development, and government policies regarding forests, agriculture, fodder, pastoral rights, and migration are the main driving forces that lead to the alteration of a pastoral lifestyle and threaten the sustainable development of pastoralism in Himachal Pradesh. According to the survey, climate change has been greatly influencing the grazing systems. Most respondents in the survey claimed that they could not find enough forages and drinking water for the grazing livestock on the high-altitude alpine meadow pastures in summer because of glacial retreat and rainfall decline. Because of frequent climate uncertainty and natural disasters, the pastoralists are facing many more difficulties in allocating the grazing time on winter and summer pastures and in planning the balanced year-round feed supplies for the grazing livestock (Table 3.4). With the increase of tree line/timberline associated with warm temperature on the high mountains, the grazing pastures of subalpine forests are shrinking and declining in both area and production. In middle hill there are outbreaks of noxious weeds such as Crofton weed (*Eupatorium adenophorum*), which is known locally as *Kali Basauti*, because of dryness and warmness. Some respondents said that this exotic plant has invaded into subalpine meadows and lowland silvopastures (agroforestry). The spread and dispersal of this invasive plant have led to not only reduced forage production but also decreased animal production (milk and meat), even resulting in the loss of livestock because of its being poisonous. Moreover, some foresters and farmers in the lowland plains and valleys blame the mobile herders for the spread and outbreak of Crofton weed as they think that the migratory livestock carry the seeds of this invasive plant in their hair during middle hill grazing and disperse them in the lowland farms and forests when they migrate there for winter grazing. To cope with these difficulties, the local pastoralists have developed some adaptive strategies; that is, quite a number of the respondents move their livestock earlier in summer to high-altitude pastures for grazing to take advantage of early growth of forages associated with increased temperatures. Some pastoralists raise more goats to control the Crofton weed as goats can eat and digest this noxious plant without great problems. Some pastoralists store the crop

Table 3.4 Pastoralists' responses and adaptations to climate change in the Indian Himalaya

Impacts and mitigation of climate change	Proportion of respondents
Lack of forages	86.1 %
Lack of drinking water	100 %
More livestock loss because of floods	2.8 %
Early grazing to summer pastures	65.7 %
Farmers' organization raises funds for collective actions	12.3 %
Local NGOs help to cope with climate change	Rare
Local governments help to cope with climate change	Rare

residues and cultivated feeds for balancing of the animal requirements during feed-deficient times.

In line with growing human population, increased infrastructure, economic development, and the subdivision and fragmentation of agricultural land, the availability of grazing lands for pastoral communities is dramatically decreasing. As stated by the pastoralist respondents, land use in lower altitudes of the Himachal Pradesh has been greatly altered in recent decades by a number of driving factors, such as afforestation activities, road construction, agroforestry development, and agricultural expansion (Fig. 3.9). These land use changes have seriously reduced the size of available winter pastures for pastoralists and have also disturbed or blocked their migratory patterns. As a result, local pastoralists have to change their migratory routes and have faced serious problems of livestock loss due to roadkill, theft, and tiredness. Especially, agroforestry development and agricultural expansion have increased the heavy tensions between mobile herders and local farmers. In the past, the agricultural or agroforestry cultivators paid the pastoralists to manure their fields, but now the cultivators do not allow the pastoralists to herd their livestock on the agricultural or horticultural fields as they have replaced the livestock manure with chemical fertilizer. The reduced access to winter pastures in plains or low-valley areas has pushed the local pastoralists to adopt the early movement of the herds up through the middle

Fig. 3.9 Development of agroforestry is blocking migratory routes of grazing animals in Himachal Pradesh, India. (Photo by Shikui Dong, 2011)

hill forest belt to high-altitude pastures with prolonged summer grazing. As a result of Forest Department not issuing winter grazing permits and increased grazing taxes charged by local residents, the economy in low-altitude areas has changed from a mixed agropastoral system to an agricultural- or horticultural-based economy. In coping with these social changes, the pastoralists have diversified their livelihoods as agropastoralists, cultivators, and migratory labor. For example, according to the survey, 25 households out of 55 total pastoralist households in the village of Nawal in the Palampur tehsil have shifted their livelihood to agricultural production. The survey indicates the diversification of livelihood is a prevalent trend in a pastoral society to adapt to the socieconomic changes in Himachal Pradesh, even in the Indian Himalaya.

In addition, increased political marginalization is presently playing an important role in accelerating the decrease of pastoral activities in Himachal Pradesh, even in the whole of the Indian Himalaya. Bcause of the small population and migratory lifestyle, pastoralists in the Indian Himalaya have often been overlooked in the policy decisions at various levels. According to pastoralist respondents, nonparticipation in policymaking and ignorance of their rights and status by the local and central governments in India have seriously marginalized these communities. Some newly implemented policies related to farming, forest and animal husbandry, and poverty alleviation have been directly or indirectly influencing pastoral production in the region. Various development schemes for the pastoral population have an agricultural preference, and pastoralism is considered to be an activity supplementary to agriculture, which has resulted in a bias against pastoralists. As one of the priorities for regional development, sedentarization of pastoralists is now widely supported by the governments in Indian Himalayan states such as Himachal Pradesh. The establishment of national parks and protected areas, along with the expansion of agriculture/agroforestry into marginal pasture areas, has suppressed the pastoral production systems in the region. The records of the herder respondents indicate that the recent establishment of the Great Himalayan National Park in Himachal Pradesh has deprived them of access to about 300 km^2 of summer pastures without their having been allotted grazing rights in any alternative regions. The afforestation program for carbon sequestration in lowland forestry areas initiated by the Forestry Department has altered or fragmented the traditional migration routes, forcing the pastoralists to shorten the grazing time on the winter pastures or to find other alternatives to compensate for the winter grazing.

3.3.4 Implications of the Case Study

Similarly to what was found by previous researchers (Bhasin 1988, 2011; Chakravarty-Kaul 1998; Ives and Messereli 1989), transhumant grazing accompanied by vertical movement of livestock in a cyclic manner is a very important indigenous grazing practice in the Indian Himalaya. This practice adopted by pastoral communities living in the high-altitude areas of the Indian Himalaya exploits the seasonal

abundance of grazing areas on both temporal and spatial scales. In most cases, mobile grazing in the Indian Himalaya, as in other Himalayan areas such as the Nepalese Himalaya, is guided by indigenous rules and institutions (Chakravarty-Kaul 1998; Dong et al. 2009). Mobility is one of the most important adaptations in the pastoral society of the Indian Himalaya, through which pastoralists can successfully manage their environment with a high degree of diversity. The mobility characterized by seasonal movement promotes the capability of the opportunistic migratory pastoralism to balance the relationships between livestock, pastures, and the human population by creating the possibility for marginal regions to support livestock and human life. Migration to different locations with a combination of seasonal and ecological variables in pasture and water is the basis for the survival strategy of pastoralists in the harsh environments in this region. As stated by Janzen 1993, "mobile livestock keeping is a best active human adaptation to the harsh environment and is probably the only way of putting the pastures to economic use without a huge expenditure of capital." The indigenous mobile grazing system allows pastoralists to take advantage of pasture resources with low productivity and water resources with an irregular spatial distribution.

The traditional pastoral system, including a migratory cycle, local economy, and social organization, is based on efficient use of seasonally varied resources through collective actions in marginal environments of the Indian Himalaya. Well-organized local institutions have strengthened the collective actions of pastoral communities at both the household level and the community level. The commonly agreed norms and rules among the pastoral societies have promoted the efficient use of pastoral resources in the Indian Himalaya. Although climatic, socioeconomic, and political changes have brought pressures and threats to sustainable development of pastoralism in the Indian Himalaya, local pastoralists have adjusted accordingly in numerous ways. As mentioned earlier, adaptation is about building resilience and reducing vulnerability of coupled social–ecological systems such as pastoral systems to absorb disturbance and still retain their basic function and structure (Walker et al. 2004; Folke 2006; Walker and Salt 2006; Kassam 2010). This case study shows that local pastoralists in the Indian Himalaya have developed adaptive management systems in their traditions of pastoral resource use. The flexibility of these management systems to climatic, socioeconomic, and political change seems to be a key strength. Effective and appropriate strategies for sustaining the pastoral development in the Indian Himalaya require a comprehensive understanding of traditional pastoral systems as the local people have practiced them over centuries. The autonomous adaptations adopted by local pastoralists require an enabling policy environment in the context of the complexity of these changes, especially for the pastoral societies in the Indian Himalaya, which are generally politically marginalized. Deep understanding of traditional production systems and indigenous knowledge, strategies, and practices can empower pastoralists and enhance their capacity to maintain the subsistence economy in fragile environments

3.4 Case Study from the Qinghai–Tibetan Plateau of China: Social Dynamics of Pastoral Communities To Cope with Rangeland Degradation

3.4.1 Background

The Qinghai–Tibetan Plateau (QTP) is located in western China and is known as the "Roof of the World" because of its high altitude. The QTP is also called the "Water Tower in Asia." because it is the source area of many of Asia's major rivers. Rangelands/grasslands cover about 60 % of this vast land mass and provide critical ecosystem services to humans on local, regional, and global scales (Foggin 2008). These rangelands have served as the dominant grazing pastures for indigenous livestock and are regarded as one of the major pastoral production bases in China (Dong et al. 2012). Extensive grazing has been the major land use for the QTP's rangeland in throughout history, and pastoralism has played key roles in local livelihood and the regional economy (Dong et al. 2011). Tibetan-dominated communities have lived on these rangelands as pastoralists to raise yaks and Tibetan sheep for meat, milk, wool/hair, and hide for centuries (Long et al. 2008). The QTP supports more than 13 million grazing yaks (more than 90 % of the world's total population) and about 42 million grazing Tibetan sheep (Long et al. 1999; Dong et al. 2012). For thousands of years, the QTP's pastoralists have lived harmoniously with nature through their indigenous grazing practices (Dong et al. 2007; Cai and Zhang 2013). However, rangeland degradation associated with climate change and human disturbance is threatening the pastoral production system in the fragile and vulnerable landscapes of the QTP (Dong et al. 2010a, b). The rangeland degradation can be the cause and the effect of sociopolitical changes and will negatively affect the productivity and sustainability of pastoral systems, limiting the sustainable development of a coupled human–natural system of pastoralism on the local scale and ecological, social, and economic systems on the regional scale (Dong et al. 2012).

Although the analysis with three-dimensional "vulnerability/resilience" coordination framework in Chap. 2 shows that that rangeland degradation has increased the vulnerability of the QTP's pastoralism in all three dimensions of livelihood, institutions, and ecosystems, it is critically important to examine the potential of pastoral societies to maintain the human–natural system of the QTP's pastoralism, particularly from the perspectives of local people's perceptions, actions, and behaviors, as well as local institutions' responses and reactions. Much historical and present evidence regarding pastoral societies across the QTP has shown that local pastoralists do have the wisdom to cope with the changes resulting from inside and outside drivers and to adapt to new situations through mobility, diversification, preparedness, exchange, and local specificity. For example, the local pastoralists have used the strategy of mobile grazing for generations to cope with uncertain environmental changes (such as drought, snowstorms, landslides, diseases, pest outbreaks) to secure the supply of feed and water resources. Over centuries, the adaptive management applied by local pastoralists has capitalized on the physical and climatic characteris-

tics and the plant communities and has converted many physical and ecological constraints into socioeconomic opportunities (Cai and Zhang 2013). Therefore, this case study was conducted to documents the local pastoralists' actions to cope with rangeland degradation resulting from climate change and human disturbance, as well as their strategies regarding sustainable pastoral management on the QTP.

3.4.2 Methods

The case study was conducted between 2010 and 2012 at two pastoral sites in Gansu Province, Zhuaxixiulong Township of Tianzhu Tibetan Autonomous County, and Huangcheng Township of Sunan Yugur Autonomous County (Fig. 3.10). Both sites are located in the Qiliang Range, the eastern edges of the QTP with the an average elevation above 3000 m. Tianzhu was the first Tibetan autonomous region formed after the People's Republic of China was founded in 1949. With 230,000 people, Tianzhu has the highest population density in all pastoral counties in Gansu Province, even in the whole of China. About 35 % of the population of Tianzhu are Tibetans, whose livelihood is mainly pastoralism. Sunan is home to the Yugur ethnic minority groups, who have practiced traditional transhumant grazing for centuries. There are 15,000 Yugurs in China, and 90 % of them live in Sunan as pastoralists, whose ethnic traditions are somewhat similar to Tibetan, Mongolian, and Han Chinese traditions. In addition to cultural–ethnic differences, there are significant

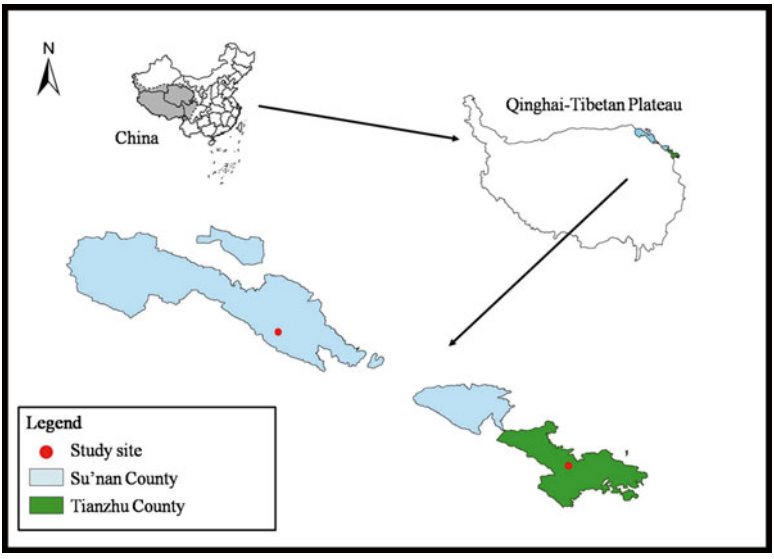

Fig. 3.10 Location of case study sites, Tianzhu County and Sunan County of Gansu Province, China

differences ingrazing pastures in terms of rangeland vegetation; that is, the humid alpine meadow mainly grazed for yak farming in Tianzhu and the dry alpine steppe mainly grazed for sheep farming in Sunan. At both sites, rangeland degradation associated with climate change and overgrazing is a key limit for sustainable pastoral production. Although Sunan's rangeland is much healthier than Tianzhu's rangeland because of better management and lower grazing pressure, both sites are being greatly affected by climate change.

To collect the general information about the indigenous grazing practices, traditional pasture management, pastoral institutions, local perception, and response and adaptation to environmental changes, the field surveys were performed by use of integrated approaches including participatory rural appraisal, open-ended questions and pretested questionnaires (14 and 10 households in Tianzhu and Sunan respectively), key-person interviews (three and four individuals in Tianzhu and Sunan respectively), and group discussion (24 and 11 participants in Tianzhu and Sunan respectively). Supplementary information about problems, constraints, challenges, opportunities, and changes in pastoral management systems, external public support, and partnerships was collected and recorded through group discussion and personal communications (including both professionals and practitioners). All the primary information of the survey was documented by transcription of sound recordings or film recordings. Secondary information regarding pasture management, pastoral development, and government policies was collected and updated with use of various data sources, including research publications, reports, newsletters, and yearbooks. The data quality was controlled by careful investigation and cross-checks with different sources. Systematic qualitative techniques recommended by Patton (1990) and Miles and Huberman (1994) were used to analyze all the data.

3.4.3 Results

3.4.3.1 Local Perception and Preparedness

The case study indicates that local people have a clear perception about environmental changes, socieconomic transformation, and political dynamics. Simultaneously, the local people have to prepare to adapt to or cope with all these changes and dynamics. Although there are no experimental instruments to record the real scenarios of precipitation and temperature dynamics, the local pastoralists can give a clear description of climate change from their personal experiences. Almost all the interviewees in the case study reported a general trend of temperature change, much hotter summers and autumns but colder springs and colder winters than before. The pastoralist respondents felt that there is a 15- to 30-day delay in the start of spring and that summer starts 15–30 days earlier in comparison with the past. The dryness is a significant change in the patterns of precipitation and water supply. Most of the interviewees reported that both rainfall and snowfall have declined significantly in recent years and

water scarcity is a big problem for forage and livestock production (Table 3.5). A male herder in Tianzhu County said: "Decades ago, there were many wells on the summer pastures in the surrounding mountains; we had to wear rubber boots to herd the livestock on the dense grasses, which were as high as my knees. However, currently, as most of the wells have dried up, livestock cannot obtain enough drinking water and spend a long time walking to obtain enough grass for grazing. If this situation continues, the drought and warming continues in the coming years, the springs will disappear. Grazing will face a big problem." Similarly, a female herder in Sunan County stated: "As the herders, we are really afraid of drought on the rangeland. Most of the time, the livestock drink water from springs, which dry up in dry years. In the past 2 years, there has been a continuous drought. Recently, there are many places (in pastoral areas) where drinking water is hardly available. We have to go a few kilometers to find drinking water. The drought directly affects our forage production. The damage caused by drought is really severe in pastoral areas."

Rangeland degradation is another evident environmental change, which has been generally noticed by the local people. More than 80 % of respondents in this case study felt that rangeland degradation, including decreased grass production and forage quality and decreased grass coverage and height, had happened over the past few decades and is continuing. As described by a rangeland extension agent in Tianzhu County "the rangeland condition has indeed changed. Compared with the 1970s and 1980s, grass height here (Zhuaxixiulong Township) has decreased around 10 %, and plant cover has decreased about 20 %." A similar statement was obtained from a herder in Tianzhu County: "Although the government has invested a lot of subsidies to restore and protect the grasslands, rangeland degradation has not been completely mitigated. Our yaks were larger in the 1970s and 1980s than the present when you compare animals of the same age.

Table 3.5 Local pastoralists' perceptions and adaptation strategies regarding climate change

Items	Tianzhu County	Sunan County
Temperature change	Colder winter and spring, hotter summer and autumn	Colder winter and spring, hotter summer and autumn
Precipitation change	Less snowfall in winter and spring, less rainfall in summer and autumn	Less rainfall in summer and autumn
Feelings about climate change	Spring ends earlier, summer starts earlier, mountain wells decline, river flow decreases	Spring ends earlier, summer starts earlier, mountain wells decline
Impacts of climate change on grazing systems	Shortage of forage, lack of drinking water for livestock	Shortage of forage, lack of drinking water for livestock
Changes in grazing strategies	Early movement to summer pasture and lengthening of summer grazing	Early movement to summer pasture and lengthening of summer grazing
Institutional responses	More collective actions, enhancing partnerships and collaboration with professionals	More collective actions, enhancing partnerships and collaboration with professionals

Because of declining rangeland quality and water shortage, the yaks become smaller. For example, in the past a 6-year-old yak produced around 150 kg of beef, but nowadays they produce just 120 kg of beef." As for the cause of rangeland degradation, both the professionals and the pastoralists stressed climate change and overgrazing. For example, the rangeland extension agent said: "Grassland degradation is partly due to global warming, but a main reason is overgrazing." A herder in Sunan said: "Personally, I think overgrazing is happening here." In Sunan's dry alpine steppe (a type of rangeland), a grasshopper disaster associated with a drier climate is becoming an environmental problem according to local pastoralists and professionals. To mitigate rangeland degradation, the local pastoralists and professionals cared more about the carrying capacity of rangelands for long-term development. Most of the herders were willing to prevent rangelands from degrading in collaboration with professionals.

Growing population, increased living standard, and diversified livelihoods are some socioeconomic transformations experienced by the local people. Through public survey and interviews, it was found that the present (human) populations in Zhuanxixiulong Township of Tianzhu County and Huangcheng Township of Sunan County are 1.4 times and 1.8 times as high as they were 3 decades ago, and there are growing pressures on grazing pastures because of the increased population. As a female herder in Sunan said "Our population has increased. Each family may have three to four children. If a family has many children, the pasture is divided between the children; the pasture becomes smaller for each family. The rangeland has more pressure now than before, as the size of the pastures cannot be increased with the human population. Moreover, the survey of this case study shows that the increased living standard is threatening pastoral production." A male herder in Tianzhu County stated: "Our living expense is quite high here. If we raise fewer animals, our income will not be increased and our living standard will not be improved. So we need to raise more animals. But if we raise more animals, it's bad for the rangeland. We are falling into a trap (between rangeland protection and income generation)." Clearly, the local pastoralists are concerned more about social and environmental problems such as population growth, increased cost of living, overgrazing, and rangeland degradation, although their living standards were greatly improved. Therefore, they are ready to cope with them through local preparedness(e.g., depopulation through migration and livelihood diversification). In Tianzhu, as stated by a male herder, "a few pastoral people have moved into cities for migratory labor."

Political changes and their impacts are widely sensed by the local people. The survey of the case study indicates that the Rangeland Individualization and Herder Settlement policies initiated by the central government in the 1990s have been gradually landed in both counties. Conflicting responses to the impacts of these policies were obtained from the interviewed pastoralists. Some of them thought that the implementation of these policies has promoted the effective utilization of rangeland resources and improved the herders' livelihoods, whereas some of them believed the implementation of these policies has accelerated rangeland degradation by changing indigenous grazing practices. With the implementation of "Grassland

Ban" (or "Retire Livestock, Restore Grassland") aiming at protecting rangeland ecosystems and restoring degraded rangeland since 2002, the pastoralists are encouraged to fence their individual pastures for rotational grazing or fallow and resettle themselves in towns or cities for other livelihood. As a result, both pastoral livelihood and rangeland conditions have been greatly changed. In Sunan, a local official stated: "In recent years, our herders have moved from tents in the rangelands to apartments in town built by the government (as ecological immigrants to other livelihood). This is a big change." However, most pastoralists have to struggle with preparing for unexpected difficulties, such as building new social networks and learning new technologies of grazing management.

3.4.3.2 Adaptive Action and Management

To cope with environmental, socioeconomic, and political changes, local people have developed adaptive strategies in addition to preparedness. Although local pastoralists are still maintaining transhumant pastoralism, a cycling movement of livestock between summer and winter pastures, they have made some adjustments according to the changes in the climate conditions and rangeland health on temporal and spatial scales to maintain sustainable grazing. To overcome the problems of drinking water shortage and forage production reduction associated with climatic dryness and water scarcity, the local pastoralists move their livestock upward to summer pastures at high altitude earlier than before, and they move their livestock downward to winter pastures at low altitude later than before (Fig. 3.11). To take advantage of the early start of summer, the local pastoralists adopt a prolonged grazing time with higher livestock densities on summer pastures and a shortened grazing time with lower livestock densities on winter pastures. As such, rangeland degradation of winter pastures, which are normally overgrazed by high livestock populations with long winter grazing, can be somewhat mitigated. In addition, the local pastoralists strived to mitigate rangeland degradation through "frequent movement" and "reseeding of the campsite on departure" when they moved their livestock along the grazing routes.

With the implementation of government's Rangeland Individualization and Grassland Ban policies, the pastoralists have translated their indigenous transhumant grazing practices into rotational grazing management. They fence their individualized pastures (mostly winter pastures) into different paddocks, which are rotationally grazed by the appropriate amount of the livestock according to the carrying capacity of the rangelands that are set by local extension agents from their measurements or by the pastoralists themselves from their own estimation. Under the supervision of professionals (local extension agents or researchers), the local pastoralists plant some fodder crops such as oats in their yards or livestock pens to increase supplemental feed for livestock during longer and colder winters. In such a way, they can control the grazing pressures on the native rangelands and reduce the risk of rangeland overgrazing and degradation. In collaboration with the professionals, the pastoralists adopt innovative strategies to combat natural disasters and miti-

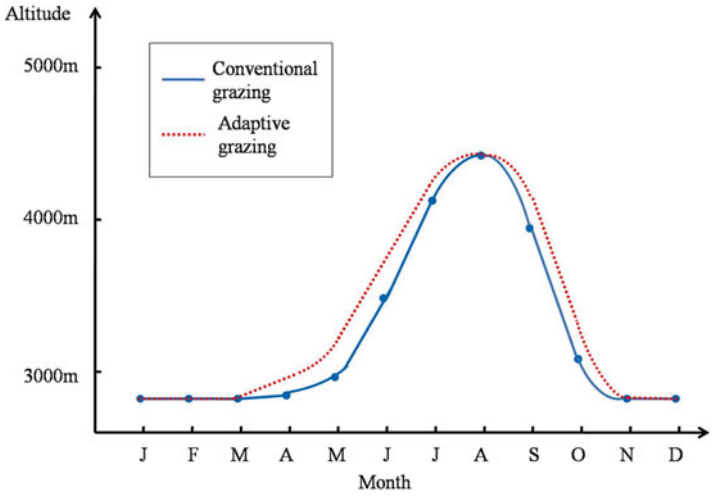

Fig. 3.11 Adaptive grazing strategies used by local pastoralists in coping with climate change

gate rangeland degradation. For example, the herders in Sunan County have been working with researchers to bring grazing chicken to control the grasshopper plague in an experimental project (Fig. 3.12); the herders in Tianzhu County have been working with local extension agents to control the rodent damage through the application of pesticides and to restore the degraded pasturelands through fencing and reseeding in a pilot project.

3.4.3.3 Multiple Partnerships and Networks

Collaboration among different stakeholders, pastoralists, researchers, extension agents, and government officials through social networks or political partnerships is a good way to promote local adaptations and innovations in political, technological, and social dimensions for sustainable pastoralism in the case study sites. The researchers have done on-the-ground work closely with local pastoralists to solve the real-world problems that are challenging and threatening their livelihood. As an interviewed researcher said: "The basis of doing research is to get the research questions from the herders. If they have some problems that need to be solved, we help them find solutions or develop research projects. So our research is really from the grassroots, we get support from the herders." This can be verified in a separate interview by the statement from one female herder in Sunan County: "The researchers come here to do some (scientific) analysis. They really help us and benefit our pastures. If it benefits our pasture, then it also benefits our income. So we welcome them (scientific researchers) from our hearts and support them." The researchers also work closely with local extension agents and government officials to translate their research findings into pastoral practices. For example, In Zhuaxixiulong

Fig. 3.12 Chicken grazing on alpine steppe in Sunan County initiated by researchers at Lanzhou University, China (photo by Kiran Goldman, 2010)

Township of Tianzhu County, the scientific researchers work with local pastoralists to experiment on the cultivated perennial grasslands with two goals: to reduce the grazing pressure on native rangelands by rearing livestock on productive cultivated pastures, and to provide alternative options for restoring degraded rangelands. The local extension organization (Grassland Station of Tianzhu County) is responsible for translating the research findings from these experimental studies into practical application through a pilot project focusing on reseeding the lands that were damaged by rodents. From our on-the-ground observations and local professionals' assessment results, it is evident that the ecological function and productivity of the rangeland as well as livestock have been greatly improved.

The survey in this case study showed that the local pastoralists have also built partnerships with the government, which provide financial support and policy instrument measures for the local pastoralists, such as funding for building stalls and fences and an eco-compensation policy for reducing livestock numbers on the rangelands. One interviewed male herder in Tianzhu County said: "The government's policies and investments have benefitted us greatly. For example, we would not be able to afford the pesticide for controlling rodents or the materials for building fences (for rotational grazing and fallow). In recent years, the government has provided a lot of subsidies for fencing. This has been very useful for rangeland protection. Without the government's support and investment, we can do nothing to combat the rangeland degradation." One interviewed female herder in Sunan County stated: "As herders, we see the rangelands as our life. In recent years, we

have protected our rangelands very well. We have built fences (to protect rangelands) and improved our forage species (on cultivated pastures) with the government's policy and financial support."

From the survey, it can be seen there are some emerging partnerships among the pastoralists, although the Rangeland Individualization policy has broken their traditional community-based pastoral management systems. Some households in the case study sites come together voluntarily to collectively graze their livestock, plant their fodder crop, and harvest and store forages to copr with the uncertainties of climate change. The household collectives have made rules or norms on their own as oral or written agreements to regulate the pastoral activities, such as setting the migratory time, finding the drinking water resource, and fixing grazing. Additionally, the local pastoralists have built close networks among relatives, friends, and neighbors, through which they can learn new practices, share experiences, and communicate information. The survey indicates that the herders try to build adaptive capacities by themselves with the support obtained through the internal and networks as well as multistakeholder partnerships.

3.4.4 Implications of the Case Study

It is widely recognized that rangeland degradation associated with climate warming, overgrazing, and policy changes has threatened the pastoral production systems in the fragile and vulnerable areas of the QTP (Yeh 2003, 2010; Xu and Liu 2007; Wang et al. 2007; Harris 2010; Dong et al. 2010a, b, 2011, 2012). Klein et al. (2004) found from a simulation experiment that climate warming resulted in the decline of species richness in the QTP's alpine meadow and shrubland. They also observed that experimental warming led to a decline of the net productivity of alpine plants, particularly palatable grasses during the growing season (Klein et al. 2007). Zhang et al. (2015) found that experimental warming significantly reduced the vegetation living state of the QTP's alpine steppe. In contrast, Wang et al. (2012) concluded from a comparative experiment that heavy grazing rather than warming causes degradation of the QTP's alpine meadows. This viewpoint was supported by a great number of scholars who insist that the dominant drivers of alpine degradation in the QTP are overgrazing (Ma et al. 1999; Shang and Long 2005; Wu and Du 2007). In addition, some scholars stressed that population growth (Zhang et al. 2004), rangeland individualization, and fencing facilitated by government policies (Yan et al. 2005) have resulted in overstocking and rangeland degradation. However, Harris (2010) stated that the major causes of the QTP's rangeland degradation remained uncertain because of the vaguely tested hypotheses (e.g., overstocking is a clear driver of rangeland degradation, although policy initiatives aimed at sustainability may lead to overstocking because of insufficient understanding of current social–ecological systems of pastoralism). Therefore, Dong et al. (2012) argued that breaking human–natural systems (social–ecological systems) is greatly associated with rangeland degradation in the QTP and other areas of the developing world, where

policy instruments do not achieve the objectives of promoting sustainability of rangeland production systems mainly because of overlooking emergent issues at the interface between the ecological, economic, and social perspectives (Fig. 3.13). There are inextricable linkages between the drivers of change and the adaptive responses in terms of the social, institutional, and biophysical constraints and challenges faced by local pastoral society today (Wu et al. 2015).

As the real receptors and reactors to all these drivers of environmental, socioeconomic, and political changes in the pastoral realm, the local pastoralists have evolved their own perceptions and are well prepared to cope with all these changes. Most importantly, they have developed adaptive action strategies based on their own knowledge and wisdom to maximize the positive impacts of these changes and minimize their negative effects, and even to convert many limitations of these changes into opportunities in sustainable pastoralism. These adaptive action strategies, according to this case study, mainly include mobility, specificity, preparedness, diversification, exchange, collaboration, and partnership. All these strategies can promote practical applications of newly developed natural resource management framework; that is, a three dimensional framework of adaptive management, social learning, and resilient thinking (complex adaptive system) in the pastoral system of the QTP. In this three dimensional framework, as summarized by Tyler (2008), "adaptive management typically emphasizes natural science and ecological systems, social learning emphasizes

Fig. 3.13 Rangeland degradation of Gonghe County where the "Grazing Ban" policy is advocated using a big board (Photo by Shikui Dong, 2012)

human agency and interaction, and resilience thinking addresses social-ecological systems as complex entities that behave in dynamic and cyclical fashion. They (these three dimensions) can offer insights into practices that support learning, adaptation and sustainability." The results of this case study suggest that new institutions are needed to foster the adaptive action strategies of the QTP's pastoral systems in the era of environmental degradation, socioeconomic transformation, and political dynamics. The new institutions need to foster more widespread interactions among pastoralists and other stakeholders through networks, partnerships, consultative bodies, and collective actions to enhance the resilience of coupled human (e.g., indigenous practices and tradition) and natural (e.g., physical conditions) systems on the QTP.

3.5 Strengthening the Resilience of Human–Natural Systems of Pastoralism in the Himalayas

Although these three case studies on Himalayan pastoralism differ in socioeconomic, political, demographic, and cultural settings, they have addressed similar issues regarding the causes and effects of environmental, socioeconomic, and political changes in pastoral systems. Moreover, they have commonly highlighted the complicated interactions and feedbacks between human and natural systems of pastoralism in coping with all these changes, and the integration of various tools and strategies from the ecological and social sciences as well as other disciplines in sustainable pastoral development. As such, these three case studies have offered unique interdisciplinary insights into human–natural systems of pastoral management practices that support learning, adaptation, and sustainability. Moreover, the three case studies have highlighted the importance of human–natural systems in formulating a more integrated understanding of nature and society to promote the resilience of pastoral systems in the Himalaya. As stated by Liu et al. (2007a), coupled human–natural systems challenge traditional planning and management assumptions and strategies for natural resources and the environment. The success or failure of many policies and management practices is based on their ability to take into account the complexities of human–natural systems (Liu et al. 2007b).

The implications of the coupled human–natural system approaches for sustainable pastoral development in the Himalayas can be oriented specifically to policy decision making. Local pastoralists in a wide area of the Himalaya (Nepalese Himalaya, Indian Himalaya, and Chinese QTP) represent a repository of rich indigenous knowledge essential to sustain pastoral management, and underscore the need to integrate local adaptations and collective actions coping with climate changes into modern technological development and public decision making. Property rights and local institutions are vital components of political instruments in rational sharing of rangeland resources among the pastoral communities and need to be considered in the common decision analysis of pastoral conservation and production in the Nepalese Himalaya and the Indian Himalaya. Partnerships and collaboration through

social networks among different stakeholders are critically important for maintaining the stability of pastoral production systems in the QTP of China, and they need to be integrated in the pastoral resource research, planning, and government.

Management practitioners and policymakers responsible for enhancing resilient pastoralism in the Himalaya are expected to become experimental learners by systematically applying scientific knowledge and approaches of coupled human and natural systems to their management and decision-making practices. Policy decisions must balance the needs of society with the best scientific knowledge of coupled human and natural systems. To facilitate this, the interfaces between social, economic, physical–biological, and ecological components in resilient human–natural systems of pastoralism must be improved. There is a pressing demand to collect and integrate new and existing research results into packages that can be used by management practitioners and decision makers. Socioeconomic and cultural components of human–natural systems for sustainable pastoralism need to be stressed and well integrated with scientific objectives and policy priorities to equitably balance local pastoralists' needs with national or regional pastoral management policies and strategies. Comprehensive programs of integrated ecological, social, and economic research should be facilitated to provide a sound foundation for decision making. Increased support and funding for researches into human–natural systems are critical to the future of Himalayan pastoralism, and must include interdisciplinary investigations of pastoral resource use and management systems, complex adaptive systems, and syntheses of the state of current knowledge.

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References

Alirol P (1979) Transhumaning animal husbandry systems in Kaligchowk Region (central Nepal). Swiss Association for Technical Assistance/Integrated Hill Development Project, Kathmandu

Bhasin V (1988) Himalayan ecology: transhumance and social organization of Gaddis in Himachal Pradesh. Kamal Raj Enterprise, New Delhi

Bhasin V (2011) Pastoralists of Himalayas. J Hum Ecol 33(3):147–177

Cai H, Zhang XF (2013) A participatory survey on status and local pastoralists' consciousness to animal husbandry in alpine grassland. Grassl Turf 33:66–72

Chakravarty-Kaul M (1998) Transhumance and customary pastoral rights in Himachal Pradesh: claiming the high pastures. In: Mountain research and development. International Mountain Society and United Nations University

Chan YN (2002). Livestock and rangeland management in Shangri-La Gorge, Shangri-La County, Northwest Yunnan, China. MSc thesis, Lund University

Chand SP, Gurung BD, Rood PG (1991) Farmers' traditional wisdom: where does it stand within the present agricultural research systems of Nepal? Pakhribas Agricultural Centre (PAC) occasional paper no 4, Dhankuta

Chapagain DP (1986). Managing public lands as a common property resources: a village case study in Nepal. PhD thesis, University of Wisconsin, Madison

Derville M, Bonnemaire J (2010) Marginalization of yak herders in Bhutan: can public policy generate new stabilities that can support the transformation of their skills and organization? Innovation and sustainable development in agriculture and food. ISDA, Montpellier, pp 1–10

Dong SK, Lassoie JP, Yan ZL, Sharma E, Shretha KK, Pariya D (2007) Indigenous rangeland resource management in the mountainous areas of northern Nepal: a case study from the Rasuwa District. Rangeland J 29:149–160

Dong SK, Lassoie JP, Shrestha KK, Yan Z, Sharma E, Pariya D (2009) Institutional development for sustainable rangeland resource and ecosystem management in mountainous areas of northern Nepal. J Environ Manage 90:994–1003

Dong SK, Li JP, Li XY, Wen L, Zhu L, Li YY, Ma YS, Shi JJ, Dong QM, Wang YL (2010a) Application of design theory for restoring the "black beach" degraded rangeland at the head water areas of the Qinghai-Tibetan Plateau. Afr J Agric Res 5:3542–3552

Dong SK, Wen L, Zhu L, Li XY (2010b) Implication of coupled natural and human systems in sustainable rangeland ecosystem management in HKH region. Front Earth Sci China 4(1):42–50

Dong SK, Wen L, Yang ZF, Liu SL, Lassoie JP, Zhang XF, Yi SL, Li JP (2011) Vulnerability of worldwide pastoralism to global changes and interdisciplinary strategies for sustainable pastoralism. Ecol Soc 16(2):10, http://www.ecologyandsociety.org/vol16/iss2/art10/

Dong SK, Lassoie JP, Wen L, Zhu L, Li XY, Li JP, Li YY (2012) Degradation of rangeland ecosystems in the developing world: tragedy of breaking coupled human-natural systems. Int J Sustain Soc 4:357–371

El-Ashry M (2009) Adaptation to climate change: building resilience and reducing vulnerability. Recommendations from the 2009 Brookings Blum Roundtable. United Nations Foundation. http://www.brookings.edu/~/media/Research/Files/Papers/2009/9/climate%20change%20poverty/09_climate_change_poverty_el_ashry.PDF

Farooquee NA (1994) Transhumance in the central Himalaya: a study of its impact on environment, Ph.D. Thesis, HNB Garhwal University, Srinagar, India.

Farooquee NA, Saxena KG (1994) Adaptation, conservation and livestock management in high hills of central Himalaya: indigenous knowledge and practice. In: Somvanshi R, Lokeshwar RR (eds) Current advances in veterinary science and animal production in India. International Book Distribution Company, Lucknow, pp 123–129

Farooquee NA, Majila BS, Kala CP (2004) Indigenous knowledge systems and sustainable management of natural resources in a high altitude society in Kumaun Himalaya, India. J Hum Ecol 16:33–42

Foggin JM (2008) Depopulating the Tibetan grasslands. Mt Res Dev 28:26–31

Folke C (2006) Resilience: the emergence of a perspective for social-ecological systems analyses. Glob Environ Change 16:253–267

Gadgil M, Berkes F, Folke C (1993) Indigenous knowledge for biodiversity conservation. Ambio 22:151–156

Gibbs JN, Bromley DW (1989) Institutional arrangements for management of rural resources: common property regimes. In: Berkes F (ed) Common property resources: ecology and community-based sustainable development. Belhaven, London, pp 22–33

Gill GJ (1993) Indigenous system in agriculture and natural resource management: the policy dimension. In: Tamang D, Gill GJ, Thapa GB (eds) Indigenous management of natural resources in Nepal Tamang. Proceeding of the workshop on indigenous management of agriculture and natural resources, Dhulikhel, Nepal, 8–9 June 1992. Winrock International, Kathmandu, pp 3–12

Gilmour DA (1990) Resource availability and indigenous forest management systems in Nepal. Soc Nat Resour 3:145–158

Gordon HS (1954) The economic theory of a common pool resource: the fishery. J Polit Econ 62:124–142

Hardin G (1968) The tragedy of commons. Science 162:1243–1248

Harris RB (2010) Rangeland degradation on the Qinghai-Tibetan plateau: a review of the evidence of its magnitude and causes. J Arid Environ 74:1–12

Ives JD, Messereli B (1989) The Himalayan dilemma: reconciling development and conservation. Routledge, New York

Janzen J (1993) Mobile Livestock Keeping in Somalia - General Situation and Prospects of a Way of Life Undergoing Fundamental Change. In: Baumann M. P. 0., Janzen J. and Schwartz H. J. (eds.) Pastoral Production in Central Somalia, . OTZ, Eschborn

Kassam KS (2010) Pluralism, resilience, and the ecology of survival: case studies from the Pamir mountains of Afghanistan. Ecol Soc 15(2):8, http://www.ecologyandsociety.org/vol15/iss2/art8/

Klein JA, Harte J, Zhao XQ (2004) Experimental warming causes large and rapid species loss, dampened by simulated grazing, on the Tibetan Plateau. Ecol Lett 7:1170–1179

Klein JA, Harte J, Zhao XQ (2007) Experimental warming, not grazing, decreases rangeland quality on the Tibetan Plateau. Ecol Appl 17:541–557

Kreutzmann H (2012) Pastoralism—a way forward or back? In: Kreutzmann H (ed) Pastoral practices in High Asia. Agency of 'development' effected by modernisation, resettlement and transformation. Springer, Dordrecht, pp 323–336

Land Resource Mapping Project (1986). Summary report of LRMP. His Majesty's Government of Nepal and Government of Canada. Land Resource Mapping Project, Kathmandu

Liu, J.G., Dietz T., Carpenter S.R, Alberti M., Folke C., Moran E., Pell A.N., Deadman P., Kratz T., Lubchenco J., Ostrom E., Ouyang Z.Y., Provencher W., Redman C.L., Schneider S.H., and Taylor W.W. (2007a). Complexity of coupled human and natural systems. Science 317(5844):1513-1516.

Liu, J.G., Dietz, T., Carpenter, S.R., Folke, C., Alberti, M., Redman, C.L., Schneider, S.H., Ostrom, E., Pell, A.N., Lubchenco, J., Taylor, W.W., Ouyang, Z.Y., Deadman, P., Kratz, T. and Provencher, W. (2007b) Coupled human and natural systems, Ambio, 36: 639–649.

Long RJ, Zhang DG, Wang X, Hu ZZ, Dong SK (1999) Effect of strategic feed supplementation on productive and reproductive performance in yak cows. Prev Vet Med 38:195–206

Long RJ, Ding LM, Shang ZH, Guo XH (2008) The yak grazing system on the Qinghai-Tibetan plateau and its status. Rangeland J 30:241–246

Ma YS, Lang BN, Li QY, Li YF, Li FJ (1999) The present status of the grassland eco-environment at the headwater areas of Qinghai-Tibetan Plateau and resume strategies of degraded grassland. Grassl China 55:59–61

Macchi M, Gurung AM, Hoermann B, Choudhury D (2011) Climate variability and change in the Himalayas: community perceptions and responses. International Centre for Integrated Mountain Development, Kathmandu,

Maikhuri RK, Nautiyal S, Rao KS, Chandrasekhar K, Gavali R, Saxena KG (2000) Analysis and resolution of protected area-people conflicts in Nanda Devi Biosphere Reserve, India. Environ Conserv 27(1):43–53

Meinzen-Dick R, Gregorio MD (2004) Collective action and property rights for sustainable development: overview. In: Meinzen-Dick R, Gregorio, MD (eds) Collective action and property rights for sustainable development: 2020 vision for food, agriculture and environment. 2020 focus II, brief 1 of 16'. International Food Policy Research Institute, Washington, pp 1–2

Miles MB, Huberman AM (1994) Qualitative data analysis: an expanded sourcebook, 2nd edn. Sage, Thousand Oaks

Ostrom E (1990) Governing the commons: the evolution of institutions for collective action. Cambridge University Press, London

Patton MQ (1990) Qualitative evaluation and research methods, 2nd edn. Sage, Newbury Park

Rai N, Thapa MB (1993). Indigenous pasture management systems in high-altitude Nepal: a review. HMG Ministry of Agriculture/Winrock International Policy Analysis in Agriculture and Related Resource Management, research report series, no 22. Winrock International, Kathmandu,

Rajbhandary HB, Pradhan SL (1990). Livestock development and pasture management. In: National Planning Commission/The World Conservation Union (eds) Background papers to the national conservation strategy for Nepal. The World Conservation Union, Kathmandu, pp 1–10

Rawat GS (1998) Temperate and alpine grasslands of the Himalaya: ecology and conservation. Parks 8:27–36
Scott A (1955) The fishery: the objectives of sole ownership. J Polit Econ 63:116–124
Shang ZH, Long RJ (2005) Formation reason and recovering problem of the "black soil type" degraded alpine grassland in Qinghai-Tibetan Plateau. Chi J Ecol 24(6):652–656
Sharma VP, Rollefson IK, Morton J (2003) Pastoralism in India: a scoping study. Centre for Management on Agriculture, IIM, Ahmadabad
Shrestha TB (2001). Status review national strategies for sustainable development forestry/rangeland/biodiversity. The World Conservation Union, Kathmandu
Singh KS (1996) Peoples of India series. Anthropological Survey of India, New Delhi
Singh JP, Roy MM, Radotra S (2009) Grasslands of Himachal Pradesh. Indian Grassland and Fodder Research Institute , Jhansi
Sundriyal RC (1995) Grassland forage production and management in the Himalaya: a review. J Hill Res 8(2):135–150
Tamang D (1993) Challenges and opportunities in farm and community resource management in Nepal. In: Tamang D, Gill GJ, Thapa GB (eds) Indigenous management of natural resources in Nepal Tamang. Proceedings of the workshop on indigenous management of agriculture and natural resources, Dhulikhel, Nepal, 8–9 June 1992. Winrock International, Kathmandu, pp 13–23
Tesfay Y, Tafere K (2004). A pastoral forum organized by the Dryland Coordination Group (DCG) in Ethiopia, 27–28 June 2003. DCG report no 31, November 2004. Dryland Coordination Group, Mekelle
Tourism for Rural Poverty Alleviation Program (2005) Tourism resource mapping profile: Resuwa District. (NPTC limited), Chabahil: Kathmandu, Nepal
Tyler SR (2008) Adaptive learning in natural resource management: three approaches to research. Working paper 22. International Development Research Centre
Walker B, Salt D (2006) Resilience thinking: sustaining ecosystems and people in a changing world. Island, London
Walker B, Holling CS, Carpenter SR, Kinzig A (2004) Resilience, adaptability and transformability in social-ecological systems. Ecol Soc 9(2):5, http://www.ecologyandsociety.org/vol9/iss2/art5/
Wang GX, Wang YB, Li YS, Cheng HY (2007) Influences of alpine ecosystem responses to climatic change on soil properties on the Qinghai-Tibet Plateau, China. Catena 70:506–514
Wang SP, Duan JC, Xu GP, Wang YF, Zhang ZH, Rui YC, Luo CY, Xu BRBY, Zhu XX, Chang XF, Cui XY, Niu HS, Zhaio YQ (2012) Effects of warming and grazing on soil N availability, species composition and ANPP in alpine meadow. Ecology 93:2365–2376.
Wu N (1997) Indigenous knowledge and sustainable approaches for the maintenance of biodiversity in nomadic society: experiences from eastern Tibetan Plateau. Erde 128:67–80
Wu X.Y., Zhang X.F., Dong S.K., Cai, Zhao T.R., Yang W.J., Jiang R., Shi Y.D., Shao J.L. (2015) Local perceptions of rangeland degradation and climate change in the pastoral society of Qinghai-Tibetan Plateau. The Rangeland Journal, 37: 11–19.
Xu WX, Liu XD (2007) Response of vegetation in the Qinghai-Tibet Plateau to global warming. Chin Geogr Sci 17:151–159
Yan ZL, Wu N, Yeshi D, Ru J (2005) A review of rangeland privatization and its implications in the Tibetan Plateau, China. Nomadic Peoples 9:31–51
Yeh ET (2003) Tibetan range wars: spatial politics and authority on the grasslands of Amdo. Dev Change 34:499–523
Yeh E (2010) Restoring the grasslands? Chinadialogue, 26 January
Zhang HF, Liu FG, Zhou Q, Duo HR (2004) Degradation mechanism of the grass in Qinghai Plateau and its prevention and control countermeasures. J Nat Disasters 13:115–120 (in Chinese)
Zhang Y., Gao Q.Z, Dong S.K., Sherman R., Wang X.X., Li,Y.Y., Tang L., Wu X.Y. (2015) Effects of grazing and climate warming on plant diversity, productivity and living state in the alpine rangelands and cultivated grasslands of the Qinghai-Tibetan Plateau. The Rangeland Journal 37: 57–65.