

Traditional livelihood based on sheep grazing in the Khangchendzonga national park, Sikkim

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The Khangchendzonga National Park, located in Sikkim is a part of the Eastern Himalaya biodiversity hotspot. Traditional sheep herding practices in the park based on village consultations and field surveys to understand the population trend, migration pattern, fodder preferences, incomes and benefit sharing, ecological impacts and risk mitigation techniques were analysed. The study revealed that traditionally sheep in the greater Himalayas and sheep and yak in the trans-Himalaya have been grazed in the national park. However, over the last six decades, sheep population declined rapidly and has been increasingly replaced by the larger bodied livestock, yaks and horses. The shepherds traditionally performed long distance migration and timed their movement to match with seasonal fodder resource availability thus minimizing their grazing impacts. The flock size was small and the herders earned subsistence level of incomes from the sale of lambs and wool. The extant shepherd community possess immense traditional knowledge about the fodder resources, medicinal plants and wildlife. Nutrient analysis of the fodder plants was found to support the traditional wisdom of the shepherds. Recognition of their skills and making them partners in conservation by the park management has been proposed.

Keywords: Herding, Grazing, Forage, Sustainable development, Eastern Himalaya, Participatory conservation, Traditional knowledge

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Sikkim, one of the smallest states in India having a geographical extent of 7,096 km² forms a part of the eastern Himalaya. This region is also included as a part of the 34 global biodiversity hotspots of the world^{1,2}. In order to conserve the representative floral and faunal assemblages the Government of Sikkim established Khangchendzonga National Park (KNP; 1784 km²) in 1977 that covers nearly one fourth of the total geographical area of the state. Both the greater Himalayan (86%) and the trans-Himalayan (14%) landscapes are represented within this park. The KNP is renowned for its high altitude landscape having nine peaks which rise above 7,000 m including the third highest peak in the world, i.e. Mt. Khangchendzonga (8,586 m). 90% of the park lies above 3,000 m, and 34% is under glaciers, ice-sheets or perpetual snow. The park also harbours more than 150 glaciers and 73 glacial lakes³. The monsoon climate is characterized by an extended, wet summer followed by a long, dry winter. Wide altitudinal and eco-climatic variation has given rise to as many as 18

forest types⁴. Broad landscape level classification indicates that KNP comprises of temperate oak forests (11%), subalpine conifer and krummholtz forests (14%), alpine forests (22%) and snow and rock (53%). A total of 1,580 species of vascular plants have been recorded from the park and the surrounding forests⁵. Eight herbivores, ten carnivores and three pheasants have been reported from the park^{6,7}.

Large cardamom (*Ammomum subulatum* Roxb.) farming in the sub-tropical belt and livestock rearing in the temperate and alpine belt are the main livelihoods in the western part of state, especially in and around KNP. Recently, tourism in select villages has brought about local prosperity. The cultural diversity of the local communities living adjacent to the KNP has resulted in a variety of lifestyles. The *Gurungs* and *Mangers* were the shepherds, the *Bhutias* were the traders and yak herders, the *Lepchas* and the *Limboo* were the hunter-gatherers and shifting cultivators, the *Chettri* and *Bahun*s were the agropastoralists rearing cattle and the *Tibetan Dokpas* were the nomadic yak and sheep herders in the trans-Himalaya.

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The stunning variation in altitude of 7,466 m (1,220-8,586 m), the exceptionally high biodiversity and the existence of nine major ethnic communities on its fringes makes this park a global natural and cultural heritage site. The questions for this study on sheep pastoral system were related to the dynamics of livestock composition and population, patterns in migration, levels of incomes and benefit sharing, ecological impacts, forage quality and risk mitigation techniques.

Methodology

A combination of techniques including consultations, with traditional sheep herders, village meetings and extensive field surveys was used. The study area was the greater Himalayan part of KNP and the villages adjacent to it, where the sheep grazing livelihood was still being practiced. The data were collected from 2004 to 2006 with field surveys during summer and village consultations in winter.

Information from herders, ex-herders and other resource users was collected using participatory appraisal tools like historical time-line, participatory resource mapping and pair-wise ranking. Consultations were conducted in 17 villages over 49 days and one focal group herder interaction workshop was also organized. Each of these meetings had between 50 to 100 participants including ex-herders. Information on pastoral systems related to historical and current population trends, ownership pattern, migration routes and incomes using these participatory appraisal tools were recorded. The per capita income of the state was based on the economic survey⁸. The study area was surveyed in summer season in 14 field visits spanning 125 days from 2004 to 2006 and a census of the herders and information relating to livestock holding, ownership pattern, migration and fodder preference was recorded. Most of the plants were identified closest to the genera and species in the field using the regional floras available^{9,10}. Voucher specimens of unidentified plants were collected and later verified from other monographs and herbaria at Gangtok and Dehra Dun. Native uses of plants were noted from the local field guides. Herd owners when interviewed were inclined towards under reporting their livestock holding and under estimating their incomes. Comparatively, the herd caretakers who were employed by the herd owners on wages were more forthcoming and reliable. The most reliable information on livestock was collected from them and from the ex-herders, who had

sold off their livestock recently since they did not have any direct stake in this enterprise. One livestock unit (LU) was taken as equivalent to three sheep based on previous studies¹¹.

Forage analysis was carried out in the laboratory at Wildlife Institute of India. Key fodder plants of the summer and winter pastures were short listed for forage analysis based on field vegetation surveys, herder interviews and village meetings. Forage analysis including fiber and protein was carried out following standard procedures¹². The amount of Neutral Detergent Fiber (NDF), which is a measure of all the fiber in the forage, was measured using detergent and heat. The amount of Acid Detergent Fiber (ADF), which is the poorly digested and indigestible parts of the fodder (i.e. cellulose and lignin) and Acid Detergent Ash (ADA) was quantified using sulfuric acid and heat. Nutrient analysis was done using the standard modified Kjeldahl method¹³. The crude protein was calculated by multiplying the nitrogen (N%) in the diet with 6.25. Relative Feed Value (RFV) was calculated from the estimates of Dry Matter Digestibility (DMD) and Dry Matter Intake (DMI) as percentage of Body Weight (BW)^{14,15}. $\%DMD = 88.9 - (0.779 \times \%ADF)$, $\%DMI = 120 / \%NDF$, Relative Feed Value (RFV) = $(\%DMD \times \%DMI) / 1.29$. In the end, the findings of the study were discussed thread bare with the ex-herders and their comments incorporated.

Results

Evolution of pastoral systems

The livestock composition and population in the KNP have been rapidly changing over the last six decades (Table 1). Current livestock composition includes sheep, cow, yak, yak-cow crossbreed and horse. Historical records indicate that while sheep and trans-Himalayan yaks (Tibetan breed) were traditionally grazed in the alpine landscape of KNP, cows, buffaloes, yaks (Nepalese breed), female yak-cow crossbreeds (*urang* or *dzomo*) and horses in the greater Himalaya have arrived only over the last 60 yrs¹⁶⁻¹⁸. The total livestock population in KNP reduced significantly from about 11,010 in 1950 to 3,710 in 2004, while the total livestock biomass increased from about 6,08,000 to 7,64,000 kg during this period. The sheep population in KNP has declined rapidly from about 8,800 in 1950, to 1,141 in 10 flocks owned by 33 families in 2004. The overall trend is of smaller sized livestock (e.g. sheep) giving way to larger sized livestock (yak and their

Table 1—Dynamics of livestock population and biomass in KNP from 1950 to 2004

Livestock type	Population			Biomass (in '000 kg)		
	1950	1975	2004	1950	1975	2004
Greater Himalaya						
Sheep (<i>banpaala</i> breed)	8800	5200	1141	264	156	34
Cow	100	600	150	30	180	45
Buffalo	0	200	5	0	60	2
Yak (Nepalese breed)	50	200	779	13	50	195
Female yak-cow crossbreed (<i>urang</i> or <i>dzomo</i>)	0	0	469	0	0	164
Pack animal (horse and <i>dzo</i>)	60	60	316	21	21	111
Trans Himalaya						
Sheep (Tibetan breed or <i>bherlung</i>)	1000	1000	0	30	30	0
Yak (Tibetan breed)	1000	630	850	250	158	213
Total livestock	11010	7890	3710	608	655	764

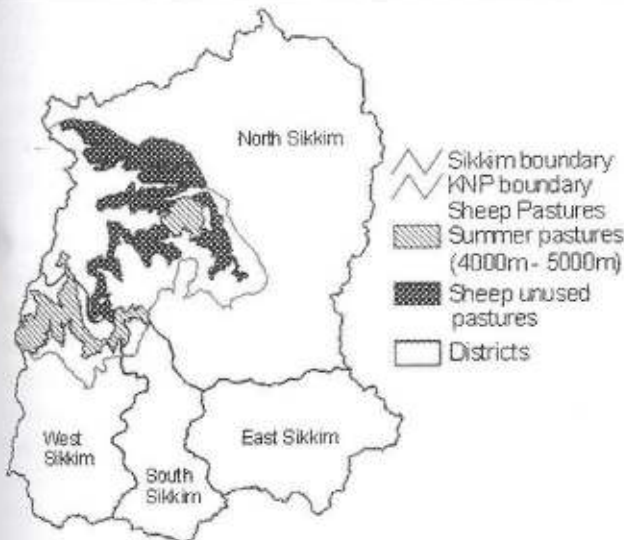


Fig. 1—Location of sheep pastures in KNP

crossbreeds and horses). The Tibetan breed of domestic sheep or *Bherlung* in the trans-Himalaya has got extinct from within the KNP during this period.

Migration patterns

The earliest written records of sheep herding in the Greater Himalaya of KNP are found in the travelogue of Sir JD Hooker, who mentions about nomadic *Gurung* shepherds in the alpine meadows of West Sikkim⁸. Sheep herding has been a traditional livelihood of the *Gurung* and *Manger* community. They are semi-nomadic, agro-pastoralists and their indigenous breed of sheep is known as *banpaala*. In late spring, the sheep herders migrate up (*umbole*) to

the high altitude pastures (4,000–5,000 m) and return (*undole*) down to their villages (1,000–1,800 m) by late autumn (Fig. 1). In the alpine zone, during the summer monsoons they stay in makeshift tents (*goth*) and shift camp frequently on a weekly basis. *Rhododendron campanulatum* and *Juniperus indica* firewood is used for cooking and heating. In the KNP presently they access the alpine meadows within Churong, Prek, Rangit and Rimpi (Rangyong) watersheds during summer while in winter they descend down to the fallow farmer's fields. These families belong to the villages of Dhoopi, Narkhola, Pokhri, Karjee, Rungdung, Chung, Melli, Dechenthang and Sardung in West district and one household each from Sada-Phamtam in South district and Mangan in North district.

Ecological impacts

The sheep traditionally migrate long distance between the subtropical villages (1,000–1,800 m) in winter to the alpine meadows (4,000–5,000 m) within KNP in summer. Natural ground fodder is abundantly available in the alpine meadows of the KNP during summer only. During winter due to heavy snowfall the alpine vegetation is not available to the livestock. The temperate and sub-alpine forests of KNP are the multi-layered evergreen oak and silver fir forests with a dense middle storey of dwarf bamboo and *Rhododendron* with a moss-dominated ground cover. *Yushania maling* (*malingo*) and *Thamnocalamus spathiflorus* (*raat nigalo*) are the main bamboo species that grow up to a height of 7 m with a 7–10 cm girth and are densely packed with an average of 325 stems per 10 m sq plot. Natural ground fodder cover was found to be less than 2% in these forests in pristine state. Scarcity of natural fodder during the long winter season from November to March is the biggest challenge to sustainable livestock production within KNP. The shepherds overcome this hurdle by descending down to the fallow agricultural fields and village commons during winter. Thus traditionally the migration pattern of the shepherds closely mirrors the seasonal availability of natural fodder and was found to be ecologically sustainable with minimum grazing impacts. Thus, proper zonation of KNP into core, buffer and multiple use zones and seasonal sheep grazing within pre-designated areas (buffer zone) would be the best strategy for long term management of this park.

Incomes, ownership and benefit sharing

The incomes from pastoral systems depend on the herd size, livestock management system and the

breeding strategy. The fixed costs include the expenses of hiring a caretaker, his living expenses, while the running costs (which vary with flock size) include the feed and salt requirements of the livestock. Table 2 shows the key economic traits of these sheep which are reared mainly for sale of lambs and wool. The flock composition is 95% female and is grazed in the adjoining meadows every morning and return to the caretakers shed before sunset. Mid June to mid September are the three summer months available for milk production, but the production is meager. The milk is processed into butter, which has a high demand owing to its soothing and cleansing properties. Autumn (*undole*) is the lambing season for sheep and in spring (before *umbolq*) the male lambs and the unproductive females are sold off in the village and fetch about Rs 2,000 each which is used to purchase rations for the summer months. As per the *Gurung* and *Manger*

traditions, male sheep are slaughtered in religious ceremonies like *Kul pooja*, *Naya deota puja* and social functions like marriages. The sheep are sheared twice, once in spring before *umbolq* and then in autumn after *undole*, yielding totally about one kilogram of wool, which fetches Rs 50 in the local market. This wool is packed into bales of 2.5 kg each called *dharnis*. It is used to make mattresses (*bhurkhasan*), blankets (*raadi*) and jackets (*lukuni*) using the traditional handloom and natural red dye of the *Rubia cordifolia* (*majito*) plant. At present there are 33 sheep herders, who own 11.4 LU (1000±700 kg of sheep biomass) each. The per capita income of the state which was Rs 26,838 in 2005 was used as the baseline⁹. Relative to this the sheep herder earns Rs 20,622 (0.8 times) annually.

Risk mitigation

The major risks involved are early snowfall, falling off cliffs, feeding on poisonous plants, depredation by carnivores and diseases. In the past occasionally wild dogs and rarely snow leopard used to depredate on the sheep in the alpine pastures. Guard dogs, fire and lanterns were used to keep the carnivores at bay. However over the last 30 yrs no such instance has come to light. There have been instances of sheep getting poisoned after feeding on the tender shoots of plants like *Aconitum ferox* (*Bikh*) and *Pieris formosa* (*Bolu*) during *umbolq*, when other forage is in short supply. The shepherds have tremendous traditional knowledge of the alpine flora and fauna. They are adept at trapping alpine birds like Himalayan monal and snow partridge and hunting ungulates mostly musk deer and Himalayan tahr using traps and hunting dogs.

Forage analysis of alpine fodder plants

Buki was the generic name used for graminoids of the alpine zone by the shepherds. *Heracleum* sp. (*ganer*), *Allium prattii* (*dandu*), *Selinum tenuifolium* (*cheeru*), *Kobresia nepalensis* (*sun buki*), *Deschampsia caespitosa* (*chamrey*), *Juncus* sp. (*suire buki*), *Kobresia duthiei* (*bhalu buki*) and *Festuca valesiaca* (*rani buki*) are the preferred fodder species as per ranking by the shepherds. Quantifying the protein and fiber content is important for determining the quality of forage. Laboratory analysis of these plants was carried out (Table 3). Low fiber content (NDF less than 40%), high potential digestability (ADF less than 31%) and high protein content (CP more than 19%) are the desirable traits of top quality prime forage¹⁵. While poor quality forage has high fiber content (NDF more than 65%), high potential

Table 2—Key economic traits of sheep in KNP

Economic Traits	Value	Units
Adult weight	30	kg / sheep
Age of first calving	2-3	Years
Gestation period	6	Months
Daily milking yield	0.35	liters / day
Lactation length	6	Months
Milking period	3	Months
Calving interval	1	Month
Wool yield	1	kg / year
Life span	10-12	Years
Total calving	7-8	no of lambs
Sale value of lamb	2000	Rs / lamb
Sale value when adult	2000	Rs / sheep
Sale value when old	2000	Rs / sheep

Table 3—Protein and fiber levels in key alpine forage (collected in June 2005)

Fodder Species	NDF	ADF	CP	DMD	DMI	RFV ^a	QS ^b
	%	%	%	%	%		
<i>Heracleum</i> sp. (<i>ganer</i>)	43	37	23	60	3	129	1
<i>Carex</i> sp. (<i>harkat</i>)	64	29	9	66	2	97	3
<i>Kobresia nepalensis</i> (<i>sun buki</i>)	71	33	19	63	2	83	4
<i>Juncus</i> sp. (<i>suire buki</i>)	73	37	12	60	2	77	4
<i>Kobresia duthiei</i> (<i>bhalu buki</i>)	77	36	15	61	2	74	5
<i>Festuca valesiaca</i> (<i>rani buki</i>)	81	41	11	57	1	65	5

^a Relative Feed Value (RFV)- Reference hay of 100 RFV contains 41 % ADF and 53 % NDF

^b Quality Standard assigned by Hay Market Task Force of American Forage and Grassland Council

indigestibility (ADF more than 45%) and low protein content (CP less than 8%).

The alpine grasses and sedges had uniformly very high fiber content (NDF greater than 64). The forage digestibility varied a lot with *Festuca valesiaca* being highly indigestible (DMD=57) while *Carex sp.* (DMD=66) showed very high digestible characteristics. All the other grasses and sedges showed average digestibility. Their protein content too varied a lot (CP between 9% to 19%). *Kobresia nepalensis* (*sun buki*) was found to have a very high nutrient value of 19% amongst the graminoids. The herders too have a high regard for this sedge, the literal translation of its local name is *golden fodder* and it forms extensive meadows in the upper alpine zone. The Apiaceae member *Heracleum sp.* (*ganer*) was strongly recommended by the herders as high nutrient forage preferred not only by their domestic livestock but also by the Himalayan musk deer. The forage analysis revealed that *Heracleum sp.* had a very high intake value (NDF=43%), good digestibility (ADF=37%) and very high protein content (CP=23%) confirming that it was indeed a high quality (RFV=129) fodder plant of the alpine meadows.

Conclusion

Interviews with local villagers and historical records show that traditionally in the greater Himalayan part of the KNP, *banpaala* breed of sheep were the dominant livestock that used to graze in the alpine meadows during summer and then descend down to the farmer's fields in winter. However, over the last six decades their number is rapidly declining and they are being replaced by larger sized livestock mostly yaks and horses. Low ecological impacts and high equity in benefit sharing made the sheep herding livelihood sustainable. These shepherds possess tremendous traditional knowledge of the biodiversity and its use, and the results of the nutrient analysis of the fodder plants reinforces this point. Enlisting the support of the park management in these sheep herders in conservation management has been proposed. They should be recognized as *Himal Rakshaks* (Honorary Mountain Guardians) and trained in scientific monitoring of biodiversity and climate change. In turn, limited sheep grazing could be allowed within pre-designated areas and routes which may be notified as buffer zones to meet the legal requirements of the national park. This will result in a more effective, participatory "on ground"

conservation of the park jointly with the Forest Department.

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References

- 1 Official method of analysis, (Association of Official Analytical Chemists (AOAC), 15th ed, Washington DC USA), 1990, 66-88.
- 2 Canbolat O, Kamalak A, Ozkan CO, Erol A, Sahin M, Karakas E & Ozkose E, Prediction of relative feed value of alfalfa hays harvested at different maturity stages using in vitro gas production, *Livestock Research for Rural Development* Vol 18, Article #27, Retrieved March 11, 2007, from <http://www.cipav.org.co/lrrd/lrrd18/2/canb18027.htm>, 2006.
- 3 Champion FW & Seth SK, *A Revised Survey of the Forest Types of India*, (Manager, Government of India Press, Nasik, India), 1968.
- 4 Chetri N, Impact of habitat disturbances on bird and butterfly communities along Yuksam-Dzongri trekking trail in Khangchendzonga Biosphere Reserve, PhD Thesis, (North Bengal University, India), 2000.
- 5 CISMHE. Carrying Capacity Study of Tista Basin in Sikkim, Vol II, Land Environment - Geophysical Environment, Centre for Inter-disciplinary Studies of Mountain and Hill Environment, (University of Delhi, Delhi), 2005, 113-114.
- 6 Critical Ecosystem Partnership Fund (CEPF), Ecosystem Profile: Indo-Burma Hotspot, Eastern Himalayan region, WWF US Asia programme, 2005.
- 7 Grierson AJC & Long DG, *Flora of Bhutan*, Vol I-III, (Royal Botanical Garden, Edinburgh), 1983-1991.
- 8 Hooker JD, *The Himalayan Journal: Notes of a Naturalist*, Vols I & II, Reprint, (Natraj Publishers, Dehra Dun), 1853.
- 9 Lama MP, *Sikkim: Economic Survey 2006-2007*, (Government of Sikkim, Gangtok), 2007.
- 10 Maity D & Maiti GG, *The Wild Flowers of Kanchenjunga Biosphere Reserve*, Sikkim, (Noya Udyog, Kolkata), 2007.
- 11 Mittermeier RA, Gils PR, Hoffman M, Pilgrim J, Brooks T, Mittermeier CG, Lamoreaux J & da-Fonseca GAB (eds), Hotspots revisited. Earth's biologically richest and most endangered terrestrial ecoregions, (CEMEX, USA), 2004.
- 12 Myers N, Mittermeier RA, Mittermeier CG, da Fonseca GAB & Kent J, Biodiversity hotspots for conservation priorities, *Nature*, 40 (2000) 853-858.
- 13 Polunin O & Stainton A, *A concise flowers of the Himalaya*, (Oxford University Press), 1987.
- 14 Risley HH, *The Gazetteer of Sikkim*, Calcutta, (Bengal Secretariat Press, Calcutta), 1894.
- 15 Rohweder DA, Barnes RF & Jorgensen N, Proposed hay grading standards based on laboratory analyses for evaluating quality, *J Anim Sci*, 47 (1978) 747-759.
- 16 Singh HB, Jackson R & Sharma E, Dynamics of grazing in an alpine meadow of the Khangchendzonga National Park in Sikkim Himalaya, Proc VIth Int Rangeland Congress, Townsville, Australia, 1999.

- 17 Smith WW & Cave GH, *The Vegetation of the Zemu and Llonakh Valleys of Sikkim*, In the records of the Botanical Survey of India, Vol IV, No 5, (Superintendent Government Printing, India), 1911, 272.
- 18 Van Soest PJ, Robertson JB & Lewis BA, Methods for dietary fiber, neutral detergent fiber, and non-starch polysaccharides in relation to animal nutrition, *J Dairy Sci*, 74 (1991) 3583-3597.
- 19 Van Soest PJ, Robertson JB & Lewis BA, Methods for dietary fiber, neutral detergent fiber, and non starch polysaccharides on relation to nutrition, *J Dairy Sci*, 70 (10 (1991) 3583-3597.
- 20 Tambe S & Rawat GS, Ecology, economics and equity of the pastoral systems in the Khangchendzonga National Park, Sikkim Himalaya, India, (Ambio, Royal Swedish Academy of Sciences), 2008.