Kirghiz and Wakhi livestocks in Afghan Pamirs in 2007

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Cover photo: A group of Kirghiz domestic yaks in Big Pamir, Afghanistan, July 2007.

All photographs: WCS Ecosystem Health Project Team
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TABLE OF CONTENTS

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EXECUTIVE SUMMARY

The Afghanistan Ecosystem Health Project Team carried out three surveys in Wakhan District, Badakhshan Province in 2007 to study: 1/ Kirghiz livestock in Big Pamir (Part I); 2/ Wakhi livestock in Little Pamir (Part II); and 3/ Wakhi livestock in Big Pamir (update of 2006 survey) (Part III). Our goal was to estimate the number and ownership of livestock, to determine the seasonal patterns of their range use and the timing of transhumances, and to assess livestock health status, occurrence of transmissible diseases, risk of disease spillover between domestic and wild ungulates, and predation level due to wild carnivores.

Kirghiz are nomadic pastoralists, performing seasonal movements between winter and summer grazing areas in Pamirs, but for short distances at each move. They live in the north-facing slopes of the northeastern part of the Big Pamir and the eastern part of the Little Pamir. They stay all year round in Pamirs. Wakhi are mostly sedentary farmers who live in small villages located at lower altitudes in the Wakhan corridor. Only a minority of them are transhumance herders. They use the surrounding Pamir Mountains as seasonal pastures, bringing their livestock (sheep, goats, yaks, cattle, Bactrian camels, horses and donkeys) into potential contact with wildlife.

During summer missions (17 June–12 September 2007), we surveyed 31 Kirghiz households in 8 settlements and 4 different grazing areas in Big Pamir, 42 Wakhi households in 13 settlements and 4 different grazing areas in Little Pamir, and eventually 15 Wakhi households in 4 settlements and 3 grazing areas in Big Pamir. Data presented in this progress report are based on 88 interviews as well as on direct observations and veterinary investigations of livestock.

According to the interviews, an estimated 2221 sheep, 432 goats, 372 yaks, 8 heads of cattle and 82 Bactrian camels were herded by the 31 Kirghiz households; 1809 sheep, 478 goats, 523 yaks and 65 cattle heads were herded by the 42 Wakhi households of Little Pamir; and 980 sheep, 362 goats, 162 yaks, 43 cattle and 4 camels by the 15 Wakhi households of Big Pamir. Overall direct counts showed that livestock were at least 25% more numerous than interview estimates. Based on a number of extrapolations and assumptions we roughly estimated Kirghiz livestock in Big Pamir in summer 2007 at approximately 9000 sheep and goats, 1250 yaks, 25 cattle, and 270 camels; Wakhi livestock in Little Pamir in summer 2007 at 4900 sheep and goats, 900 yaks, 65 cattle and 11 camels; and eventually Wakhi livestock in Big Pamir in summer 2006 at 9500 sheep and goats, 800 yaks, 300 cattle heads and 60 camels.

Ruminant livestock in Pamirs suffer heavy losses particularly during winter, largely due to harsh weather conditions and meager forage, coldness and undernutrition being the first cause of death. Overall the second cause of death is infectious diseases and the third predation. From interviews we have estimated mortality rates in sheep at 25.3%, 13.1%, and 15.2%, in goats at 46.7%, 12.5%, and 12.7%, and in yaks at 23.2%, 16%, and 8.8% in surveyed Kirghiz livestock in Big Pamir, Wakhi livestock in Little Pamir, and Wakhi livestock in Big Pamir, respectively. According to our estimates, Kirghiz in Big Pamir have lost nearly one third of their livestock during past year, twice as much as Wakhi from Little and Big Pamir. Overall predation accounted for much higher losses than recorded during earlier surveys. On average for the past year Kirghiz lost 1 every 27 sheep due to predation compared to 1 every 43 sheep in Wakhi of Big Pamir, and 1 every 69 sheep for Wakhi of Little Pamir.

Two interrelated factors play important roles in the health status of livestock in Pamirs: the seasonal variability in the availability and quantity of forage and the occurrence of infectious diseases. The principal cause of mortality in ruminants was undernutrition and coldness, which affected all species during winter. At the beginning of spring there was a burst of abortions among sheep, goats and yaks. We noted that many diseases affected Kirghiz domestic ruminants in Big Pamir including: Foot and Mouth Disease, contagious ecthyma, infectious mastitis, as well as sheep ked infestation in summer pastures, but to a lesser extent than Wakhi livestock of Big Pamir (Ostrowski, 2006).

We have also recorded significant populations of equids. Surveyed Kirghiz owned 50 horses and 16 donkeys, Wakhi from Little Pamir had 57 horses and 114 donkeys, and Wakhi from Big Pamir owned 22 horses and 47 donkeys. Kirghiz and Wakhi acknowledged that equids are very resilient to diseases and seldom die of disease outbreaks.

Results of interviews suggested that direct transmission of infectious agents from small ruminants to wild ungulates is very unlikely in Big and Little Pamir during summer as there are no reported direct contacts between them in the current land use context. However, the risk of direct transmission in winter or of indirect transmission of pathogens through insect vectors, contaminated foods, soil or water, cannot be ruled out. A potential source of disease spillover between livestock and wildlife could come from large ruminants, especially yaks, often left unattended at high altitude pastures and possibly in closer contact with wild ungulates than sheep and goats.

In summer 2007 we have initiated a cooperative data collection exercise with Wakhi herders of five major settlements in Big Pamir. We trained them at recording the position of their herds at regular intervals with provided GPS units. Preliminary results are promising. They already improved our understanding of livestock range use during summer. For example, the data set collected in Nakchirshitk in the Manjulak grazing area showed that livestock pastured outside the global grazing area tentatively described in our 2006 report (Ostrowski, 2006), in an area where Marco Polo sheep have been recently observed in summer (Habib, 2006). The study is scheduled to continue until summer 2008.

In winter 2006–2007 we have deployed three electronic thermometers logging air temperature every 15 minutes in upper Wakhan Valley and Big Pamir (Part III). To our knowledge this is the first longitudinal set of continuously-recorded climatic data for Wakhan Valley and Pamir. We hope to compile information on air temperature for at least three consecutive years. From the first analyzes, based on only 5 months of recording in Big Pamir and 11 months in upper Wakhan (c. 47000 data points), we confirm that, as expected, temperatures in winter are remarkably cold, as low as –25°C to –30°C in early morning in Big Pamir in January 2007. During day in January temperature remained around –17°C to –20°C (lower than –15°C). In summer 2007, August was the hottest month but daytime temperature never reached 30°C in Kret, upper Wakhan, and temperatures above 30°C are presumably uncommon and possibly unknown in Pamirs. In this regard, upper Wakhan and Big Pamir present similar daily amplitude of temperature variations but at two different levels of thermal thresholds. From December 2006 to April 2007 average temperatures were 6–10°C lower in Big Pamir than in upper Wakhan, a discrepancy explained by the 1000 m difference in elevation between the two recording sites. The much lower winter average temperatures in Big Pamir may explain the significantly higher mortality rates among Kirghiz livestock.

GENERAL INTRODUCTION

The Wakhan is a narrow corridor in the extreme north-east of Afghanistan, bordered by China, Tajikistan and Pakistan. It encompasses the Afghan Pamir, a very rugged part of the Pamir region, divided into Big Pamir or Great Pamir (Pamir-e Kalan or Pamir-i-Buzurg) and Little Pamir (Pamir-e Khurd). Administratively, the Wakhan corridor falls under Wakhan district, one of the 29 districts of the Badakhshan province. It is sparsely populated by two ethnic groups: the Wakhi and the Kirghiz.

Wakhi, who are the most represented group in the area, are nowadays mostly agriculturalists although they often keep livestock. They are settled in the lower, mid and upper parts of the Wakhan valley, where they grow crop. Only a minority of them uses the surrounding Pamir Mountains for grazing their animals in summer. Kirghiz (also spelled Kyrgyz) are nomad pastoralists who practice nomadic animal husbandry. They remain in the Pamirs all year round, moving regularly from one pasture are to another, but for short distances each time.

One of the main goals of WCS Afghanistan Ecosystem Health Project Team is to document population size, geographical origins, ownership, range use and health status of livestock that use permanently or intermittently Big and Little Pamirs.

In 2006, we started our study with a survey of Wakhi livestock in Big Pamir. In July–August, we evaluated livestock species composition, numbers, ownership, range use, and transhumance patterns. We also assessed their health status through clinical examinations and questionnaire investigations. In November–December, we carried out a second mission to better quantify disease prevalence in livestock and map the range used by livestock. We collected 471 blood samples from sheep and goats to test their exposure to several pathogens that may pose a disease risk both to them and to the wild ungulates they may encounter. Finally, we identified the Central Veterinary Laboratory at Kabul, a structure depending on the Ministry of Agriculture, as a technical partner in this work. A report presenting our work was produced (Ostrowski, 2006).

In 2007, we carried out three more surveys in the Afghan Pamirs. This time, besides updating our data on Wakhi livestock in Big Pamir (June, July and September 2007), we studied Kirghiz livestock in Big Pamir (July 2007) and Wakhi livestock in little Pamir (September 2007). The present report presents collected data. It is divided into four independent chapters: 1/ Kirghiz livestock of Big Pamir; 2/ Wakhi livestock in Little Pamir; 3/ update on Wakhi livestock Big Pamir (numbers and range used during summer by sheep and goat herds in five of the six most important settlements); and 4/ the first ever continuous records of ambient air temperature in upper Wakhan and Big Pamir from winter 2006–2007 to summer 2007. Initially we wanted to include the results of serological investigations carried out in 2007 as well. Exposure to brucellosis, Q fever, chlamydiophilosis, toxoplasmosis and Blue Tongue disease have been tested on a cohort of sheep and goats sampled in Big and Little Pamirs. However, as several positive results still require confirmation from a foreign laboratory, and as testing for exposure to Foot and Mouth Disease (FMD) and Peste des Petits Ruminants (PPR) at the CVL of Kabul under FAO mandate is still pending, we decided to postpone the publication of these preliminary results until next year.

To complete our picture of livestock in Afghan Pamir, we still need to investigate Kirghiz livestocks in Little Pamir, which should hopefully be done in 2008. Yet, the surveys carried out in 2006 and 2007 have already started to clarify the complex issue of livestock disease epidemiology in the Afghan Pamir ecosystem, as well as the risk of disease spillover between domestic and wild ungulates.

ACKNOWLEDMENTS

We thank all WCS staff at Kabul for logistical support throughout the missions, and particularly Mr. Inayatullah who carried out all local arrangements to the benefit of our work. Special thanks go to Mr. Rohullah Sanger, GIS assistant at WCS Kabul for the time he took to produce the maps presented in the report. We of course acknowledge the invaluable help of Wakhi participants to the missions. We are especially thankful to Mr. Sayeed Naqibullah who was and invaluable mediator when we visited the Kirghiz community in Big Pamir.

PART I. KIRGHIZ LIVESTOCK IN BIG PAMIR IN 2007

INTRODUCTION

In Afghanistan the Kirghiz community is confined to the eastern reaches of the Big and Little Pamirs. Unlike Wakhi agropastoralists who graze their livestock in Pamirs in summer and go back to villages in the valley in winter, Kirghiz (also spelled Kyrgyz) are strict pastoralists who remain in the Pamirs all year round. Thus, Kirghiz livestock are exposed to the harsh winter conditions, low barometric pressure, and relative hypoxia of altitude climes, which may in turn affect herd composition, husbandry practices, and health status. One aim of our work in Afghan Pamirs being to compare Wakhi and Kirghiz livestock health status, we have replicated the same methodology used in 2006 among Wakhi of Big Pamir to investigate Kirghiz herds. We here report on the results of our investigations on Kirghiz livestock pasturing in Big Pamir in summer 2007.

OBJECTIVES AND METHODS

Objectives

This survey was dedicated at studying the livestock of the Kirghiz population using Big Pamir. Our goal was to estimate the number and ownership of livestock in a selection of Kirghiz settlements, to determine the seasonal patterns of their range use and the timing of transhumances, and to assess livestock health status, occurrence of transmissible diseases and risk of disease spillover from domestic to wild ungulates, as well as the predation level due to wild carnivores. We only provide firsthand data collected in the field. The report tries to be a snapshot as accurate as possible of Kirghiz livestock in Big Pamir at the time of our survey.

Methods

Dates of surveys

The survey took place between 28 June and 10 July 2007. Depending on the visited settlement, livestock was finishing grazing spring pastures or starting to graze summer pastures. The survey was part of the 2007 mission, which intended to collect data on Wakhi livestock of Little Pamir (Part II) and complete our knowledge of Wakhi livestock of Big Pamir (Part III). Summary of daily activities can be found in Appendix 1.

Team composition

The Ecosystem Health Project Team which carried out the survey on Kirghiz livestock in Big Pamir was composed of:

- Dr. Stéphane Ostrowski, team leader, WCS Ecosystem Health Project Manager;
- Drs. Ali Madad Rajabi and Hafizullah Noori, two Afghan veterinarians graduated in 2005 from Kabul Veterinary College, trainees and research assistants;

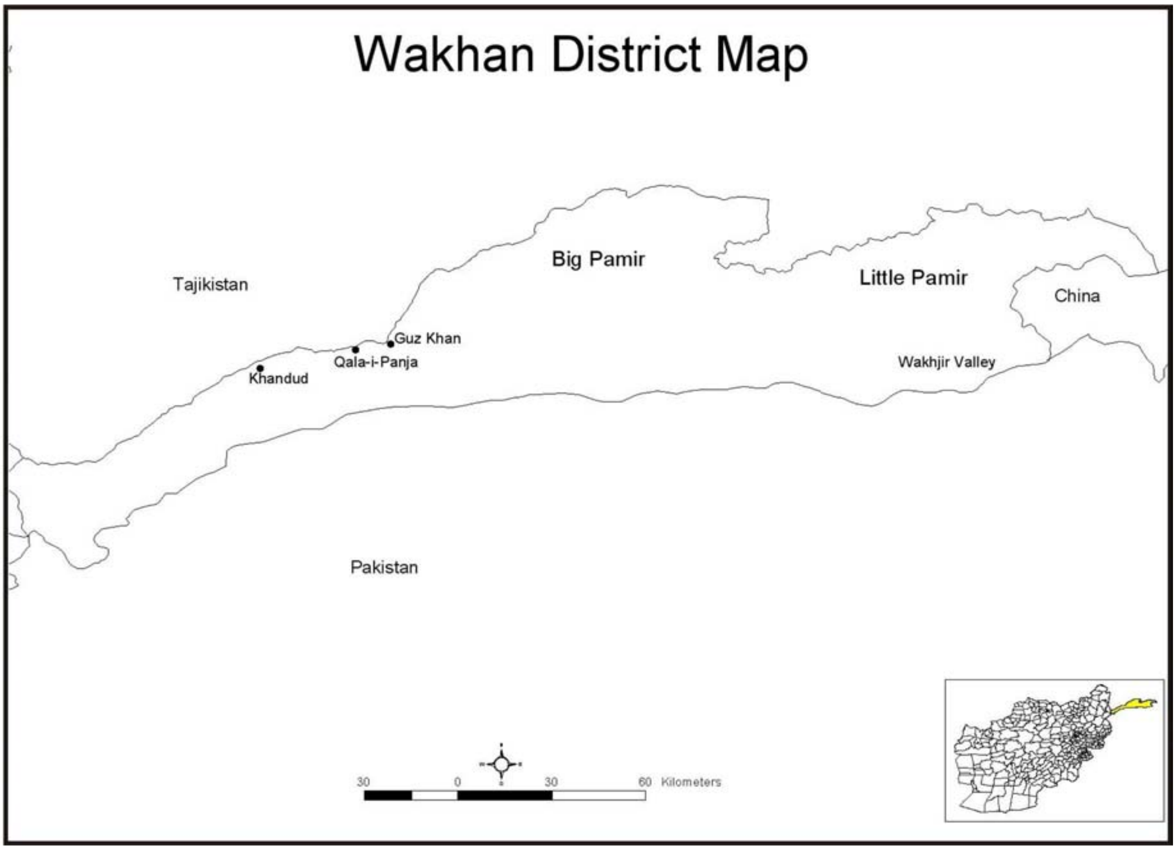

Figure 1. Map of the Wakhan District, Badakhshan Province, Afghanistan, showing Big and Little Pamirs.

- Mr. Sayeed Naqibullah, graduated from Faizabad Agriculture University, research assistant;
- Mr. Inayat, a Wakhi trainee from Qila-e Panja identified by Mr. Inayat Ali, WCS Community Conservation staff member based at Kret, upper Wakhan;
- Mr. Attam Beg, a Wakhi man from Kret, trained as a cook by Mr. Inayat Ali.

Survey area

This year, we focused on Kirghiz livestock pasturing in Big Pamir. Big Pamir (also called Great Pamir) is included in Wakhan District, one of the 29 districts of the Badakhshan Province in northeastern Afghanistan (Figure 1). Locally known as Pamir-e-Kalan or Pamir-i-Buzurg, the Big Pamir comprises the main block of mountains at the western end of the Pamir Knot between the fork of the Pamir and Wakhan rivers. It encompasses high mountains that culminate at 6700–6900 m and high plateaus averaging between 3900 and 4700 m in elevation. The Big Pamir extends over about 5500 km^2 of the Wakhan and encompasses the Big Pamir Wildlife Reserve (Figure 2). This designated 680-km^2 reserve has unfortunately never been implemented and one mission of WCS Afghanistan Biodiversity Conservation Project in Wakhan will be to update its management plan.

Afghan Kirghiz occupy the north-eastern part of Big Pamir, east of the Big Pamir Wildlife Reserve (Figure 2). They are strict pastoralists and seem to practice a nomadism of more limited amplitude than other nomadic populations in Central Asia.

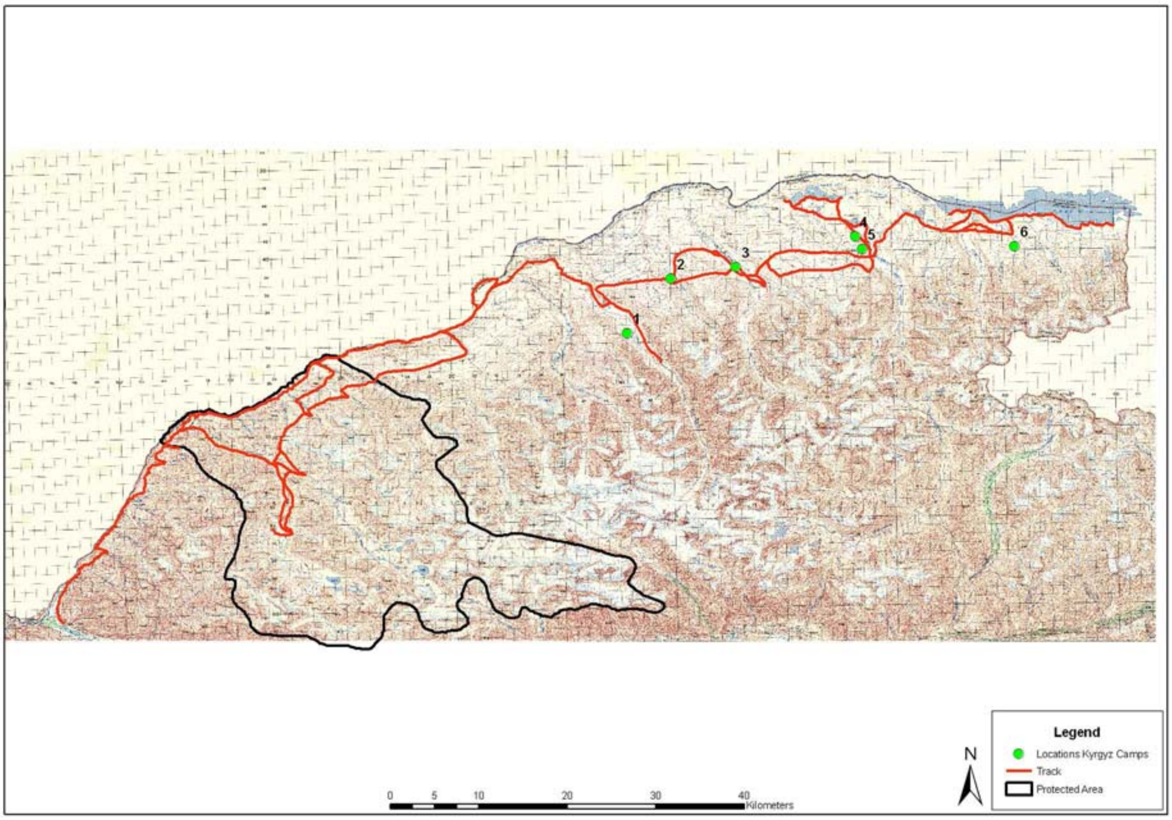

Figure 2. Topographic map of Big Pamir, Badakhshan Province, with plotted track (red solid line) of Ecosystem Health Project Team mission in Wakhi and Kirghiz areas in July 2007. Black solid line represents the Big Pamir Wildlife Reserve. Plain-green dots are visited Kirghiz settlements: Sang-e-Kalan in Tila Bai Valley (1); Ilgonak (2); Beshkunak (3); Shaur (4); Guristani Tuk (5); and Istik (6).

In winter, they graze their livestock in the vicinity of Zorkul Lake and in the western valleys of Bai Tibat and Tila Bai, less than 20 km apart from summer pastures, which lie higher up on Pamir north-facing slopes. In 2008, we plan to extend our study of Kirghiz livestock to Little Pamir populations.

Transport

Team members flew or drove to Faizabad, capital of Badakhshan Province, and drove to Ishkeshim. To reach the starting point of our summer expedition in Big Pamir, we traveled in the Wakhan Valley with 4 four-wheel-drive cars, two rented in Kabul and two belonging to WCS. On 17 June, we sent back the cars, hired donkeys and horses for riding and packing purposes, and proceeded walking and riding from Goz Khun. Later, we had to return pack animals and hire new ones (horses, donkeys and yaks) between each pasture areas. Between 17 June and 14 July, we walked or rode (on horse or yak) between and within Wakhi and Kirghiz summer pastures and settlements of Big Pamir (Appendix 1). After mapping the journey with ArcView 3.2, we estimated the distance covered by our team at 380 km (Figure 2).

Location of pasture areas and settlements in Big Pamir

We identified the summer pastures and settlements of the Kirghiz community in Big Pamir thanks to several sources: the seminal ethnographical study of Shahrani (2002) on the

Kirghiz and Wakhi of Wakhan; a report from a humanitarian team who investigated the health status of Kirghiz in summer 2006 (Duncan and Duncan, 2006); and information provided to us by Mr. Amin Uddin, Shah Ismail's youngest brother in Qila-e Panja on 23 July 2006, and by Mr. Kok Aslam, the leader of Kirghiz of Big Pamir, on 30 June 2007. We cross-checked this information in each visited settlement.

Data collection and analysis

We collected data through interviews, direct counts and veterinary investigations on livestock (clinical examinations and sampling).

Interviews

Upon our arrival in a settlement, we enquired about the number of present households (Plate 1). We then interviewed member(s) —usually elders— from a selection of households (Table 1). Between one and three team members conducted the interviews (Plate 2) in Dari[1]. One of the interviewers subsequently translated them in English. Each interview lasted 30–45 minutes and consisted in 84 predetermined questions about the respondent, the number of livestock his household owned or attended in Big Pamir, transhumance timing and mapping, range use, current livestock health status, livestock management practices, diseases and current clinical symptoms observed in livestock. The same questions were presented in the same manner and order to each interviewee. The data used here derived from answers to questions dealing specifically with pastoral practices, livestock husbandry and health status. We tallied answers, calculated the percentages of various responses and carried out statistics with Statistix 8.1 software.

Size of livestock populations and seasonal movements

We collected information through interviews about the number of livestock (sheep, goats, cows, yaks, Bactrian camels, horses and donkeys) attended by Kirghiz in Big Pamir. After the interviews, we carried out direct counts to compare our figures to the ones provided by the respondents and assess the interviews' sensitivity. However, direct counts proved difficult to perform. On several occasions Kirghiz shepherds were reluctant about letting us count their livestock. Sometimes they also voluntarily moved their sheep and goats back to the settlement after sunset, making counts difficult to carry out because of the reduced luminosity. Eventually, several close settlements herded sheep and goats in one large group. Overall we had the impression that Kirghiz were not positive with us investigating the size of their livestock herds. For these reasons data on livestock numbers whatever the method used are to be considered as 'broadly accurate'. Interviews also provided us with information on the seasonal movements of livestock in Big Pamir.

Livestock husbandry and health status

Interviews and direct observations provided us with data on husbandry and health status of livestock. We also carried out clinical examinations and got the chance to perform postmortem examinations of two healthy adult sheep slaughtered for meat. Finally we collected 91 blood samples on sheep and goats for serological screening.

[1] Kirghiz's native language is Kirghiz (belonging to the Altaic group) but they also speak Dari (Persian group).

Plate 1. A Kirghiz settlement in summer, with its typical burst of late afternoon milking activities. Yurts are surrounded by yak calves eager to suckle, while their mothers are milked by Kirghiz women. Ilgonak Valley, Big Pamir, 9 July 2007.

Plate 2. Dr. Hafizullah questions a group of Kirghiz about the number of households present in their settlement of Ilgonak Valley, Big Pamir, 9 July 2007.

RESULTS

Kirghiz pasture areas, settlements, households and movements

Kirghiz of Big Pamir are organized in complex pastoral units. We define a pastoral unit as the spatial and temporal assemblage of grazing communities that share the same seasonal grazing areas each year. Based on geographical traits we have identified four main pastoral units (PU) in Kirghiz of Big Pamir. The western-most, if we exclude the isolated Kirghiz settlement in Bai Tibat Valley, is the Tila Bai—Sirt—Ilgonak unit (PU1). Going east, we found the Hotan-e-Daman-e-Mullah—Beshkunak unit (PU2), then the Shaur–Ghaznikol—Zeragan—Moola unit (PU3), and the easternmost Istik—Karajilga—Sar Maqur unit (PU4). Within each PU, there are grazing areas which are broadly defined zones used seasonally by the households. Typically in each grazing area households are regrouped in settlements. We identified for example three settlements within the Ilgonak summer grazing area, which totaled 26 households (Table 1). Kirghiz households move their belonging and herds within these grazing units in a gradual manner, essentially determined by forage availability and accessibility. Typically each household will re-settle its yurt(s) 2 to 4 times per year at the same settlement location each year. Grazing areas are relatively small (assumed on maps <250 km^2) and the range accessible to Kirghiz is non-expandable, as it is restricted in the north and the east by the frontier with Tajikistan, in the west by Wakhi grazing areas and in the south by permanent snows and glaciers of Big Pamir summits. Movements within each grazing unit must therefore be carefully planned to optimize range use. These movements units are difficult to study as they often occur non-concomitantly. Typically the different households of the same pastoral unit will share at the same period of the year the same broad grazing area. However they do not necessarily move from one grazing area to the other at the same time. Even households from the same settlement, and within a household, people and livestock, may move at different times. Indeed people may move ahead of their livestock to prepare the new camp. For example when we visited PU1 between 28 June and 9 July, we observed that the three households from one settlement using the Ilgonak area in summer were still in their winter/spring settlement in Tila Bai area on 29 June. At the same time, all households from the other three winter settlements of the Tila Bai area had already moved to the Ilgonak area. The same day but at another settlement in the Tila Bai area, only one out of the five households using Sirt summer grazing area was still present. We don't know the reasons behind these 'uncoordinated' movements between and within Kirghiz settlements but they may be related to the social structure of each settlement. In general we had the impression that Kirghiz rather relied on individual-, than on community- or settlement-decision processes.

We identified 11 settlements during our survey: 4 of them in PU1, 2 in PU2, 4 in PU3, and 1 in PU4 (Table 1). Overall, we surveyed 31 Kirghiz households in 8 settlements from the four pastoral units (Table 2). The numbers of households we identified were close to those recorded by Duncan and Duncan in August 2006. Our sometimes lower numbers (Table 1) may come from the fact that our visit took place earlier in the season, at a time where households were still relatively dispersed between summer and spring grazing areas. As a consequence we may have overlooked several isolated households.

Table 1. Kirghiz pastoral units, grazing areas, and number of households in Big Pamir in summer 2007.

Pastoral unit (PU)	Summer grazing area*	Nb of recorded households (present study)	Nb of surveyed household (present study)	Nb of households according to Duncan and Duncan (2006)
Tila Bai—Sirt —Ilgonak (PU1)	Sirt	4	0	5
	Ilgonak	26	15	30
Hotan-e-Daman-e-Mullah—Beshkunak (PU2)	Beshkunak	6	6	5
Shaur—Ghaznikol—Zeragan—Moola (PU3)	Zeragan	18	7	9
	Moola	–	–	10
Istik—Karajilga—Sar Maqur (PU4)	Sar Maqur	–	–	10
	Karajilga	–	–	9
	Istik	14	3	14

*Spelling follows Mock (2006).

The areas grazed in summer were located at higher altitudes than those grazed in spring and winter. Looking across the valley of the Pamir River or the Zorkul Lake to the main massifs of the Tajik Pamirs, they lie at altitudes usually between 4300 and 4600 m asl, along the north facing slopes. None of them are located within the Big Pamir Protected Area. From a physiogeographical point of view, summer pastures used by Kirghiz and Wakhi in Big Pamir are comparable. Steep mountain slopes alternate with high terraces and are dominated by woody shrub species such as *Artemisia*, *Ephedra*, and *Astragalus*. Areas of perennial tussock grasses seem uncommon. Above the 4500-m contour a zone of typical alpine flora composed of *Aster*, *Potentilla* and *Saxifraga* appears, with sporadically distributed sedge meadows dominated by *Carex* and *Kobresia*. Livestock mainly use the *Artemisia* mountain steppes but they also graze sporadically higher pastures with Alpine flora. All these summer grazing areas are high-terraces and gently undulating altitude pastures (Plate 3). Wetland areas can also be found in winter pastures, for example in Tila Bai Valley, and near Zorkul and Ghaznikol Lakes (Plate 4).

Data on livestock[2]

Numbers

Interviews

According to 31 household interviews, there were an estimated 2221 sheep, 432 goats, 372 yaks, 8 cattle and 82 Bactrian camels being pastured by Kirghiz in Big Pamir during summer 2007 (Table 2). However, several Kirghiz refused to communicate the number of livestock they tended. For those who agreed, provided numbers were usually lower than our direct counts. When questioned about such discrepancies, Kirghiz provided no explanations. In addition, it was not unusual for us to be visited at our camp by at least one Kirghiz after the interview sessions, who would deny livestock numbers provided by his neighbors during the interviews.

[2] Data concerning horses and donkeys which are non-ruminant livestock are treated separately.

Plate 3. The village of lower Istik area where Kirghiz spend most of the winter is deserted in summer, as are winter pastures (in the foreground). Above the village, summer pastures are visible. Big Pamir, 5 July 2007.

Plate 4. A wetland area near Zorkul Lake used by Kirghiz livestock in spring and autumn. During summer, altitude wetlands are breeding grounds for bird species such as the ruddy shelduck (*Tadorna ferruginea*), the common tern (*Sterna hirundo*) and the redshank (*Tringa totanus*). Big Pamir, 7 July 2007.

Table 2. Number of livestock attended by the 31 Kirghiz households surveyed in Big Pamir in summer 2007.

Pastoral unit	Name of settlement (interviewed households)	Sheep	Goat	Yak	Cattle	Bactrian camel
Tila Bai—Sirt—Ilgonak	Ilgonak_1 (6)	210	46	67	8	17
	Ilgonak_2 (3)	132	145	50	0	7
	Ilgonak_3 (6)	455	110	79	0	28
	Subtotal (%)	797 (35.9)	301 (69.6)	196 (52.7)	8 (100)	52 (63.4)
Hotan-e-Daman-e-Mullah—Beshkunak	Beshkunak_1 (3)	62	16	16	0	2
	Beshkunak_2 (3)	1055	25	74	0	5
	Subtotal (%)	1117 (50.3)	41(9.5)	90 (24.2)	0 (0)	7 (8.5)
Shaur—Ghaznikol —Zeragan—Moola	Shaur_1 (3)	200	30	32	0	18
	Guristani Tuk (4)	74	35	30	0	5
	Subtotal (%)	274 (12.3)	65 (15.1)	62 (16.7)	0 (0)	23 (28.1)
Istik—Karajilga—Sar Maqur	Istik (3)	33	25	24	0	0
	Subtotal (%)	33 (1.5)	25 (5.8)	24 (6.4)	0 (0)	0 (0)
Grand Total		2221	432	372	283	82*

*It is not clear how many of these camels genuinely belonged to Kirghiz. Investigations among Wakhi of Big Pamir in summer 2006 suggested that Kirghiz tend camels belonging to Wakhi (Ostrowski 2006).

On our way out of Big Pamir, we saw along the Pamir River a group of non-local traders with sheep, goats and a young camel that Kirghiz had bartered for market goods, such as cloths, shoes, tools, vegetable oil, tea, cigarettes and opium. In recent years, the desire of Kirghiz for merchandises they do not produce themselves seems to have increased, favoring an endemic high level of debt. Because of lack of cash, livestock constitute the main source of barter. In the past such economy mostly involved shopkeepers from Khandud and Ishkeshim bazaars, itinerant merchants, and peddlers, while Kirghiz used to bring their livestock to Kabul markets, a 90-day-long exhaustive excursion through Panshir (Shahrani, 2002). Nowadays, Kirghiz seem to rely more and more on livestock dealers who come directly to their area and trade their goods for up to four times the prices paid in Kabul. Trading is apparently practiced on a larger scale than before, with merchants bringing back with them large numbers of bartered animals (Kok Aslam, pers. comm.).

Direct counts: sensitivity test for livestock estimates

One of our main concerns when compiling livestock numbers from questionnaires is to evaluate the accuracy of the provided figures. As with all interviews, it is not always easy to motivate the respondents and to find out if they are telling the truth. This was especially the case during this survey. Indeed most of the interviewed Kirghiz either pretended to ignore the number of animals they tended or were reluctant to communicate those figures. In the Istik settlement, 11 out of 14 households even refused to provide livestock numbers. Since livestock is tended in one big herd in each settlement, it was therefore not possible to verify by direct counts the livestock numbers provided by the 3 responding families.

Table 3. Comparison of Kirghiz livestock estimates in Big Pamir based on interviews versus direct counts.

Grazing System	Name of settlement	Methods	Sheep	Goats
Tila Bai—Sirt—Ilgonak	Ilgonak_1	Interviews	210	46
		Counts[1]	360	75
		Error (%)	41.7	34.7
	Ilgonak_2	Interviews	132	145
		Counts	220	195
		Error (%)	40%	25.6
	Ilgonak_3	Interviews	455	110
		Counts	550	160
		Error	17.3	31.2
Hotan-e-Daman-e-Mullah—Beshkunak	Beshkunak_1	Interviews	62	16
		Counts	125	30
		Error (%)	50.4	46.7
	Beshkunak_2	Interviews	1055	25
		Counts	1160	30
		Error (%)	9.0	16.7
Shaur—Ghaznikol—Zeragan—Moola	Shaur_1	Interviews	200	30
		Counts	320	60
		Error (%)	37.5	50
	Guristani Tuk	Interviews	74	35
		Counts	160	55
		Error (%)	53.7	36.4
Istik—Karajilga—Sar Maqur	Istik	Interviews	33	25
		Counts	NC	NC
		Error (%)	NC	NC
Grand Total (excl. Istik)		Interviews	2188	407
		Counts	2895	605
		Error (%)	24.4	32.7

[1]Direct count results correspond to two consecutive counts made by one observer.

On many occasions we were also unable to carry out accurate direct counts of livestock because herds were brought back to the camp late after sunset. We had indications this was done on purpose to prevent us from counting the animals. Kirghiz were also unwilling to tell us where their livestock were pasturing during day. We could have followed the herds when they left the camp in early morning but felt there was no point in doing so if Kirghiz were uncomfortable about it. According to our (partial) direct counts, estimates driven from interviews underestimated herd size by c. 24–33% depending on species (Table 3).

Estimated global Kirghiz livestock population in Big Pamir

Based on a number of extrapolations and assumptions we very roughly estimated the Kirghiz livestock population in Big Pamir in summer 2007 at approximately 9000 sheep and goats, 1250 yaks, 25 cattle, and 270 camels (see Discussion).

Seasonal movements

Unlike Wakhi, Kirghiz do not possess any land or grazing rights in the Wakhan Valley and they keep their livestock in Big Pamir throughout the year. Seasonal movements of Kirghiz within each pastoral unit are pendular oscillations between relatively small grazing areas. Maximal distances between spring/autumn and summer areas rarely exceed 20 km and are usually within 300 m of elevation. Ranging from 400 to more than 1200 animals, the mixed herds of sheep and goats work as a formidable grazing front that needs to be kept in permanent movement to avoid ruining pastures in a very short time. After several weeks of grazing, the herds are moved to another area, and the abandoned grazed site is left to recover as far as nature allows. Rotational management of grazing sites implies that Kirghiz perform seasonal displacements of their camps 3 to 4 times per year. In addition to being a pasturing management practice, movements are also performed to minimize exposure of livestock and human beings to harsh winter conditions. Hence Kirghiz privilege area less exposed to freezing winds to set their winter camps. Daily range use is extremely difficult to predict as Kirghiz efficient use of the relatively poor altitude vegetation is achieved through largely empirical and observational understanding of their environment. Seasonal decisions to move to another area can either be individually or collectively taken and would vary from one year to another according to range and animal conditions. Concerning large-scale movements, Kirghiz use the highest reaches of the tributary rivers to Pamir River and Zorkul Lake during summer. In fall and spring they camp near wetland areas at relatively lower elevations and spend most of the winter and in early spring in their area of longest residence, their *qeshtow* (Shahrani, 2002), located somewhere between summer and spring/fall areas. Such seasonal movements, broadly within one tributary river valley, do apply to all Kirghiz of Big Pamir except to the western-most group who moves between two tributary valleys: Ilgonak and Tila Bai.

Tila Bai–Sirt–Ilgonak pastoral unit — Kirghiz use pastures in Ilgonak Valley and neighboring Sirt high reaches between July and early October. They then move to Tila Bai Valley where they will perform two to three successive movements until the end of spring. In autumn they stay in Kulok Bulong, Kara Gorum, Dewar-e-Tuk, or Kotan-e-Kuruk settlement areas. Then in December they may move to Kotan-e-Wartuluk or Kotan-e-Belituk, or stay in Kulok Bulong. They will stay in these areas, very close to each other during the three winter months, and then progressively move to Dewar-e-Tuk or Peshutuk areas in Tila Bai Valley, at a time when grass starts being more accessible following snow melting. They will move back to Ilgonak at the end of June or early July. Movements between areas are not uniformly performed each year and vary according to weather conditions and forage accessibility.

Hotan-e-Daman-e-Mullah–Beshkunak pastoral unit — Kirghiz move between high reaches of Beshkunak Valley in summer and wetland areas at a lower elevation in the same valley in autumn and spring. They will reside in Hotan-e-Daman-e-Mullah in Beshkunak Valley between mid October and late June.

Shaur–Ghaznikol–Zeragan–Moola pastoral unit — Moola, located in the western high reaches of Shaur Valley, is the main summering site for this population of Kirghiz. They will retrieve around Ghaznikol Lake near Pamir River in October and move to villages in lower Shaur Valley in December where they will stay until the end of June to mid July depending on grazing conditions. We have identified four of those villages: Guristani Tuk, Qachitak, Shaur, and Oqum.

Istik–Karajilga–Sar Maqur pastoral unit — In summer and autumn Kirghiz use upper reaches of Istik River and Sar Maqur area located in the eastern high reaches of Shaur Valley, then they will move to wetland areas near Zorkul Lake. Winter will be spent in the Istik or Zeragan villages, located in-between summer and spring pastures, the later being located near Zorkul Lake.

Husbandry

According to the interviews, sheep were the most common livestock species attended by Kirghiz in Big Pamir (2221), followed by goats (432), yaks (372), Bactrian camels (82) and cattle (8) (Table 2). Sheep, goats and yaks form the basis of the pastoral subsistence of Kirghiz. Yaks are the most precious livestock followed by sheep and goats. All sheep belong to the large Western Asian fat-tailed sheep breed known as *turki* or *gissara* (body mass=28–55 kg). With their long legs and thick wool cover *turki* sheep are efficient in snow and little susceptible to cold weather. Kirghiz own very few cattle compared to Wakhi, as cattle are vulnerable to winter coldness. In comparison Wakhi had nearly 300 cattle grazing in Big Pamir during summer 2006 (Ostrowski 2006). In Kirghiz community milk products are mostly derived from yaks, sheep and goats. While Bactrian camels are essentially owned for prestige by Wakhi, they are also precious pack animals for Kirghiz who ride them extensively in winter.

Small ruminant herds include sheep and goats in variable numbers. In summer 2007, the sheep to goat ratio averaged 5:1 but varied from 250:1 to 1:1. One major reason for the larger number of sheep is that, unlike goats, they paw the snow to expose parched forage during winter.

Female sheep and goats are shorn once each summer whereas males are shorn twice between spring and early autumn. Unlike Wakhi, Kirghiz do not clean sheep and goats before shearing them. Shearing is to our understanding the only mass handling activity practiced during summer. However, since shearing is not done concomitantly on all animals but progressively throughout summer, the operation may not help reducing the level of infestation with *Melophagus ovinus* (sheep ked): parasites from a sheared sheep can easily find refuge in an individual of the herd still not sheared.

Births occur mainly from March to May in small ruminants. Newborn sheep and goats are left with their mothers in the settlement for the first 4–6 weeks and then join the subadult animals. In summer, age-specific split-herding of communal populations prevails in small ruminants and yaks. In each settlement, animals from different households are herded together. Calves are kept in pens or around camps while adults and subadults are brought to the open range for grazing during the day. During the night adult sheep and goats are maintained in corrals made of 1.5 m-high stone or mud brick walls, usually located in the center of the settlements. Close to the corrals subadult animals (born in winter/spring and older than one month) are tied to long ropes grounded at both ends. They are guarded by dogs during the night. In summer every day around 4:00 some ewes and goats are milked, while those with the youngest offspring are left to milk them. The group of adults leaves the settlement around 4:30 with one shepherd but often with no dogs. They will return around 11:30 for milking and then leave again the settlement around 13:30 to come back shortly before night at 18:30–19:00. Meanwhile subadult animals leave the settlement around 5:30, return around 11:00, leave again at 14:00 to come back around 17:00. Shepherds always attend sheep and goats during their daily moves, mainly to avoid predation by wolves.

Yaks give birth in April and May, and calves are tied in the camp for the first 10–15 days when they suckle only. Milking mothers, often with several one to two-year old individuals, are driven out of the settlement around 7:00 by young shepherds or children to graze freely in the upper range of pasture areas. They return back by themselves in the afternoon usually driven by females eager to milk their calves. However, among those adults which are not used as pack animals and do not milk calves, the great majority is left unattended. They are found in the highest pastures, or in remote areas of tributary ravines that are inaccessible to other livestock. This group of animals is probably the most likely to enter into close contact with wild ungulates.

As already mentioned Bactrian camels are extensively used as pack animals during autumn and winter. Aside from being large and strong animals, they are capable of carrying large loads of goods. In December 2006 we met a caravan of 6 camels led by Kirghiz wintering in Tila Bai Valley. We estimated that each of these camels was packed with 120–150 kg of goods, twice as much as a horse.

Livestock husbandry during winter is poorly known.

Health status

Two inter-related factors play important roles in the health status of livestock in Kirghiz pastures: first, the seasonal variability in the availability and quantity of forage, and second, the occurrence of infectious diseases. Unlike Wakhi livestock which undergo a transhumance process bringing them from villages in Wakhan Valley to high pastures in Pamir, free mixing of animals from different pastoral units does not seem to occur as frequently among Kirghiz livestock, at least for sheep and goats. From that point of view, Kirghiz livestock population may be more ‘epidemiologically segmented’. It is therefore possible that exposure level to different pathogens varies significantly between populations of different pastoral units. Although our sample size is small ($N=91$) we will try to evaluate this hypothesis when we will analyze the results of the serological screenings.

Mortality

It was very difficult to evaluate accurately mortality during summer and autumn 2006, Kirghiz providing inconsistent information and often making confusions between time periods. We only provide data concerning winter and spring 2007 mortality which seemed more consistent, possibly because the most recent in their minds. Shahrani (2002) in his seminal study of Kirghiz of Pamirs indicates that their livestock suffer significant losses during winter due to the unavailability of forage. Out of the 31 households interviewed in summer 2007, only 3 (9.6%) reported no losses during preceding winter. The remaining 28 lost a total of 526 sheep, 265 goats, 107 yaks and 7 Bactrian camels. Assuming a constant productivity and extrapolating summer 2007 estimates — diminished by 30% for sheep and goats and by 5% for yaks and Bactrian camels to account for animals bartered, sold or dead after summer — we estimated mortality rates of 25.3% for sheep, 46.7% for goats, 23.2% for yaks, and 8.2% for camels for winter 2006–2007. Although such rates seem considerable, several community leaders, both among Kirghiz and Wakhi, have pinpointed that mortality of sheep and goats wintering in Pamir may reach 100% during very harsh winters. Except for camels, starvation associated with harsh weather conditions was perceived as the primary cause of winter mortality, accounting for 50%, 49.8%, and 42% of deaths of sheep, goats and yaks respectively (Figure 3). About 7–14% of sheep, goats and yaks died either with lameness and mouth lesions evocating Foot and Mouth Disease, diarrhea as the main symptom, or with internal abscesses as major post-mortem finding (typically Kirghiz, as well as Wakhi, slaughter sick animals shortly before they die to be able to eat them). Noteworthily a major cause of mortality that explained 15–18% of deaths in sheep, goats and yaks were avalanches, suggesting that livestock may seek their meager forage in steep areas. Mortality due to predation accounted for 11.6% of total losses, wolves allegedly being responsible of the death of 85.7% (6/7) of Bactrian camels.

Infectious diseases

Gastrointestinal disorders — Sheep and goats were significantly affected by gastro-enteric disorders usually translating into episodes of diarrheas. The pattern of occurrence of these disorders was very similar to that observed in Wakhi livestock of Big Pamir in 2006. The causes of diarrheic events were unknown, but they occurred most often in spring when animals accessed newly grown vegetation. This pattern suggests *Clostridium perfringens* enterotoxaemia. However, adult and subadult small ruminants also died of diarrheic disorders later in spring and in summer, which may evocate other infectious agents. Heavy stocking densities, overgrazing, crowded night housing and inexistent sanitary management could also favor outbreaks of coccidiosis or cryptosporidiosis in lambs. Infections with *Salmonella* can cause diarrhea in small ruminants of all ages. Bluetongue orbivirus can also be responsible for diarrheic events in sheep but we do not know whether *Culicoides* vectors of the disease exist at the altitude of summer pastures. Peste des Petits Ruminants (PPR) morbillivirus may be present in the small ruminant population of Big Pamir. This was suggested by Aga Khan Development Network veterinarians based in Ishkeshim who reported episodes of nasal discharge and profuse diarrheas associated with severe salivation (resulting possibly of necrotic stomatitis), a syndrome reported with PPR. However we did not note personally clinical symptoms evocative of a recent exposure to PPR morbillivirus.

Respiratory disorders — During our investigations, we estimated the prevalence of respiratory disorders in small ruminants at 5–10% in adults and <15% in subadults. The recorded clinical symptoms included sporadic coughs, dyspnea, and most often mucopurulent nasal discharge. Respiratory disorders seemed to frequently become chronic.

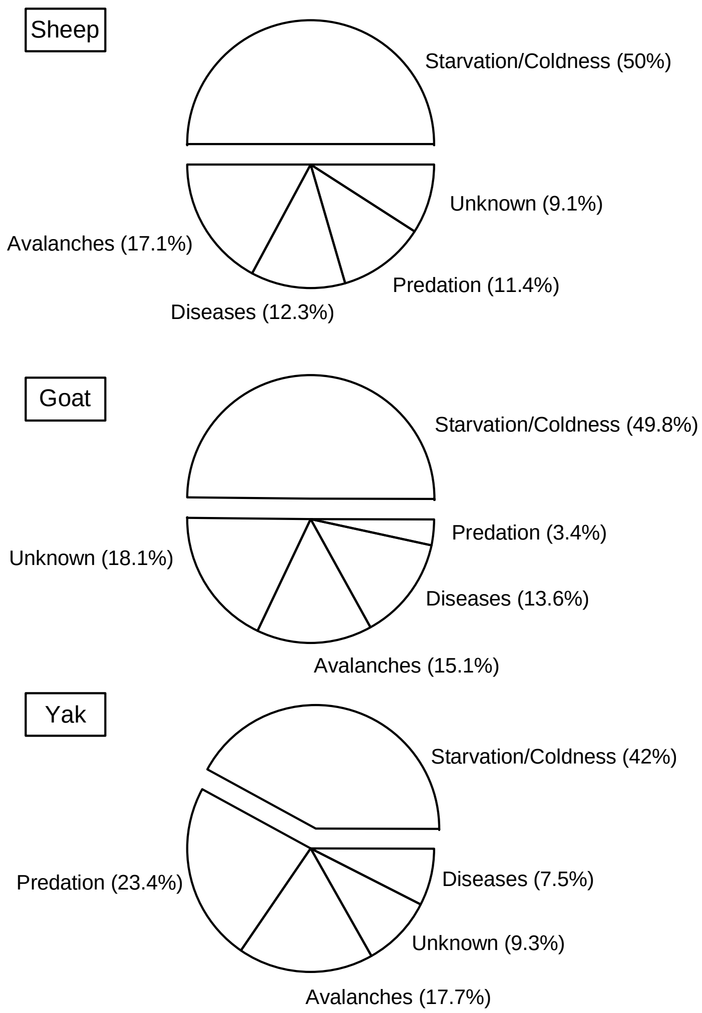

Figure 3. Causes of death of livestock in winter. Data are compiled from questionnaire answers of 31 Kirghiz households pasturing their livestock in Big Pamir in summer 2007.

We did not observe severe respiratory disorders such as acute pneumonias and pleurisy, two commons symptoms in acute forms of contagious caprine pleuropneumonia (CCPP) or pasteurellosis. It was difficult to figure out from the interviews whether these respiratory disorders caused a significant mortality, in particular among young animals. Comparatively Kirghiz subadult sheep and goats were less affected by respiratory disorders than Wakhi lambs and kids surveyed in summer 2006. This observation could be the result of an inter-annual variability.

Abortions — According to the interviews at least 92 sheep, 124 goats, 13 yaks, and 3 camels aborted in winter and early spring 2007, which would correspond to late-pregnancy abortions for sheep and goats. The numbers of abortions reported underestimated the reality as many cases might have been overlooked. It was difficult to know whether abortions occurred close to parturition time. The expected poor body condition of females at the end of winter must certainly predispose them to abortions at this period of the year. However many infectious agents such as Foot and Mouth Disease picornavirus, *Brucella* spp., *Coxiella burnetii*, *Toxoplasma gondii*, and *Chlamydiophila* spp. can also be causative. Preliminary results of serological screenings seem to exclude exposure to *Brucella* spp. and *Chlamydiophila* spp. as major causes of abortion.

Foot and Mouth Disease (FMD) — Kirghiz and Wakhi report in unison about regular outbreaks of a disease that affects the feet and mouth of their sheep, goats, cattle, yaks, and Bactrian camel simultaneously. Horses and donkeys are not affected. During our summer visit we observed on several occasions lame sheep in pastures with interdigital or coronal foot lesions that could have resulted from initial lesions of FMD. Yet, we did not record typical febrile cases with mouth vesicles in cattle, yaks or small ruminants. Most Kirghiz questioned have mentioned that FMD has affected their yaks during summer 2006. Results of serological screening will provide some insight into the level of exposure of Kirghiz livestock to this disease.

Contagious ecthyma (Orf) — This infectious dermatitis, caused by a Parapoxvirus, affects primarily lips of young animals. In Wakhi settlements such as Jabar Khan (Jermasirt) it affected 10 to 15% of lambs and kids in summer 2006 (Ostrowski, 2006). In comparison we observed very few lambs and kids with recent orf lesions in Kirghiz livestock. Herders however confirmed that the disease was common on young animals.

Keratoconjunctivitis — During our November/December 2006 survey, we observed sporadic cases of keratoconjunctivitis in adult goats in upper Wakhan villages. At that time we also met in Goz Khun a group of Kirghiz on their way to their winter settlements, located in Tila Bai Valley, who mentioned that a similar disease affected their yaks in altitude pastures in summer 2006. During the present survey we extensively investigated yaks around settlements, including in Tila Bai, and did not observe a single case of keratoconjunctivitis among known pathogens that can be responsible of keratoconjunctivitis in cattle, *Moraxella bovis*, a bacterium transmitted by flies, is the commonest. Since the peak of fly activity seems to occur later in the summer (mid July to mid August) it is possible that our survey was carried out too early in the season to observe cases of keratoconjunctivitis in yaks.

Mastitis — We did not see and were not reported of cases of severe mastitis in sheep and goats as observed in Wakhi livestock in summer 2006.

Parasites

Endoparasites — We collected feces samples from sheep, goats and yaks and stored them in 4% formalin. We will carry out coproscopies of these samples in spring 2008. Field examination of sheep droppings did not reveal the presence of tapeworm bell-shaped proglottids in fresh feces. These proglottids were most commonly found in subadult animals of Wakhi herds. Examination of the digestive tract of three healthy subadult sheep slaughtered for meat confirmed the lack of tapeworm in the duodenum of all individuals. We found no nematodes in their digestive tract and no trematodes in their livers. Although more information should be drawn from coproscopies the absence of visible nematode and trematode in the three slaughtered animals is nevertheless remarkable and suggests that endoparasite infestation is presumably low, as observed in Wakhi livestock in their summer pastures. A larger sample size including adult sheep and goats is still required to confirm the low exposure of small ruminants to these parasites in Big Pamir.

Ectoparasites — The sheep ked (*Melophagus ovinus*) is one of the most widely distributed external parasites of sheep. The skin irritation created by the parasite causes sheep to rub and bite themselves. The fleece becomes thin, ragged and dirty, while wool can be permanently discolored in patches. We found adult specimens in all the 31 examined sheep, two of them showing heavy infestations (>50 specimens/animal). On July 8, we witnessed for two hours Kirghiz shepherds shearing 12 adult sheep (Plate 5). They were all infested, with an average infestation rate of 9.4± 5.4 adult keds per animal. This relatively high infestation rate may be related to the rapid spread of the parasite when animals are densely assembled at night. Similarly to what we observed in Wakhi livestock in summer 2006, Kirghiz livestock are not infested by ticks. Whether *Ornithodoros lahorensis* (Family: Argasidae) infests Kirghiz livestock during winter, as is commonly observed in livestock throughout upper Wakhan villages at this season, is unknown. We did not observe infestation of *Tabanus* horseflies in livestock, horses, donkeys, or people. However Kirghiz mentioned that such infestation does occur but later in summer. Horseflies cause painful wound and a significant blood loss when many of them feed on an animal for several hours a day during summer. Reputedly they can carry several pathogens on their mouth parts and body, including *Bacillus anthracis*, *Anaplasma* spp., and *Francisella tularensis*. We did not observe high levels of fly infestation, but Kirghiz shepherds reported genital and udder myiasis in sheep occurring during spring. One shepherd also mentioned a case of nasal myiasis in a Bactrian camel. We will further explore the occurrence of screwworms in 2008. Finally we did not observe clinical signs of sarcoptic scabies (*Sarcoptes scabei*) or psoroptic scabies (*Psoroptes ovis*) infestation, for the latter such as during winter in Wakhi livestock.

Plate 5. Female sheep are sheared once a year during summer, an operation that takes less than 10 minutes per animal. Kirghiz use sheep wool as the primary material of yurt covers, Beshkunak settlement, Big Pamir, 7 July 2007.

Population mixing and vaccination

Like Wakhi, Kirghiz do not segregate sick and healthy animals. For example, sick females are sometimes milked before healthy ones, a practice favoring indirect transmission of pathogens. A strict isolation (quarantine) of sick animals would decrease the risk of disease transmission within herds. Improving livestock health status in the region would also need an array of methods more sophisticated than simple split-herding, since most infectious diseases in Kirghiz livestock populations have presumably become endemic. In summer pastures, clinically healthy adults live in direct contact with the younger subpopulation affected by an array of respiratory and gastrointestinal disorders. However ratios of sick to healthy juveniles (showing no lameness, coughing, sneezing, diarrhea) was much lower in Kirghiz livestock screened in June–July 2007 than in Wakhi livestock screened in August 2006 (1:12 vs. 1:4). We do not understand this difference which could correspond to a yearly variation or could be related to different herding practices.

Unlike Wakhi households of Big Pamir visited in August 2006, several surveyed Kirghiz households (7/31) had recently part of their livestock vaccinated. Four households reported that their yaks were vaccinated in 2006 and three other households reported that they had their yaks and some of their sheep and goats vaccinated in early July 2007. The work was done by Mr. Nadera from Khandud in lower Wakhan, who followed in 2005 the training for para-veterinarian organized by the Dutch Committee for Afghanistan. Upon meeting Mr. Nadera in Tila Bai on 29 June, we found out that he proposes vaccinations against FMD, 'Enterotoxaemia' and anthrax.

Data on equids

Introduction

Kirghiz have a population of horses and donkeys in Big Pamir which they ride or use as pack animals. Like yaks, equids and especially horses are a mark of prestige and thriving households may own several of them. Horses are expensive, costing 15,000 to 20,000 Afghanis (around 300–400 $US) each. At the mean altitude of Kirghiz pastures, horses don't seem to breed and thus they must be acquired from lower altitudes, from Wakhi or itinerant merchants (Shahrani, 2002). The reasons behind this unsuccessful breeding are unclear and may be grounded in reproductive physiology. We also remarked on a subset of their horse population ($N=26$) that the sex ratio of the horse population owned by Kirghiz was very significantly skewed towards males (24:1, χ^2-test, $P<0.0001$). Kirghiz obviously prefer riding stallions. Stallions are in general larger and stronger than mares and can potentially carry heavier loads over longer distances. We don't know whether this biased sex-ratio is a consequence or a cause of this lack of breeding. We will try to document this question during our next visits.

Horse-riding is an activity deeply enrooted in the way of life of the Kirghiz communities living in this remote mountain range (Plate 6). As such, they will be directly concerned by any resource development project in the area such as ecotourism or mountaineering. Indeed, horses as well as yaks are invaluable for transporting equipment, mountain gear and people during summer in steep terrains of Pamirs. While donkeys can bear heavier loads relatively to their body mass, horses have the advantage of being taller when surging streams are to be crossed. Very few donkeys are owned by Kirghiz, apparently because of their sensitivity to the harsh coldness of winters in Pamirs. It is noticeable that Wakhi do not leave their horses and donkeys in Pamirs during winter.

Plate 6. A young Kirghiz horseman literally lying on his horse's back, Big Pamir, 29 June 2007.

Numbers

Out of 31 Kirghiz households interviewed, 2 (6.2%) owned no horses, 14 (45.2%) had one horse, 11 (35.5%) had two horses, 3 (9.6%) had three horses and 1 (3.2%) possessed five horses (median=1). For comparison 53.2% of the interviewed Wakhi households in summer 2006 had no horses, and the median number of horses per Wakhi households in Big Pamir equaled zero. Overall 29 (93.5%) Kirghiz households owned together 50 horses. All horses were maintained in Big Pamir throughout the year.

Sixteen (51.6%) households owned one donkey (median=1). In comparison 60 (96.9%) Wakhi households of Big Pamir interviewed in summer 2006 owned 165 donkeys and the median number of donkeys per Wakhi households in Big Pamir was three.

To conclude, unlike Wakhi, Kirghiz owned on average more horses than donkeys, and possessed more horses per household than their Wakhi neighbors.

Seasonal uses and husbandry

Horses, and to a lesser extent, donkeys, are mostly used to travel or as pack animals from mid-spring to mid-autumn. During winter, Kirghiz extensively use their Bactrian camels and yaks as pack animals. Typically horses can carry loads of 45–75 kg for 5–7 hours a day compared to 25–35 kg for donkeys. Unlike Wakhi, Kirghiz typically ride their horses even when packed with gears (Plate 7).

Plate 7. A Kirghiz riding his horse packed with gears, here liquid nitrogen dry shippers, Gormatek, Big Pamir, 9 July 2007. Kirghiz mainly ride stallions.

However Kirghiz ride almost exclusively adult stallions, usually larger and stronger than mares, whereas Wakhi use both stallions, mares or even gelded horses. After work, horses are tied and left to rest for at least 3 hours before being offered food and water (Plate 8). Donkeys are fed and watered as soon as unpacked. When not of use during summer, equids are left to pasture around settlements. Some of these horses can become relatively feral when left long time not mounted and Kirghiz may experience difficulties at re-capturing them (Plate 9). In winter but also in other seasons during night horses, which are susceptible to cold weather, stay in the vicinity of settlements and are covered permanently with thick blankets made of yak wool (Plate 10).

Clockwise starting top left: Plate 8. After a long working day, horses are left attached for at least 4 hours with no access to food and water, Briqarv, Big Pamir, 13 July 2007. Plate 9. When not in use in summer Kirghiz may leave their stallions semi free-ranging for extended periods of time. On this picture we see Mr. Inayat Ali and Mr. Attam Beg (right) succeeding to catch such stallion with the help of the mare used during the mission, near Istik settlement, Big Pamir, 5 July 2007. Plate 10. Horses are of great value to Kirghiz who keep them covered with thick blankets made of yak wool when temperature drops. Horses are much more susceptible to coldness than yaks. Shaur, Big Pamir, 7 July 2007.

It seems that during winter Kirghiz use their horses to ride from one settlement to another or for longer trips only if snow allows. When snow falls in big quantities they mainly use camels and yaks if they need to move.

Donkeys are mainly kept for menial duties around the camp. They transport compressed sheep and goat droppings, yak dung and peat for fuel. They are also used to initiate Kirghiz youngsters to horse-riding.

Health status and mortality

Health status

When questioned about diseases affecting their horses and donkeys, Kirghiz generally acknowledged that both species are very resilient to diseases and seldom die of disease outbreaks.

No cases suggestive of glanders were reported. Glanders is a contagious, sometimes chronic but usually fatal disease of equidae caused by *Burkholderia mallei* bacteria and characterized by serial development of ulcerating nodules that occur chiefly in the upper respiratory tract, lungs, and skin. The disease seems to be present in Wakhi horses and donkeys. It is known to occur in the Badakhshan Province and a veterinarian for AKDN reported to us that it is endemic in the Ishkeshim—Zebak area. Although our 2006 investigations suggested that glanders is present among Wakhi horses and donkeys, it is however unknown to which degree the disease affects Kirghiz horse population. The presence of the pathogen agent may be particularly difficult to detect, as horses with chronic form of the disease often appear to be remarkably well with only a discrete nasal discharge of benign appearance.

Mortality

Interviewed households reported the loss of one donkey (5.9%) and nine horses (15.2%) between summer 2006 and June 2007. The donkey and five horses died during winter, the other horses died in summer 2006 (1), autumn 2006 (2), and spring 2007 (1). The donkey died of an unknown cause, two horses died with severe respiratory distress, one in summer and one in winter and the other seven horses were killed by wolves.

DISCUSSION

Validity of presented results

The bulk of the data we have presented in this report comes from interviews. One may legitimately question their validity. Respondents may lack accuracy in their answers, involuntarily provide biased information, or even distort the facts on purpose. Whenever possible we tried to cross-match the information they provided to us by assessing objectively the reality on the ground. For example we believe that livestock numbers based on interviews are largely underestimated. Because our direct counts only provide minimal estimates they do not constitute solid data. Overall livestock number estimates are certainly inaccurate and should be used with extreme caution. The main reason for this inaccuracy is that Kirghiz feared our report could be used by the central authority in Kabul as a base to tax them. Other questionable data include the causes and numbers of livestock deaths. For example several animals, which supposedly died of starvation during winter, may have died of chronic diseases resulting in a loss of body condition. In a herd endemically infected with Foot and Mouth Disease, it is also difficult, even for expert eyes, to discriminate the primary cause of death of infected animals concomitantly exposed to food shortage. Obviously energetic deficit would probably play an exacerbating role in most diseases through an immunodepressing effect. Concerning mortalities, it is possible that our figures are underestimated. Some losses could have been forgotten, miscounted (when herds of different origins are assembled in spring/summer pastures for example), or unnoticed such as abortions. In general Kirghiz were less reluctant at sharing information about occurrence of diseases and causes of mortalities than about the number of livestock they herded. On several occasions we could cross-check mortality data by interviewing related households on livestock mortality occurring in their relatives herd, and data seemed to coincide. This was particularly true concerning cases of predation and accidental mortalities such as those due to avalanches. Trustful information concerned household movements within the grazing system they used. It was easy to corroborate each ones sayings as usually all households of one settlement use the same different settlements within the grazing system. However because Kirghiz livestock in Big Pamir do not seem to pose a particular risk of disease transmission to wild ungulates, we will probably not dedicate more time at surveying this livestock population.

Kirghiz pastoralism and livestock numbers in Big Pamir

Our 2007 survey aimed at identifying Kirghiz populations pasturing their domestic animals in Big Pamir. Kirghiz are strict pastoralists depending on self-regenerating and self-maintaining range resources throughout the year and to a lesser extent on fodder for livestock supplementation during winter. Nevertheless, when surveying pastures around Zorkul Lake it is noteworthy that Kirghiz have built rudimentary irrigation systems that allow them to boost vegetation recovery after spring grazing and collect resulting fodder for winter. Because we have surveyed only a subset of Kirghiz in Big Pamir, and livestock numbers as per our interviews seem underestimated, it is hard to know how many animals graze in Kirghiz lands of Big Pamir. A simple extrapolation assuming an average population of 104 households (Duncan and Duncan, 2006), and an average of 71.6 sheep, 13.9 goats, 12 yaks, and 2.6 Bactrian camels per household (interview estimates, present study) would give a total population of 7446 sheep, 1445 goats, 1248 yaks and 270 camels. Probably a conservative estimate in regard of our direct count estimates. Based on a number of extrapolations and assumptions we roughly estimated the Kirghiz livestock population in Big Pamir in summer 2007 at approximately 9000 sheep and goats, 1250 yaks, 25 cattle, and 270 camels.

Whatever the real livestock population size is, summer fodder collection and relatively high livestock losses due to food shortage during winter indicate that Kirghiz have adopted overstocking as a short term strategy to survive all year round in Big Pamir. Whether this strategy will prove self-sustainable on the long term in debatable.

Risk of interspecies disease transmission

Horizontal interspecies transmission is a central mechanism in the emergence of diseases in wild living populations (Lafferty and Gerber, 2002). The probability for a pathogen to cross the species barrier from a 'source' to a 'receptor' species depends on its prevalence in the 'source' species, on the susceptibility of the 'receptor' species and on the rate of efficient contacts between the two species (Richomme et al., 2006). Our investigations intend to document the prevalence in livestock of Pamirs of several pathogens to which wild ungulates might be susceptible: Foot and Mouth Disease, contagious ecthyma, scabies, and infectious keratoconjunctivitis for example. Their presence in livestock using Big Pamir suggests that the risk of domestic to wild animal transmission exists. Furthermore, preliminary results of serological screening of blood samples collected in Wakhi livestock in December 2006 have highlighted the presence of infectious agents, such as *Coxiella burnetii* the agent of Q fever, which were not clinically detected but appear to circulate actively in the population. Disease susceptibility of Marco Polo sheep (*Ovis ammon polii*) is poorly known but solid data have been collected and published on genetically-close non-domestic Ovinae and Caprinae species. They could probably be used to predict which pathogens could be dangerous for Marco Polo sheep.

We interviewed representatives of 31 Kirghiz households pasturing their livestock in Big Pamir in summer 2007. We asked them about the possibility of direct contacts between their livestock and Marco Polo sheep, that is if they had observed a Marco Polo sheep within a 100-m horizontal distance of a domestic animal. We chose 100 m as most infectious agents nebulized into a wind tunnel will not remain viable after a distance of 50–100 m (Dixon et al., 2002). None of the respondents had made such observation. Moreover none of them even believed that Marco Polo sheep may visit Kirghiz summer pastures. Nowadays Marco Polo sheep are shy of men and dogs and do not approach tended herds closer than several hundred meters. Such avoidance behavior is probably linked to a significant level of persecution and may also suggest a decreasing number of Marco Polo sheep in Big Pamir. In view of our findings, we can tentatively assume that the risk of spillover of infectious agents from livestock to wild ungulate in Kirghiz grazing lands of Big Pamir by direct contact is currently reduced, at least in summer pastures. One can argue that wild ungulates may be exposed to livestock pathogens by indirect contacts. For example, tapeworms or contagious ecthyma poxvirus, which can survive in the environment, may be a threat, likewise a number of pathogens such as *Mycoplasma* spp. which can survive on mouth parts of vector insects. However even this source of transmission is likely limited since Marco Polo sheep do not seem to visit Kirghiz grazing areas in Big Pamir (Petocz, 1973; Petocz et al., 1978). It seemed to us that the risk of disease transmission if any may occur from yaks, and to a lesser extent Bactrian camels and cattle, which are often left untended in high altitude pastures. We plan to equip 4–6 free-ranging domestic yaks with GPS collars in western Big Pamir in 2008 to document their movements and range use. This would help clarifying the risk of disease transmission by direct contact from unattended livestock to Marco Polo sheep.

Losses of domestic animals due to predation

In mountains of Central Asia, extensive livestock herding is often the major source of revenue for pastoralist populations (Schaller, 1998). These areas are also home to large carnivores such as snow leopard (*Uncia uncia*) and wolf (*Canis lupus*). The level of livestock predation by these carnivores is important to assess as retaliatory persecutions are one of the most widespread and direct threats to these carnivore species (Jackson and Wangchuk, 2001). Fitzherbert and Mishra (2003) have shown that the nature of human-wild carnivore conflict in the Wakhan Corridor is similar to what is observed in other parts of the snow leopard's range. These authors suggest that the levels of predation by these large carnivores are substantial. They quote studies estimating the annual losses at an average of 2 to almost 5 heads of livestock per family (Oli et al., 1994; Mishra; 1997; Jackson and Wangchuk, 2001). Our investigations on the causes of mortality of livestock of 62 Wakhi households using Big Pamir pastures during summer 2006 suggested however that predation by wild carnivores accounted for less than 2.5% of reported deaths in their livestock between December 2005 and December 2006. Although this is of significant impact in the subsistence economy of Wakhi, globally this is a relatively low predation level. In the surveyed population 18 sheep from a unique herd were predated by a snow leopard during winter, while 2 Bactrian camels, 7 yaks, 3 sheep, 1 horse, 1 donkey and 2 dogs were killed by wolves (Ostrowski, 2006). Similarly a survey carried out in spring 2007 in the 53 villages of the Wakhan corridor found that predation by wolf and snow leopard accounted for less than 1% of reported deaths in livestock between spring 2006 and spring 2007 (Habib, pers. obs.). Yet results of the present survey suggest that losses of livestock due to predation are much higher in Kirghiz livestock of Big Pamir. In the surveyed population 106 sheep, 34 goats, 43 yaks, 6 Bactrian camels and 7 horses were killed by wolves during the year preceding our survey. Kirghiz blamed exclusively wolves as predators based most often on "strong presumption" and less frequently on bite marks, foot prints, or direct sightings of wolves. Also wolves injured 32 sheep and 2 goats which recovered subsequently. Except for goats the majority (53.6%) of predation cases occurred in winter, a strong seasonal trend in camels (100%) and horses (71.4%), whereas less significant in yaks (58.1%) and sheep (56.6%). The majority of goats (73.5%) were killed in autumn. Predation was least reported in summer; only 4.1% of all predation cases were reported in this season (Table 4).

The reasons Kirghiz livestock suffer higher losses due to predation than Wakhi livestock surveyed in 2006 are not clear. One may speculate that Kirghiz could have voluntarily inflated the number of livestock lost through predation to claim for compensation. However cross-interviews do not suggest overestimation. Predation level was comparable between settlements and to our knowledge the possibility of a financial compensation program to prevent retaliation upon the predators was never mentioned to them. Another possibility is that Kirghiz livestock are perhaps more exposed than their Wakhi counterparts to predators. Indeed most of Wakhi livestock is moved down to the villages in Wakhan Valley during winter where predation pressure is notoriously higher (Habib, pers. obs.). We have also noticed relatively fewer dogs in Kirghiz camps than in Wakhi camps. Also we do not know how carefully animals are tended during winter, and we saw very few corrals with complete roof ceiling. The lower predation level in summer is in accordance with the resource availability theory: carnivore predation on livestock decreases with an increased availability of natural preys such as, in Pamirs, hares, voles, marmots, ground-nesting birds or young vulnerable wild ungulates. Decline in prey availability in winter could be one reason for wolves preying livestock mainly in winter.

Table 4. Number of sheep, goats, yaks, camels and horses killed by wolves per season in a selection of Kirghiz settlements of Big Pamir, in 2006–2007.

	Sheep	Goat	Yak	Camel	Horse	Total
Winter 06–07	60	9	25	6	5	105
Spring 07	22	0	5	0	1	28
Summer 06 & 07	4	0	4	0	0	8
Autumn 06	20	25	9	0	1	55
Total	106	34	43	6	7	196

Kirghiz reported no losses due to snow leopards or even brown bears (*Ursus arctos*) in summer. They reported the presence of brown bears in summer in Tila Bai Valley, yet an area their livestock desert at this time of the year. Finally nothing is known about the occurrence and role of snow leopard and other possible livestock predators, such as Himalayan lynx (*Lynx lynx isabellina*) or pariah dog (*Canis lupus familiaris*) in eastern Big Pamir.

To conclude, our investigations on the causes of mortality of livestock from 31 households interviewed suggested that predation by wolves accounted for 11.6% of reported deaths in their livestock during winter 2006–2007, or 196 animals during the year preceding our investigation, all species confounded. It would correspond to 657 livestock heads per year when extrapolated to the all Kirghiz population of Big Pamir[3] or an average of one every 16 animals. This is of very significant impact in the subsistence economy of Kirghiz.

Community attitude

Like Duncan and Duncan (2006) regarding health of Kirghiz population of Big Pamir, we have had the impression that the community was also in deep need of help concerning the health of their animals. However we did not see much interest regarding possible improvements of this condition. As Duncan and Duncan wrote (2006), "it was hard to see in the community much willingness to initiate or embrace change, despite the many problems and hardship they endure. There seemed to be a general fatalistic sense of helplessness and lack of hope. It seems that the Kirghiz's sense of self-efficacy (belief in one's own ability to make changes successfully) is particularly low and that this may prove a barrier to effective health promotion". This pessimistic statement could unfortunately apply to livestock health promotion as well.

Unlike what we have observed in the Wakhi community (Ostrowski, 2006; and chapters II and III of present report), it was particularly difficult to have Kirghiz collaborate to our assessment of their livestock health condition. Many refused to answer the questionnaires arguing that they never bring action afterwards. But when we proposed to treat their non-

[3] Assuming similar predation level in un-surveyed population, an estimate of 104 Kirghiz households in Big Pamir (Duncan and Duncan, 2006), and an average of 6.3 livestock heads lost per household per year (present estimation).

milked sheep and goats with ivermectin (a broad-spectrum anti-parasite medication) for free, they also refused, saying it would hurt their animals. They only agreed to let us treat their most severely affected animals but only provided that we pay them. We refused. We could only collect 91 blood samples from sheep and goats and it took us some intensive discussions.

This non-cooperative attitude would be of particular concern, should a prophylactic action at district or provincial level be developed to control economically costly diseases such as Foot and Mouth Disease or Peste des Petits Ruminants. Without involving Kirghiz in large-scale prophylactic operations, disease control actions in the region would be bound to fail. As a matter of fact Kirghiz livestock are highly valued by customers outside Wakhan and are traded to markets as distant as Kabul. If left out of prophylactic schemes Kirghiz livestock exported out of Wakhan would constitute ambulatory reservoirs of infectious agents that would have the potential to re-infect domestic animals located along their ways to market places. From the perspective of risk of pathogen dissemination to wild ungulates, it is uncertain whether Kirghiz livestock come into direct contact with wild ungulates. Results of our investigations are not supportive of this possibility, but we also lack insight into the range-use of livestock and wildlife during winter.

CONCLUSION

Kirghiz livestock in Big Pamir suffer primarily from undernutrition and predation in winter, and from infectious disorders the rest of the year. Although interviewed Kirghiz reported frequent disease outbreaks, most pathogens seem to have co-evolved with livestock populations to become endemic, affecting the animals on a chronic mode. Typically most infectious disorders we have observed seemed to have a high morbidity but resulted in a relatively low mortality. On the short-term improving health status of livestock would need implementing sanitary management, adjusting husbandry practices, following split-herd practices towards unhealthy animals which should be isolated in quarantines, introducing mass vaccinations and most importantly detecting and eliminating scruffy specimens, those that carry asymptomatically infectious agents and transmit them to healthy individuals. However whether such measures will help decrease disease mortality on the long-term is debatable. In theory a decreased mortality through improved sanitation could also reduce the overall population resistance to pathogens through reduction of pathogen selective forces. In addition there is little doubt that a lower mortality would conduct to increased stocking rates, with increased contact rates and higher chances that pathogens circulate within populations, not to mention the overgrazing problem as a corollary consequence. Under such circumstances Kirghiz would have to rely extensively and in a durable way on medicines and vaccines that they currently cannot afford buying.

Kirghiz live in a very particular ecological context since the early 1930s when the Soviet government closed the border to the Kirghiz of Afghanistan (Felmy and Kreutzmann, 2004). They have been since that time confined to conditions of high-altitude survival. Shahrani (2002) who studied Kirghiz of Afghan Pamirs in the late 1970s coined the term of "closed frontier nomadism" for their practice of nomadism which had to evolve because of the closing of international boundaries. According to him, "their social and cultural systems together with their subsistence strategy have shown a remarkable resilience in their response to the problems of territorial loss and confinement to high altitudes" and "they have been able to retain a viable pastoral nomadic economy in the face of tremendous odds over the past several decades". Three decades later it is hard to know whether their ecological adjustment have brought demographic stability in their population. In Big Pamir recent investigations of Duncan and Duncan (2006) provided alarming demographic signals, such as a significant deficit of women over 16 suggesting a very high maternal mortality estimated at over 4000 per 100 000 live births. More socio-economic surveys of this community are needed to assert whether they are still within the confidence levels of an acceptable survival or in the worst case scenario on their way to extinction.

PART II. WAKHI LIVESTOCK IN LITTLE PAMIR IN 2007

INTRODUCTION

Part of the Wakhi community living in Wakhan, up to the village of Rorung in upper Wakhan, pastures their livestock in the western Big Pamir during summer. Those living in the eastern end of the Wakhan Valley between the village of Ptukh and Sarhad-e Broghil use the western part of the Little Pamir. In general Wakhi living in upper Wakhan have retained a stronger tradition of pastoralism than to those living in mid and lower reaches of the corridor. This is mostly due to the relative lack of arable lands in upper Wakhan. Raising livestock is their main source of revenue. Wakhi livestock using Little Pamir have received less attention than other livestock populations using Pamirs as main grazing areas. Shahrani (2002) for example was mainly interested at studying the adaptations of a society to closed frontiers and war. As such, he focused on Kirghiz, who undoubtedly have been the most isolated inhabitants of Wakhan, and their livestock. Mock et al. (2006) visited only one of the four main pasture areas of Wakhi in Little Pamir, and our team has focused until now on livestock pastured in Big Pamir (Ostrowski, 2006; chapter I of present report). Replicating the same methodology used for Wakhi and Kirghiz of Big Pamir in summer 2006 and 2007, we report here on the results of our investigations of Wakhi livestock pastured in Little Pamir during summer 2007.

OBJECTIVES AND METHODS

Objectives

WCS Ecosystem Health Project Team carried out a survey in September 2007 to study livestock of the Wakhi population using western Little Pamir in summer and to collect field data concerning their management and the presence of pathogens in their populations. Our goal was to estimate the number of Wakhi settlements and households in Little Pamir in summer, the number and ownership of livestock, to determine the seasonal patterns of range use, the timing of transhumances and the existence of over wintering practices in livestock, to assess the health status of livestock and occurrence of transmissible diseases, and to evaluate risk of disease spillover from domestic to wild ungulates. To a few exceptions we only provide firsthand data collected in the field. The report tries to be a snapshot as accurate as possible of the presence and health status of livestock in Little Pamir at the time of the survey.

Methods

Dates of surveys

This was our second survey for summer 2007. It took place between 4 September and 12 September 2007, before autumn transhumance, while livestock was grazing summer pastures. Summary of daily activities can be found in Appendix 2.

Team composition

The ecosystem health project team which carried out the summer survey in Wakhi pastures of Little Pamir was composed of:

- Dr. Ali Madad Rajabi, Afghan veterinarian graduated from Kabul Veterinary College in 2005, and appointed leader of the mission by Dr. Stéphane Ostrowski;
- Dr. Hafizullah Noori, Afghan veterinarian graduated from Kabul Veterinary College in 2005;
- Mr. Attam Beg, a Wakhi from Kret, trained as a cook by Mr. Inayat Ali (WCS Community Conservation team).

Survey area

For this second survey in summer 2007, we focused on western Little Pamir, Wakhan district, Badakhshan province (Figure 1). Locally known as Pamir-e-Khord or Pamir-i-Kuchak, the Little Pamir is a southern offshoot of Tajik Pamir located northeast of Sarhad-e Broghil village, comprising the upper course of the Wakhan River. Although it encompasses high mountains that culminate at more than 5000 m and high plateaus that average between 3900 and 4200 m in elevation, it is a massif of average lower altitude than Big Pamir. The eastern extremity of Little Pamir (c. 250 km^2) and higher reaches of the Waghjir valley (c. 300 km^2) are proposed for wildlife protection.

Transport

Team members drove to Kunduz, capital of Kunduz Province in northern Afghanistan, and then to Ishkeshim via Faizabad. To reach the starting point of our summer expedition in Little Pamir, we traveled in the Wakhan Valley with four-wheel-drive cars from WCS. On September 4, we sent back the cars, hired one donkey, two horses, and two yaks for riding and packing purposes, and proceeded walking and riding from Sarhad-e Broghil. Later, we had to return pack animals and hire new ones (horses, donkeys and yaks) between each pasture areas. Between 4 and 12 September, we walked or rode (on horse or yak) between and within Wakhi summer pastures and settlements of Little Pamir (Appendix 2).

Location of summer pasture areas and settlements in Big Pamir

We identified the summer pasture areas and settlements of the Wakhi community in western Little Pamir according to the information provided to us by Mr. Amin Uddin, Shah Ismail's youngest brother in Qila-e Panja on 23 July 2006, and the 2006 report of the WCS Community Conservation team (Mock et al. 2006). We regularly cross-checked our information by interrogating elders in each settlement

Data collection and analysis

We collected data through interviews of local land users, direct counts and clinical examination and sampling of livestock. We carried out these interviews as part of a larger study that intends to document population size, geographical origin, ownership, range use and health status of livestock using permanently or intermittently Afghan Pamirs.

Table 5. Wakhi pasture areas, settlements, and households in Little Pamir in September 2007.

*Name of pasture area	*Name of settlement	Location of settlement (Decimal degrees)	Altitude (m)	Number of households
Shpodkis	Sang Nevishta	N37.081 / E73.635	4079	4
	Barnoz	N37.194 / E73 668	4394	2
	Ghareen Shpodkis	N37.157 / E73 626	4295	4
	Sot Vijeetk	N37.134 / E73 626	4210	4
Warm	Chanaq Zherav	N37.162 / E73.819	4498	3
	Ghareen Warm	N37.147 / E73.798	4269	2
	Aqbelis	N37.114 / E73.795	4338	2
	Gharmdeh	N37.114 / E73.809	4240	2
Bai Qara	Bai Qara	N37.057 / E73.930	4056	5
Chapdara	Mulungik Kshun	N37.119 / E73.541	4046	5
	Wutsir	N37.157 / E73.583	4029	5
	Uwee-e-ben Kshun	N37.105 / E73.507	4202	3
Bet. Warm and Bai Qara	Kashch Goz	N37.113 / E73.940	4140	1
Total				42

*Spelling follows Mock (2006)

Interviews

We collected most of the data used in this study by interviewing Wakhi who pasture their livestock in western Little Pamir. At the beginning of each settlement visit we asked an elder about the number of households present in the settlement. We interviewed a representative (usually an elder) for each of the identified households. Overall we identified and visited 42 of them who pasture their animals in Little Pamir at this period of the year (Table 5). Two team members conducted the interviews.

Interviews were conducted in Dari and subsequently translated in English by one of the interviewers. Each interview lasted roughly 30–45 minutes and consisted in 84 predetermined questions about the background of the respondent, the number of livestock his household owned or attended in Little Pamir, transhumance timing and mapping, range use, current livestock health status, livestock management practices, diseases and current clinical symptoms observed in livestock. The same questions were presented in the same manner and order to each subject. The data used here derived from answers to questions dealing specifically with pastoral practices, livestock husbandry and health status. We tallied answers, calculated the percentages of various responses and carried out statistics with Statistix 8.1 software.

Size and geographical origin of livestock populations

We evaluated the size and geographical origin of the livestock populations attended by Wakhi in Little Pamir according to the interviews carried out in the area in September 2007. We also visited systematically each pasture and identified 13 functioning settlements (Table 5). We asked respondents to provide us with the current number of sheep, goats, yaks, cows, Bactrian camels, horses and donkeys they were tending in Pamir as well as their geographical origin. After the interviews, we carried out direct counts of livestock numbers to compare our figures to the one provided by the respondents and assess the interviews' sensitivity. Two of us counted three times consecutively (total 6 counts) the total number of sheep, goats and yak herded in each visited settlement. We repeated this cross-checking operation in all visited settlements.

Seasonal movements of livestock in Big Pamir

Interviews provided us with information about the seasonal movements of livestock in Little Pamir.

Livestock husbandry and health status

Interviews and direct observations provided us with data on husbandry and health status of livestock. We also carried out clinical examinations and got the chance to perform postmortem examinations of three healthy subadult sheep slaughtered for meat. Finally we collected 145 blood samples on sheep and goats.

RESULTS

Wakhi summer pasture areas, settlements and households

We identified four main summer pasture areas in Little Pamir: Shpodkis, Warm, Bai Qara and Chapdara. They are located in the western part of Little Pamir. In summer pastures, the steep mountain slopes alternate with high terraces and are dominated by woody shrub species such as *Artemisia*, *Ephedra*, and *Astragalus*. Areas of perennial tussock grasses seem uncommon. Above the 4500-m contour appears a zone of typical alpine flora composed of *Aster*, *Potentilla* and *Saxifraga*, with sporadically distributed sedge meadows dominated by *Carex* and *Kobresia*. Although livestock use mainly the *Artemisia* mountain steppes, they also graze sporadically areas at higher elevations with Alpine flora. We identified 13 Wakhi summer pasture settlements in use in Little Pamir in 2007: 4 in Shpodkis, 4 in Warm, 1 in Bai Qara, 3 in Chapdara, and 1 between Qai Bara and Chapdara. In Warm the settlement we name 'Gharmdeh' is also known as 'Wuch Raowen-Gash' (Mock et al. 2006). Eventually we were not able to locate accurately the settlement of 'Math Kuf' in Shpodkis grazing area which is mentioned by Mock et al. (2006). Compared to this earlier work we found two households with significant numbers of animals in Barnoz, Shpodkis area and one small settlement with only 14 yaks in Kashch Goz between Warm and Bai Qara grazing areas. The 13 identified settlements consisted in 42 households (Table 5).

Data on livestock (excluding equids)

Numbers

Interviews

Results of the 42 household interviews give an estimated 1809 sheep, 478 goats, 523 yaks, 65 cattle and 7 Bactrian camels being pastured by Wakhi in Little Pamir during summer 2007 (Table 6).

Table 6. Number of livestock attended by Wakhi in Little Pamir in September 2007 according to interviews.

Name of pasture area	Name of settlement	Sheep	Goat	Yak	Cattle	Bactrian camel
Shpodkis	Sang Nevishta	132	21	42	28	0
	Barnoz	150	14	28	18	1
	Ghareen Shpodkis	60	12	40	21	0
	Sot Vijeetk	380	47	60	19	1
	Subtotal (%)	722 (39.9)	94 (19.7)	170 (32.5)	86 (48.0)	2 (15.4)
Warm	Chanaq Zherav	140	39	49	10	4
	Ghareen Warm	37	10	18	3	1
	Aqbelis	250	70	28	12	1
	Gharmdeh	40	92	51	7	1
	Subtotal (%)	467 (25.8)	211 (44.1)	146 (27.9)	32 (17.9)	7 (53.8)
Bai Qara	Bai Qara	319	51	75	21	4
	Subtotal (%)	319 (17.6)	51 (10.7)	75 (14.3)	21 (11.7)	4 (30.8)
Chapdara	Mulungik Kshun	158	100	59	19	0
	Wutsir	59	5	37	12	0
	Uwee-e-ben Kshun	84	17	22	9	0
	Subtotal (%)	301 (16.6)	122 (25.5)	118 (22.6)	40 (22.3)	0
Warm / Bai Qara	Kashch Goz	0	0	14	0	0
	Subtotal (%)	0	0	14 (2.7)	0	0
	Grand Total	1809	478	523	179*	13**

*Actually only 65 cattle were present in Wakhi summer pastures (43 in Shpodkis, 13 in Warm and 9 in Chapdara), 114 being left in villages. **Two of these camels were actually in Sarhad-e Broghil and Chilkand.

These results underestimate the reality as several Wakhi did not know accurately the number of livestock they tended for other Wakhi, often their relatives, not present in the settlements during our visit. We also noticed that occasionally respondents were not including lambs, kids and calves in total numbers of livestock. In 2006, Mock et al. estimated the population of livestock herded by Wakhi in Little Pamir at 3290 sheep and goats and 680 yaks. They based their estimates on interviews of key informants in villages for animals pastured in Shpodkis, Warm and Bai Qara, and on interviews or herders in Chapdara. Because they assumed that many herders understated numbers of livestock, "so as to avoid revealing their actual wealth", they believed that their estimates should be considered minimum numbers.

Direct counts: sensitivity test for livestock estimates

One of our main concerns when compiling livestock numbers from questionnaires was to evaluate the accuracy of the provided figures. As with all interviews, it is not always easy to motivate the respondents and to find out if they are telling the truth. During this survey, all but one of the interviewed households were willing to communicate the size of their herds.

Table 7. Comparison of livestock estimates in Little Pamir based on interviews versus direct counts.

Name of pasture area	Name of settlement	Methods	Sheep	Goat	Yak
Shpodkis	Sang Nevishta	Interviews	132	21	42
		Counts[1]	310–321	68–72	55
		Error (%)	>100	>100	<30
	Barnoz	Interviews	150	14	28
		Counts[1]	264–272	40–42	59–60
		Error (%)	<100	>100	>100
	Ghareen Shpodkis	Interviews	60	12	40
		Counts	211–215	69–72	51
		Error (%)	>100	>100	<30
	Sot Vijeetk	Interviews	380	47	60
		Counts	396–401	50	62
		Error	<5	<10	<5
Warm	Chanaq Zherav	Interviews	140	39	49
		Counts	252–256	58–64	71–72
		Error (%)	>30	>30	>30
	Ghareen Warm	Interviews	37	10	18
		Counts	296–308	79–84	131–137
		Error (%)	>100	>100	>100
	Aqbelis	Interviews	250	70	28
		Counts	291–299	74–80	63
		Error (%)	<30	<10	>100
	Gharmdeh[2]	Interviews	40	92	51
		Counts	844–861	100–104	130–132
		Error (%)	>100	<10	>100
Bai Qara	Bai Qara	Interviews	319	51	75
		Counts	637–647	72–79	85
		Error (%)	>100	>30	<30
Chapdara	Mulungik Kshun	Interviews	158	100	59
		Counts	268–276	59–62	59
		Error (%)	>30	>30	0
	Wutsir	Interviews	59	5	37
		Counts	155	25	57–58
		Error (%)	>100	>100	>30
	Uwee-e-ben Kshun	Interviews	84	17	22
		Counts[2]	185–188	45–49	52
		Error (%)	>100	>100	>100
Warm / Bai Qara	Kashch Goz	Interviews	0	0	14
		Counts[2]	0	0	14
		Error (%)	0	0	0
	Grand Total Count	Interviews	1809	478	523
		Counts	4109–4199	739–783	889–900
		Error (%)[4]	>100	55–63	~70

[1]Direct count results correspond to three consecutive counts made by two observers ($N=6$). [2]One household responsible of a very large herd of sheep was unwilling to communicate about sheep numbers.

Table 8. Geographical origin of sheep, goats, yaks and cattle in Little Pamir in summer 2007 drawn from interviews

Name of village[1]	Sheep	Goat	Yak	Cattle[2]	Total
Sarhad-e Broghil	903	120	233	103	1359
Chilkand	549	214	131	35	929
Neshtkhawar	280	130	105	28	543
Ptukh	77	14	40	13	144
Khandud	0	0	14	0	14
Total	1809	478	523	179	2989

[1]All these villages apart from Khandud are located in upper Wakhan. [2]Only 45, 23, 28 and 10 cattle from Sarhad-e Broghil, Chilkand, Neshtkhawar and Ptukh, respectively, were actually in Little Pamir during our visit, others were in villages.

The exception is one household from Gharmdeh settlement in Warm pasture that was reluctant to provide us the number of tended sheep, but curiously agreed to provide numbers for goats, yaks, cattle and camels. Although most herders showed good will, we felt that they were uncomfortable to communicate about animals they were tending for others, but none of them disagreed about letting us count the total number of animals in their settlement after interviews. We were able to achieve direct counts of the livestock in all the settlements in use we identified in Little Pamir in summer 2007. The comparison of the figures driven from interviews with direct on-site counts constitutes a sensitivity test. Interview estimates were usually <50% than direct count results in most settlements. Only on one occasion, in Mulungik Kshun, the interview estimate for goats was superior to the direct count. Overall, estimates driven from interviews underestimated real herd size by *c.* 55–130% (Table 7).

Origin

According to the interviews, livestock pastured by Wakhi in western Little Pamir during summer 2007 originated from 5 villages: 4 in upper Wakhan (Sarhad-e Broghil, Chilkand, Neshtkhawar and Ptukh), and 1 in lower Wakhan (Khandud) (Table 8). It seems that transhumant livestock from villages located east of Neshtkhawar and up to Sarhad-e Broghil pastured in Little Pamir. Only one household from lower Wakhan was present in Little Pamir, in Kashch Goz, with 14 yaks. These yaks stay the year round in Little Pamir, and are tended during winter by Kirghiz, in Bozai settlement. We can therefore assume that livestock pasturing in Little Pamir are very rarely in contact with livestock from lower Wakhan (Table 8), where villages are supposedly more exposed to infectious agents from outside Wakhan. The geographical isolation of livestock in Little Pamir being relatively lower than in Big Pamir, this situation may theoretically buffer the risk of disease introduction from the rest of the Badakhshan province to the upper Wakhan Valley and Little Pamir.

We investigated the number of livestock per household. We noted a large variability in numbers of sheep and goats contributed to each settlement herd by different households, ranging from 0 to 200 animals, depending on the species.

Seasonal movements

Wakhi livestock operate seasonal movements of which magnitude varies according to species, weather and grazing rights. Out of the 42 interviewed households, 19 (45.2%) acknowledged proceeding a complete transhumance of their livestock twice a year: in spring, from their village to spring pastures in Little Pamir before moving to summer pastures. In October, they move down from summer pastures to autumn pastures, and further to their village at the beginning of winter. A total of 22 households (52.4%) operated only a partial autumn transhumance of their livestock. They moved down to villages most of their goats, all sheep from the *gadek* breed, some *turki* breed, all cows and camels, and left in Big Pamir the 'strongest' goats, most *turki* breed sheep, and part of their yaks for winter. Finally the one household (2.4%) of Kashch Goz left all its livestock (yaks only) with Kirghiz of Little Pamir. Presumably all households adjust the timing of their livestock seasonal movements according to weather and forage accessibility. Should weather conditions become harsh prematurely in autumn, they will move down earlier to villages. Animals wintering in Pamir are either tended by Wakhi or by Kirghiz herders of Little Pamir. Typically Kirghiz would charge Wakhi 7 kg of wheat flour per loaned yak at the beginning of winter (Ammuurdin Bakhshah, pers. comm.). Kirghiz are entitled to use the milk after female yaks calve. Another interesting symbiotic cooperation between Wakhi and Kirghiz concerns *turki* sheep. Kirghiz may rear *turki* sheep loaned to them by Wakhi from birth to 3–4 years old. Payment is made in the free use of sheep's milk and wool. Then, loaned animals are returned to Wakhi who usually sell them for meat. Offspring of these animals stay with Kirghiz, fueling a new cycle of cooperative rearing.

Spring transhumance usually starts in late May but can start as early as April depending on snow cover. Herds take between 2 and 3 days to reach spring pastures. In early October, high-altitude summer pastures are deserted progressively according to weather and snowfalls. Autumn pastures at lower altitude will be used as long as weather allows. They will be deserted by mid December on the latest.

According to the interviews, 763 sheep and goats (33.3%) and 183 yaks (35%) will leave Little Pamir in autumn 2007. This calculation does not take into account the fact that '*gadek*' sheep and part of the goats from households staying in Pamir is also moved down to Wakhan. If we use livestock numbers drawn from our direct counts instead of interview estimates, only 27.5% of small ruminants and yaks leave Little Pamir before winter. Roughly we estimate that 65% of livestock winter in Little Pamir and 35% retrieve to Wakhan villages. These figures differ from the one provided by Mock et al. (2006) who estimated that only c. 46–47% of sheep, goats and yaks stay in Little Pamir during winter.

Shpodkis — Transhumance movements in this grazing area are heterogeneous although all but one household originate from the same village of Sarhad-e Broghil. All livestock from Sang Nevishta return near Sarhad-e Broghil in mid October. At the beginning of spring they move to Limil where they spend around 1.5 month before rejoining Sang Nevishta. Livestock from Barnoz does not return to Sarhad but instead move to the lower part of Warm grazing area where they spend winter. In spring they move near Sang Nevishta until other households reach this area. Then they move to Barnoz.

Plate 11. A group of female yaks grazing in Warm pastures at nearly 4500 m of altitude, Little Pamir, 10 September 2007.

The four households in Ghareen Shpodkis move in autumn to Bari Tuk. Three of them will leave for Khalingiaft where they will spend winter before coming back to Ghareen Shpodkis in late spring. The fourth household stays one month during fall in Bari Tuk and then moves to lower Chapdara grazing area. At the beginning of winter all its livestock is moved down near Sarhad. In spring animals will move again to Bari Tuk, spend one month there before heading back to Ghareen Shpodkis. Eventually one household from Sot Vijeetk moves down to Chilkand village in autumn and returns in spring. The four others which originate from Sarhad-e Broghil move their herds in late autumn to Tash Parak (near Bai Qara grazing area) where they winter until early spring when they go back to Sot Vijeetk.

Warm — Animals from Chanaq Zherav move to Mirza Murad Dasht in autumn and then to Langar in winter. In early spring they will go again to Mirza Murad Dasht before heading back to Warm grazing area (Plate 11). The two households from Ghareen Warm follow a similar pattern of movement although they move directly to Langar in autumn and to Warm in spring without staying at Mirza Murad Dasht. The two households of Aqbelis stay in this area until end of autumn, move to Chechardan for winter and come back to Aqbelis in spring. Eventually, households of Gharmdeh move to Zarqab in mid autumn, to Langar in winter, and again to Zarqab in spring before coming back to Gharmdeh settlement.

Bai Qara — Households using this grazing area in summer are all from Sarhad-e Broghil. From their summer pasture they move to Mirza Murad Dasht in autumn for one month, and then to their winter pasture of Gormituk in lower Bai Qara grazing area. Soon after snow starts melting in spring they will move back to Bai Qara.

Chapdara — All households using Chapdara in summer move down to their villages in winter. In September the five households of Mulungik Kshun move with their animals to Tuk, then at the end of autumn to Lakish and then down to their village of Neshtkhawar for winter. As soon as snow cover allows in spring they will move back to Mulungik Kshun. Households from Wutsir move their livestock directly from summer pastures to the village in autumn and back in spring without prolonged stopover in-between. Eventually livestock of Uwee-e-ben Kshun are moved to Buzherav-gash (Chapdara) in autumn and then down near their village. At the end of spring they are moved up to Uwee-e-ben Kshun.

Kashch Goz — The 14 yaks of this settlement are moved in mid autumn to Bozai where they will be tended by Kirghiz. They will move back to summer grazing at the end of spring.

Husbandry

According to the interviews, sheep (1809) were the most common livestock species in Little Pamir in summer 2007, followed by yaks (523), goats (478), cattle (65) and Bactrian camels (11) (Table 7). Yaks are the most precious livestock followed by sheep and goats. Cows are brought to Pamirs to provide an additional supply of milk to herders and to allow the production of dry dairy products for winter. Bactrian camels are essentially owned for prestige. Unlike Kirghiz, Wakhi do not ride them. Sheep belong to two breeds: the dwarf, more or less native, *gadek* breed (body mass=16–25 kg), and the large Western Asian fat-tailed sheep breed known as *turki* or *gissara* (body mass=28–55 kg). With their shorter legs, *gadek* sheep are less efficient in snow than *turki* sheep and their thinner wool cover makes them more susceptible to cold weather. Because of that, most *gadek* sheep are brought back to the villages in autumn while all *turki* sheep are left in Little Pamir during the whole winter.

Small ruminant herds also include goats in variable numbers. In summer 2007, the sheep to goat ratio in settlements varied from 1:1.5 to 25:1. Only the strongest goats are kept in Little Pamir during winter and apparently more than half of them are moved down to the villages in autumn.

In general Wakhi livestock husbandry in Little Pamir was very similar to what we recorded in Wakhi livestock in Big Pamir (Ostrowski, 2006).

Health status

As already mentioned in our 2006 report on Wakhi livestock in Big Pamir, three inter-related factors played important roles in the health status of livestock herds we visited in 2007: 1/ the seasonal variability in the availability and quantity of forage, 2/ the occurrence of infectious diseases, and 3/ the free mixing of animals, either from different herds in the same pasture during summer, or from different health status (healthy and sick) within a herd. Health problems affecting livestock recorded during the present work were similar in occurrence and prevalence to what we described for the Wakhi livestock population using Big Pamir (Ostrowski, 2006). We only provide below data on mortality and abortion in livestock surveyed in Little Pamir in 2007. We collected 145 blood samples.

Table 9. Seasonal causes of deaths between summer 2006 and summer 2007, among sheep, goats, yaks and cattle from 42 Wakhi settlements of Little Pamir.

Species		Winter	Spring	Summer	Autumn	Total
Sheep	Starvation/Coldness	330	23	0	0	353
	Diseases	30	70	12	0	112
	Predation	38	16	6	0	60
	Unknown	15	0	1	2	18
Goat	Starvation/Coldness	71	5	0	0	76
	Diseases	2	4	0	0	6
	Predation	6	0	2	0	8
	Unknown	1	2	1	0	4
Yak	Starvation/Coldness	82	0	3	0	85
	Diseases	13	17	1	0	31
	Predation	19	1	2	3	25
	Unknown	1	0	1	1	3
Cattle	Starvation/Coldness	1	0	0	0	1
	Diseases	1	2	0	0	3
	Predation	0	0	0	0	0
	Unknown	0	4	0	0	4
Total		610	144	29	6	789

Mortality and abortion

The surveyed 42 households reported the death of 543 sheep, 94 goats, 144 yaks and 8 cattle for the year preceding the survey (summer 2006 – summer 2007). The principal cause of death was starvation and coldness which killed 65.3% of livestock, followed by diseases with 19.3% of deaths, predation with 11.7% and unknown reasons 3.7% (Table 9). Deaths due to starvation and coldness happened during winter or in early spring, with the notable exception of three yaks which died in summer from surinfected frostbite lesions acquired in winter. Wakhi are the first to admit that an unknown number of deaths due to 'coldness and starvation' may also be caused by undercurrent diseases. Undernutrition probably affects the immune protection of the animals.

Winter mortality —Wakhi interviewed in Big Pamir in summer 2006 reported significant losses during preceding winter due to coldness and forage shortage. Out of the 55 interviewed households, only 7 (12.7%) reported no losses (Ostrowski, 2006). Similarly, only 6 (14.3%) out of the 42 households interviewed this year reported no losses during the winter preceding our survey. The remaining 36 households lost overall 330 sheep, 71 goats, 82 yaks and 1 cow. Sheep and yaks also died of diseases, 10 sheep died with severe respiratory problems and 20 others died within a week after being massively infested by ticks on their return from Pamir. Assuming a constant productivity and extrapolating summer 2007 estimates — diminished by 30% for sheep and goats and by 5% for yaks to account for animals bartered, sold or dead after summer — we estimated mortality rates at 14.2% for sheep, 15.2% for goats, and 13.6% for yaks for winter 2006–2007. These figures are consistent with those estimated for winter 2006–2007 in the livestock of the 15 Wakhi households interviewed 10 days later in Big Pamir: 18.1% for sheep, 16.4% for goats, and 8.2% for yaks (see Part III). They are not significantly lower than mortality rates estimated for winter 2005–2006 on another subset of 55 Wakhi households of Big Pamir: 21% for sheep, 22% for goats, and 17.5% for yaks (Ostrowski, 2006). Starvation and coldness were perceived as the primary causes of winter mortality, accounting for 79.9%, 88.7% and 83.5% of deaths of sheep, goats, and yaks, respectively. As mentioned earlier a number of deaths imputed to starvation might have been caused by undiagnosed chronic diseases affecting body condition. Mortality due to predation accounted for 10.3% of total losses in winter with 38 sheep, 6 goats, 19 yaks and 1 camel being killed by wolves. This is very close to the 10.4% predation mortality estimated for the livestock of 15 Wakhi households using Big Pamir in winter 2006–2007 (see Part III). Animals predated by wolves were unattended or, on rare occasions, killed at night in their corral.

Spring mortality — Mortality was lower in spring than in winter. Spring mortality was dominated by abortions in early spring, diseases and sporadic cases of predation. Only six households (14.2%) reported no abortions. Overall 165 sheep, 107 goats and 11 yaks aborted at the end of winter or in the beginning of spring 2007, probably in late pregnancy stage. Those figures should be considered a minimum as two households reported abortions in sheep without quantifying them, and eight households reported they might have overlooked several inconspicuous cases. Following the assumptions we used to estimate winter mortality rates, late winter/early spring abortions affected at least 5.6%, 20.0% and 1.3% of sheep, goat and yak populations, respectively. There was an unexpectedly high abortion rate in goats. Most infectious diseases affecting sheep in spring were related to the consumption of new grasses and consecutive severe digestive tract disorders. Wakhi reported 17 cases of sudden deaths. They could have resulted from acute enterotoxaemia or possibly anthrax cases. At least 9 newborn yaks died within 2 days of the first colostrum consumption apparently with acute broncho-pneumonia. A total of 16 sheep, 1 yak and 2 camels were killed by predators.

Summer mortality — Mortality in summer was lower than in spring and winter. Respondents reported the death of 12 sheep and 1 yak of unknown diseases, 3 yaks of frostbite lesions incurred during winter, and 1 yak of surinfected nostril abscess. In addition 6 sheep, 2 goats, 2 yaks and 1 camel were killed by wolves. No abortions were reported.

Autumn mortality — Autumn is a period of transhumance and reacclimation to valley settlements. Three yaks were killed by wolves. No abortions were reported.

Data on equids

Introduction

Wakhi keep a population of horses and donkeys in Little Pamir which they ride or use as pack animals. Like yaks, horses are a mark of prestige and thriving households may own several of them.

Table 10. Geographical distribution of equids owned by Wakhi land users of Little Pamir in summer 2007.

Locality	Settlement / Village	Horse	Donkey	Number of households without horses
Shpodkis pasture	Sang Nevishta	2	5	1
	Barnoz	1	2	0
	Ghareen Shpodkis	6	14	0
	Sot Vijeetk	7	10	1
Chapdara pasture	Mulungik Kshun	0	0	1
	Wutsir	3	2	0
	Uwee-e-ben	0	3	2
Warm pasture	Chanaq Zherav	0	0	1
	Ghareen Warm	2	3	0
	Aqbelis	0	0	0
	Gharmdeh	3	3	0
Bai Qara pasture	Bai Qara	7	2	0
Bet. Warm and Bai Qara	Kashch Goz	1	1	0
Wakhan villages	Sarhad-e Broghil	7	26	NS
	Chilkand	6	12	NS
	Neshtkhawar	9	20	NS
	Ptukh	3	11	NS
Total		57	114	6/42

Numbers and origins

Out of 42 Wakhi households who used Little Pamir in summer 2007, 6 (14.3%) owned no horses, 22 (52.4%) had one horse, 10 (23.8%) had two horses, 2 (4.8%) had three horses, 1 (2.4%) had four horses, and 1 (2.4%) possessed five horses (median=1). Overall 26 (85.7%) households owned together 57 horses. Thirty-two horses were maintained in Little Pamir, near settlements, and 25 were left in villages. All but one horse (Kashch Goz settlement) originated from upper Wakhan.

All but two households of Little Pamir owned donkeys. Forty households (95.2%) owned 114 donkeys distributed as: 4 households (9.5%) had one donkey, 16 (38.1%) had two, 7 (16.7%) had three, 9 (21.4%) had four, 3 (7.1%) had five, and 1 (2.4%) had six (median=2). Analysis of equid ownership confirmed that Wakhi from Little Pamir owned more horses than Wakhi from Big Pamir (Wilcoxon Rank Sum Test, $P<0.002$), whereas the distribution of donkeys was similar in these two Wakhi populations ($P=0.75$). We showed in 2006 that only the most prosperous Wakhi households own horses (Ostrowski, 2006). Results of the 2007 survey would suggest that Wakhi using Little Pamir could be more prosperous than those using Big Pamir.

Seasonal uses and husbandry

Practices are similar to those recorded in Wakhi from Big Pamir (Ostrowski, 2006).

Health status and mortality

Health status

When questioned about diseases affecting their horses and donkeys, Wakhi usually acknowledged that both species are resilient and seldom die of diseases. Only one infection seems to kill them. According to the symptoms they described in interviews, we believe it could be glanders in its acute form. See Ostrowski (2006) for a complete description of the disease.

Mortality

Interviewed households reported the loss of one donkey (0.8%) and three horses (5%) between summer 2006 and September 2007. None of the animals died in Little Pamir but while they were in villages. Two horses and one donkey died during winter while one horse died in summer. One horse and the donkey presented symptoms evocative of acute glanders (tenacious, unilateral, hemorrhagic, mucopurulent nasal discharge), one horse died of unknown reason in summer, and the last one apparently died of coldness in winter 2006–2007. Animals were usually in poor body condition before death, a situation that can result from undernutrition or undercurrent diseases such as chronic forms of glanders.

DISCUSSION

Wakhi in Little Pamir

Nowadays, Wakhi are mostly agriculturalists although they often keep livestock. They are settled in the lower, mid and upper parts of the Wakhan valley, where they grow crop. Only a minority of them uses the surrounding Pamir Mountains for grazing their animals. They can be categorized as agropastoralists and strict pastoralists. Agropastoralists follow a prime subsistence strategy based on combined mountain agriculture. It has the advantage of simultaneous fodder production in the permanent homesteads for herds which are grazed in the high pastures during the summers (Felmy and Kreutzmann, 2004). Strict pastoralists depend entirely on self-regenerating and self-maintaining range resources throughout the year and very little, if at all, on fodder for livestock supplementation during winter. Unlike Kirghiz, only a few Wakhi are strict pastoralists. They are usually commissioned by other families, to tend their livestock in Pamirs, a system called '*amanat*' (see Mock et al., 2006 for more details).

This survey aimed at identifying Wakhi populations pasturing their domestic animals in Little Pamir. We believe we have identified most settlements in use in 2007. They were all located in the western part of the Little Pamir and consisted in 42 households, mostly coming from villages in upper Wakhan. Upper Wakhan enjoys less favorable conditions for crop farming than lower parts of the valley and Wakhi, there, mostly relied on livestock farming as a main source of revenue. Even inhabitants of the Chilkand and Sarhad-e Broghil villages, where arable lands are relatively more extended than in the rest of the upper Wakhan, owned large numbers of livestock and particularly horses. As a matter of fact they presented the economical features of the more prosperous households.

The 42 identified households represented about 13% of the 320 households recorded in upper Wakhan in 2006 (Mock et al., 2006). According to our livestock direct counts, they owned approximately one third of Wakhi sheep and goats using Afghan Pamirs in summer and half of the yaks.

Livestock epidemiological situation

Because of their distant location from the rest of Badakhshan, livestock grazing in Little Pamir are relatively sheltered from disease agents imported from the rest of the province. They seldom come into direct contact with other livestock populations apart except when they are cooperatively tended by Kirghiz with their own livestock during winter. There is however a risk of disease introduction into Little Pamir via livestock movements between Pakistan and Afghanistan in the eastern tip of Wakhan. Kirghiz from Little Pamir are known to use livestock markets of northern Pakistan as more accessible commercial outlets to their animals than Kabul animal market. Although the trade which crosses the relatively accessible high passes of the Hindu Kush mountain range is rarely used to import animals (Mock and O'Neil, pers. comm.), Kirghiz livestock would nevertheless be in the front line in the case of disease introduction from Northern Pakistan. They could then transmit infectious agents through direct contacts to Wakhi livestock tended by Kirghiz in Little Pamir during winter. In theory the disease could then spread within the whole Wakhi population of Little Pamir in spring and summer when animals loaned to Kirghiz will come back in their original herds. But infectious agents may face at this stage a dead-end situation because of the relative lack of contacts between infected animals and other livestock populations. We can therefore hypothesize that Little Pamir may play the role of an epidemiological buffer zone. It is too early to know whether this hypothesis is valid but comparison of serological exposure of different livestock populations in Wakhan district to a range of pathogens may provide some insight into this hypothesis.

Risk of interspecies disease transmission

An essential question underlying all of our investigations in Afghan Pamirs is: what is the risk of disease transmission between domestic and wild ungulates? The observations we made in Little Pamir support our earlier preliminary conclusions (Ostrowski, 2006). According to our understanding of livestock health situation, pastoral practices, and occurrence of wild ungulates in the area, the risk of direct pathogen transmission between small ruminants and wild ungulates seems to be low in Little Pamir, at least in summer. We asked representatives of the 42 Wakhi households pasturing their livestock in Little Pamir in summer 2007 about the possibility of direct contacts between their livestock and Alpine ibex or Marco Polo sheep, that is, if they had observed wild individuals within a 100-m horizontal distance of their livestock. We chose 100 m as most infectious agents nebulized into a wind tunnel will not remain viable after a distance of 50–100 m (Dixon et al., 2002). All respondents mentioned that Marco Polo sheep do not occur in their pasture areas. Furthermore, although two (4.7%) interviewees mentioned having occasionally spotted Alpine ibex in summer pastures, none had ever observed direct contacts between their livestock and Alpine ibex in summer.

Provided they broadly share the same pastures, wild ungulates may however be exposed to livestock pathogens by indirect contacts. For example, tapeworms, contagious ecthyma poxvirus, or air-transmitted FMD picornavirus, which can all survive in the environment, or pathogens such as *Mycoplasma* which can survive on mouth parts of vector insects, may be a threat to wildlife.

Finally disease spillover may occur from livestock (usually cattle, yaks and Bactrian camels) left untended in high altitude pastures during summer. This could be the case in Little Pamir where yaks are left to roam free during winter.

Disease susceptibility of Marco Polo sheep (*Ovis ammon polii*) has been poorly documented but solid data have been collected and published on Alpine ibex. They could be used to predict which pathogens are susceptible to be dangerous for Alpine ibex roaming in the western Little Pamir.

Losses of domestic animals due to predation

Wakhi grazing their livestock in Little Pamir represent only about 13% of the Wakhi population of Wakhan but they own around 30% of the sheep population in the district. According to the interviews, wolves killed 25 yaks, 60 sheep, 8 goats and 4 Bactrian camels between summer 2006 and September 2007 (Table 11). Respondents reported no predation due to snow leopard. The majority of preyed yaks and camels were unattended, confirming the comments by Fitzherbert and Mishra (2003) that leaving animals to graze unattended is a poor anti-predatory management, especially against wolves. In Little Pamir, herds of sheep and goats are most often guarded by a young adult accompanied by one or two dogs. Unlike Fitzherbert and Mishra (2003) we did not see children tending livestock but like them we noted the poor construction of open corrals and stables where animals are penned in winter.

We confirmed the observation made by Fitzherbert and Mishra (2003) that most predator attacks on livestock occur in winter (Table 11), when wild carnivores suffer undernutrition and are presumably less reluctant to approach herds in the vicinity of inhabited areas. We could personally observe wolf footprints crisscrossing the snow in the surroundings of a village in lower Wakhan in December 2006 (Ostrowski 2006).

Unattended yaks seem to pay a relatively high tribute to wolf predation, especially in winter. Wakhi from Little Pamir reported 19 (76%) cases of predation on their yaks in winter and 6 (24%) cases for the rest of the year (Table 11). Arguably herders of Little Pamir lost c. 3% of their yak population through predation from summer 2006 to summer 2007. A total of 10 yaks were predated at night, 7 during day, and 8 at unknown time. Although herders reckoned seeing wolves or their tracks around only 8 (32%) of the killed yaks, this is a reasonably high frequency of sighting, considering that most predations in yak occurred on unattended animals during night. In the four cases (7 deaths) reporting direct sightings, wolves were in packs of 3, 2, 5, and 4 individuals. In general herders consider predation as irrefutable when wolves or their tracks are seen around their dead livestock. On the other hand, when they find half-eaten carrions, they never consider the possibility of a case of scavenging by carnivores on an animal which may have died of another cause.

Table 11. Numbers of Wakhi sheep, goat, yaks, cattle and camel killed by wolves in Little Pamir between summer 2006 and summer 2007 according to interviews.

	Sheep	Goat	Yak	Camel	Cattle	Total
Winter	38	6	19	1	0	64
Spring	16	0	1	2	0	19
Summer	6	2	2	1	0	11
Autumn	0	0	3	0	0	3
Total	60	8	25	4	0	97

We therefore consider that the figure of 25 yaks killed because of predation is probably a maximum value.

In absolute value, sheep was the principal livestock prey for wolves in Little Pamir as 60 animals were predated during the year preceding the survey. However, it constitutes <1.5% of the estimated population of sheep grazing in western Little Pamir. As for yak the majority (63.3%) of predation cases occurred in winter. Nineteen sheep were predated at night, 6 during day and 35 at an unknown time of the day. Herders saw wolves in 9 (15%) cases only. In the five cases (9 deaths) reporting sightings, wolves were single in three cases, two in one case, and in a pack of three in the last case. As for yaks, we consider the number of 60 sheep killed because of predation as a maximum value.

Finally nothing is known about the occurrence and role of other possible livestock predators, such as Himalayan lynx or pariah dog.

To conclude, our investigations on the causes of mortality of livestock from 42 households using Little Pamir pastures suggest that predation by wild carnivores accounted for 11.7% of reported deaths between summer 2006 and September 2007.

CONCLUSION

In mountainous areas of western Little Pamir, the abundance of domestic herds and over utilization of forage resources during summer have led to a relative impoverishment of range land and to a poor vegetation recovery rate (D. Bedunah pers. comm.). Because of this intense grazing pressure it is likely that wild ungulates compete with livestock in summer ranges and are de facto more or less excluded from these areas at this period of year. Hence cohabitation between domestic and wild ungulates seems excessively diluted in space and time and the risk of disease spillover by direct contact between domestic and wild ungulates is probably reduced. However we still need to assess the risk of disease transmission by direct or indirect contacts from unattended cattle and yaks to wild ungulates, especially Marco Polo sheep. On a larger scale we still need to carry on our study of livestock/wildlife cohabitation patterns in Kirghiz pastures of Little Pamir to complete our understanding of disease spillover risk at a range-scale level.

Hopefully in 2008, we will finalize our study of livestock populations in Afghan Pamirs with Kirghiz of central and eastern Little Pamir.

PART III. UPDATE FOR 2007 ON WAKHI LIVESTOCK IN BIG PAMIR

INTRODUCTION

During our 2006 summer survey (16 July – 22 August 2006) in Big Pamir, the Afghanistan Ecosystem Health Project Team identified 11 currently used Wakhi herding settlements. Overall, the 11 settlements consisted of 62 households. During our winter survey (23 November – 18 December 2006), we visited the 14 villages from which the 62 households originated from, spread throughout lower, mid, and upper Wakhan (Ostrowski, 2006). It was a great opportunity to look for herds we might have overlooked during our summer survey. It turned out to be the case. We identified several livestock owners or herders who reported to us that they had not been surveyed by our team in summer 2006: three in Goz Khun, one in Shelk, three in Sargez, six in Rorung and two in Dehghulaman village. We were therefore able to locate their summer settlements and visit them during summer 2007. We report about their livestock as investigated in June, July and September 2007.

In our 2006 report, we had also pointed out that assessing the extent of the range used by livestock was necessary, particularly in view of the possible contacts between them and wild ungulates (Ostrowski, 2006). In the present report we compile and discuss the preliminary results on range use data recorded with handheld GPS units distributed to five herders tending their livestock in areas of Big Pamir known to be visited by wild ungulates (Shikargah and Manjulak).

Plate 12. The brother of Mr. Wali Jon from Goz Khun. He is the elder of the Wakhi settlement of Zarnaw which was not surveyed in summer 2006, Briqarv, Big Pamir, 14 July 2007.

OBJECTIVES AND METHODS

Objectives

The surveys carried out in June, July and September 2007 were dedicated at completing our health and management database on livestock of the Wakhi using western Big Pamir in summer. Our goal was to estimate the number and ownership of livestock not surveyed during the summer 2006 survey, to study their seasonal patterns of range use, their timing of transhumances and the existence of over wintering practices. We also needed to assess livestock health status and to evaluate the risk of disease spillover from domestic to wild ungulates. Another objective was to set up a collaborative data collection exercise involving Wakhi herders tending their livestock in areas where they are the most likely to meet Marco Polo sheep. We asked five of them to record with GPS units the locations of their herds in order to document as accurately as possible the range used by livestock during summer. To a few exceptions, we only provide in this report firsthand data collected in the field. The report tries to be an accurate snapshot of the presence and health status of a selected number of Wakhi livestock herds in Big Pamir.

Methods

Identification of livestock populations not surveyed in summer 2006

During our winter 2006 survey, we asked the heads of Shuras and other community leaders from Goz Khun to Rorung villages in Wakhan Valley if they knew of some households who had not been surveyed during summer. We found that three livestock owners in Goz Khun, one in Shelk, three in Sargez, six in Dehghulaman and two in Rorung had been overlooked. We asked them about their herd's locations in Big Pamir and visited them during summer 2007.

Dates of surveys

We carried out three surveys during summer 2007: between 18 June and 27 June (June survey), on 12–13 July (July survey), and on 18–19 September (September survey). Summary of activities per day can be found in Appendix 3.

Team composition

The ecosystem health project team which carried out the three update surveys on Wakhi livestock pasturing in Big Pamir in June, July and September 2007, was composed of:

- Dr. Stéphane Ostrowski, team leader, WCS Ecosystem Health Project Manager (June and July surveys)
- Dr. Ali Madad Rajabi, Afghan veterinarian graduated from Kabul Veterinary College in 2005 (June, July and September surveys). Appointed leader of the mission by Dr. Stéphane Ostrowski for September survey.
- Dr. Hafizullah Noori, Afghan veterinarian graduated from Kabul Veterinary College in 2005 (June, July and September surveys);
- Mr. Inayat, Wakhi trainee from Qila-e Panja identified by Mr. Inayat Ali, WCS Community Conservation team based at Kret, upper Wakhan (June and July surveys);

- Mr. Attam Beg, a Wakhi from Kret, trained as a cook by Mr. Inayat Ali, WCS Community Conservation team ((June, July and September surveys).

Data collection and analysis

We collected data through interviews of local land users, direct counts and veterinary investigations on livestock (clinical examinations).

Interviews

We interviewed representatives (most of the time elders) of the Wakhi households tending their livestock during summer in the Senin, Shikargah and Sargez valley pastures in Big Pamir. Upon our arrival in a settlement, we asked an elder about the number of present households (Plate 12). Two members of the team conducted the interviews in Dari and one of them subsequently translated them into English. Overall, we carried out 15 interviews during summer 2007. Each interview lasted roughly 30–45 minutes and consisted in 84 predetermined questions about the background of the respondent, the number of livestock his household owned or attended in Big Pamir, transhumance timing and mapping, range use, current livestock health status, livestock management practices, diseases and current clinical symptoms observed in livestock. Questions were always presented in the same manner and order. We tallied answers, calculated the percentages of various responses and carried out descriptive statistics with Statistix 8.1 software.

Size and geographical origin of livestock populations

We asked interviewees the number of sheep, goats, cows, yaks, Bactrian camels, horses and donkeys they were tending in Pamir as well as their geographical origin. After the interviews, we carried out direct counts to compare our figures with those provided by the respondents and assess the interviews' sensitivity. Two team members counted on three consecutive times (total 6 counts) the total number of sheep, goats and yaks herded in each visited settlement. We performed this cross-checking operation in the Kund-a-Thur, Zarnaw and Vagd Boi settlements. The interviews also provided us with information on the seasonal movements of livestock in Big Pamir.

Livestock husbandry and health status

Through the interviews, we obtained data on husbandry practices and health status of livestock. We also carried out clinical examinations but did not collect blood samples.

Training of Wakhi herders to use hand-held GPS units

Data on Marco Polo sheep distribution collected by Petocz (1973) and by Habib (2006) suggest that livestock herds pasturing in the Shikargah area are the most likely to come into contact with wild sheep. Therefore, we focused our attention on four Wakhi settlements in the Shikargah Valley which we visited between 20 and 23 June 2007. In each of them we identified, with the help of a settlement elder, a herder willing to collaborate with us and trained him at using a GPS unit. On the 24 June 2007, we also visited the Nakchirshitk camp in the Manjulak grazing area where Marco Polo sheep had also been observed in summer 2006 (Habib, 2006) and proceeded similarly.

Table 12. Background data on the GPS tracking study of Wakhi livestock, Big Pamir, June 2007.

Pasture area studied	Summer camp	Name of involved herder	Model of GPS unit	Date of deployment	Indemnities
Shikargah	Qabal Gah	Mr. Tila Bai	Garmin eTrex	20 June	50$/month
Shikargah	Kund-a-Thur	Mr. Norudin	Garmin 60 series	22 June	Idem
Shikargah	Mulung Than	Mr. Jumah Khan	Garmin 60 series	22 June	Idem
Shikargah	Darah Big	Mr. Abdulaziz	Garmin eTrex	23 June	Idem
Manjulak	Nakchirshitk	Mr. Hoch	Garmin V and then Garmin 60 series	25 June	Idem

Herders were shown how to change the batteries of their GPS unit, switch it on and off, acquire a location and store it into the memory (Plate 13). We let them operate the unit by themselves under our supervision for a couple of hours. We instructed the herders to position themselves within their herd before marking a position, three times per day: at 6:00, 9:00, and 3:00 (±10 minutes). In order to build up their level of responsibility towards the work we asked them not to 'subcontract' the duty to another herder if occasionally they were not in charge of the conductance of the herd. We offered them 50$/month (the cost of a big adult *Turki* sheep), paid upon completion of the work. While on our way back from our survey of Kirghiz settlements in Big Pamir, we revisited on 12 July 2007 the herder in Nakchirshitk camp and changed his sophisticated GPS unit for a more 'friendly-user' model. The five GPS units were retrieved from herders in September 2007 after we completed the survey of Wakhi livestock in Little Pamir (see Part II). Data concerning GPS unit deployment are compiled in Table 12.

Plate 13. Dr Ali Madad Rajabi teaches Mr. Hoch in Nakchirshitk settlement to use a handheld GPS unit, Big Pamir, 24 June 2007.

Table 13. Wakhi pasture areas, settlements, and households visited in Big Pamir in June and September 2007.

*Name of summer pasture area	*Name of settlement	Location of settlement (UTM WGS 84)	Number of households
Senin	Zarnaw	43S 304555 4117318	3
Sargez valley	Dariah Sargez	43S 320381 4097720	2
Shikargah	Vagd Boi Khord	43S 314504 4105855	6
	Kund-a-Thur	43S 313700 4107800	4

*Spelling follows Mock (2006)

RESULTS

Surveyed Wakhi households

We identified 15 households that we had overlooked during our summer 2006 survey, which they confirmed during the interviews. They were located in three different pasture areas and grouped in four settlements (Table 13). Two households were located in Sargez valley, six others in Vagd Boi Khord settlement in upper Shikargah, four in Kund-a-Thur/Shikargah, and the last three in Zarnaw below Senin pasture area in the north-western part of Big Pamir. The settlement of Khushabad in upper Shikargah was not in use at the time of our surveys.

Data on livestock (excluding equids)

Numbers

According to the interviews, the 15 households had 980 sheep, 362 goats, 162 yaks, 43 cattle and 4 Bactrian camels pasturing in Big Pamir during summer 2007 (Table 14). All interviewees were willing to communicate about the livestock they owned or tended for other Wakhi (often their relatives) not present in the settlements during our visit. We investigated the number of livestock per household. As in 2006, we noted a large variability in numbers of sheep and goats per household, ranging from 14 to 240 animals.

We evaluated the accuracy of the provided figures by counting animals in the field. We were able to carry out direct counts for 3 out of the 4 surveyed settlements. The comparison of the figures driven from interviews with direct on-site count (Table 15) constituted a sensitivity test. Interview estimates were within 10% of direct count results in Zarnaw and Vagd Boi Khord, whereas they were more than 50% lower in Kund-a-Thur (Table 15). The large discrepancy observed in this last settlement was explained by the fact that interviewed people did not include lambs and kids in the totals they provided to us. In addition many of the yaks and cattle grazing around Kund-a-Thur did not belong to them, but were free-ranging animals from other settlements, a situation commonly observed in upper Shikargah for non-breeding specimens of these two species.

Origin

According to the data collected through the interviews, livestock originated from five villages: one in mid Wakhan (Goz Khun), and four in upper Wakhan (Shelk, Sargez, Rorung and Dehghulaman) (Table 16). Rorung and Dehghulaman being located east of

Karich, the range of origin of Wakhi livestock pasturing in Big Pamir proposed in our 2006 report (Ostrowski, 2006) should be extended to the east. With at least 630 sheep and goats pasturing in Big Pamir, the herd originating from Goz Khun could significantly contribute to the overall grazing pressure in Big Pamir.

Seasonal movements

Wakhi livestock perform complex seasonal movements of which extent and organization vary according to grazing rights, herd composition, weather and arrangements between livestock owners and herders. Big Pamir, and from summer pastures to their village in autumn. Four households (26.7%) however performed only a partial transhumance of their livestock, moving their animals to lower altitudes for winter but not to their home villages. Out of the 15 interviewed households, 11 (73.3%) proceeded a complete transhumance of their livestock twice a year: from their village to the western Big Pamir summer pastures in spring and from summer pastures to their village in autumn. Four households (26.7%) however performed only a partial autumn transhumance of their livestock, moving animals to lower altitudes for winter but not to their home villages and back to higher altitude pastures in summer. Households visited in Kund-a-Thur reach this site around mid June in provenance from Sargez and Shelk villages. They stay the whole summer in this area and move to Dariah Sargez in mid October. They pasture their livestock there until as late as the end of December depending on snow falls, and then move their animals either to their villages if winter is severe or to Sargez valley if winter is mild, at a locality named Sheon (UTM–WGS84 43S 316592 4094292). The two households using Dariah Sargez in summer leave this site in mid October and take their livestock back to Rorung village where they spend winter. They come back to Dariah Sargez in late June. Livestock herds from Goz Khun stay the whole year long in Big Pamir. In late November two herds move down from their autumn pastures in Senin either to Jin Karv if snow is abundant or to Pur Sang if it's not. Both wintering sites are located very near the Pamir River, roughly a day walk from Goz Khun. They will stay in this area until April and then move to Zarnaw in late April. In late November one herd is moved to Tila Bai Valley and left the all winter with Mr. Kok Aslam, the head of the Kirghiz of Big Pamir. In April it comes back to Zarnaw. Only at the beginning of September the three herds will move collectively high up in the mountains to reach Senin pastures. The six households we met in Vagd Boi Khord on 18 September all came from Dehghulaman village and operated a remarkable variety of seasonal movements, which showed the difficulty to understand the complexity of range use from questionnaire investigations only. One household had been in Vagd Boi Khord since early July and was to move late in October or even in November, if snow allowed, to Wardeef area (not localized yet). They would then take their livestock at the beginning of winter to Neshtkhawar village until late June when they would move back to Vagd Boi Khord. Three households were to move in late October or early November to their home village of Dehghulaman. Then in May they would move to Asan Katich (upper Shikargah) and at the end of August to Vagd Boi Khord. Eventually two households were to descend to Wardeef at the end of October, then to Neshtkhawar at the beginning of winter. In June they would move to Dehghulaman, their home village, stay a month there before moving up to Asan Katich in July, and move to Vagd Boi Khord at the beginning of September.

Table 14. Number of livestock attended by Wakhi in summer 2007 in 4 settlements in Big Pamir according to interviews.

Name of pasture area	Name of settlement	Sheep	Goat	Yak	Cattle	Bactrian camel
Senin	Zarnaw	480	150	44	0	0
	Subtotal (%)	49.0	41.4	27.1	0	0
Sargez valley	Dariah Sargez	80	42	17	0	0
	Subtotal (%)	8.2	11.6	10.4	0	0
Shikargah	Vagd Boi Khord	235	62	68	16	4
	Kund-a-Thur	185	108	33	27	0
	Subtotal (%)	42.8	47	62.5	100	100
	Grand Total	980	362	162	43*	4

*In addition households from Zarnaw and Dariah Sargez had respectively 45 and 9 cattle in their villages in Wakhan Valley.

Table 15. Comparison of livestock estimates in 4 Wakhi settlements in Big Pamir based on interviews versus direct counts.

Name of pasture area	Name of settlement	Methods	Sheep	Goat	Yak
Senin	Zarnaw	Interviews	480	150	44
		Counts[1]	497–503	161–169	46
		Error (%)	<10	<10	<5
Sargez valley	Dariah Sargez	Interviews	80	42	17
		Counts	–	–	–
		Error (%)	–	–	–
Shikargah	Vagd Boi	Interviews	235	62	68
		Counts	248–251	64	67
		Error (%)	<10	<5	<5
	Kund-a-Thur	Interviews[3]	185	108	33
		Counts	358–372	202–217	61–64
		Error (%)	>50	>50	>50
	Subtotal[3]	Interviews	900	320	145
		Counts	1103–1126	427–448	174–177
		Error (%)	18–20	25–28	17–18
	Grand Total count		1183–1206	469–490	191–194

[1]Direct count results correspond to three consecutive counts made by two observers ($N=6$). [2]Only interview estimates could be used for livestock of Dariah Sargez. [3]Calculated for interview results of 3 settlements.

Table 16. Numbers[1] of sheep, goats, yaks and cattle pasturing in Big Pamir in summer 2007 according to their geographic origin.

Species	Goz Khun	Shelk	Sargez	Rorung	Dehghulaman	Total
Sheep	480	65	120	80	235	980
Goat	150	50	58	42	62	362
Yak	44	10	23	17	68	162
Cattle	0	6	21	0	16	43
Total	674	131	222	139	381	1547

[1]Based on interviews of 15 households.

Table 17. Seasonal causes of deaths between summer 2006 and summer 2007, among sheep, goats, yaks and cattle in 15 Wakhi settlements of Big Pamir.

Species		Winter	Spring	Summer	Autumn	Total
Sheep	Starvation/Coldness	124	0	0	0	124
	Diseases	13	0	11	0	24
	Predation	10	11	6	1	28
	Other	4	3	0	0	7
Goat	Starvation/Coldness	54	0	0	0	54
	Diseases	0	1	0	0	1
	Predation	1	2	2	1	6
	Other	0	0	0	0	0
Yak	Starvation/Coldness	0	0	0	0	0
	Diseases	0	0	0	0	0
	Predation	12	1	0	1	14
	Other	3	0	0	0	3
Cattle	Starvation/Coldness	0	0	0	0	0
	Diseases	1	0	0	0	1
	Predation	0	0	0	0	0
	Other	0	0	0	0	0
	Total	222	18	19	3	262

Health status

As already mentioned in our 2006 report on Wakhi livestock in Big Pamir, three inter-related factors played important roles in the health status of the livestock herds we visited in 2007: 1/ seasonal variability in the availability and quantity of forage, 2/ occurrence of infectious diseases, 3/ and free mixing of animals from different villages in the same pasture during summer as well as mixing within these herds of diseased and healthy individuals. Health problems recorded in livestock during this survey were similar in occurrence and prevalence to what we already described for the rest of the Wakhi livestock population using Big Pamir (Ostrowski, 2006). We only provide here data on mortality and abortion in livestock surveyed in 2007. We did not collect blood samples this time.

Mortality and abortion

The surveyed households reported mortality of 183 sheep, 61 goats, 17 yaks and 1 cow for the year preceding the survey (summer 2006 – summer 2007). The main cause of death was starvation and coldness in winter which accounted for 67.9% of losses, followed by predation with 18.3% of deaths, diseases with 9.9% and other reasons with 3.8% (avalanche, post-surgery of castration, or unknown reasons) (Table 17).

Winter mortality — Our summer 2006 survey revealed that Wakhi livestock suffered significant losses during winter because of coldness and of the lack of forage. Out of the 55 households interviewed in Big Pamir in summer 2006, only 7 (12.7%) reported no losses during preceding winter. Similarly during the present survey only 2 (13.3%) households reported no losses during previous winter. The other lost 151 sheep, 55 goats and 15 yaks. Assuming a constant productivity and extrapolating summer 2007 estimates — diminished by 30% for sheep and goats and by 5% for yaks to account for animals bartered, sold or dead after summer — we estimated mortality rates at 18.1% for sheep, 16.4% for goats, and 8.2% for yaks in winter 2006–2007. These estimates were consistent with those made for winter 2005–2006 on a subset of 55 Wakhi households (that were 21% for sheep, 22% for goats, and 17.5% for yaks; Ostrowski, 2006). Although such rates seem considerable, several community leaders pinpointed that mortality of sheep and goats wintering in Pamir may reach 100% during very harsh winters. Starvation and coldness were perceived as the primary causes of winter mortality, accounting for 82.1% and 98% of deaths of sheep and goats respectively. Thirteen sheep and one goat died of diseases. Some deaths imputed to starvation may have been caused by undiagnosed chronic diseases affecting body condition. Mortality due to predation accounted for 10.4% of total losses in winter: 2 yaks were killed by a snow leopard; 10 sheep, 1 goat and 10 yaks were killed by wolves. Animals predated by wolves were usually unattended or on rare occasions killed during night in their corral.

Spring mortality — Compared with winter's mortality, mortality during spring 2007 was low, dominated by early spring abortions and sporadic cases of predation. Ten households (66.6%) reported abortions. Overall at least 25 sheep, 11 goats and 2 yaks aborted in spring 2007. Following the assumptions we made to estimate winter mortality rates, spring abortion may have affected 3.0%, 3.3% and 1.1% of sheep, goat and yak populations, respectively. Also 11 sheep, 2 goats, and 1 yak died of predation.

Summer mortality — Mortality level was similar in summer and spring. Respondents reported 17 sheep and 2 goat deaths. A total of 11 sheep died with severe diarrheas while 6 sheep and goats were killed by wolves. No abortions were reported.

Autumn mortality — Autumn is a period of transhumance and reacclimation to valley settlements. One sheep, one goat and one yak were killed by wolves during this period. No abortions were reported.

Data on equids

Numbers and origins

Wakhi keep a population of horses and donkeys in Big Pamir during summer which they ride or use as pack animals. Like yaks, equids and especially horses are a mark of prestige and thriving households may own several of them. Horses are expensive, costing 15,000 to 20,000 Afghanis (around 300–400 $US) each, and are often traded or sold to Kirghiz.

Out of the 15 Wakhi households surveyed during summer 2007, 6 (40.0%) owned no horses, 1 (6.7%) had one horse, 5 (33.3%) had two horses, 1 (6.7%) had three horses and 2 (13.3%) possessed four horses (median=2). Overall 9 (60%) households owned 22 horses. Sixteen horses were maintained in Big Pamir near settlements and 6 were left in villages. All surveyed households owned donkeys. The 15 households owned 47 donkeys distributed as: four households (26.7%) had one donkey, four (26.7%) had two, one (6.7%) had three, two (13.4%) had four, two (13.4%) had five, one (6.7%) had six, and one (6.7%) had eight (median=2).

Table 18. General data on downloaded GPS files of herds' locations collected in Big Pamir in summer 2007.

Settlement name	Period of deployment	[1]Effective deployment (%)	[2]Corrected database (%)	[3]Work effectiveness
Nakchirshitk	25 June – 17 September	57 / 85 (67.0)	165 / 739 (22.3)	2.9
Qabal Gah	20 June – 16 September	-- / 89	--- / 258	?
Darah Big	23 June – 16 September	-- / 86	--- / 269	?
Kund-a-Thur	22 June – 11 September	68 / 86 (79.0)	184 / 293 (62.8)	2.7
Mulung Than	22 June – 15 September	61 / 82 (74.4)	178 / 260 (68.5)	2.9

[1]Ratio of number of days with at least one location to number of days of theoretical deployment of the GPS unit. [2]Ratio of number of locations taken at least one hour apart to all locations collected. [3]Number of effective locations collected per effective days of deployment.

Analysis of equid ownership showed that only the most prosperous households owned horses (Ostrowski 2006). The present survey confirms this trend. The three households originating from Goz Khun who owned c. 40% of the surveyed population of sheep and goats also owned 45% of horses.

Health status and mortality

No health problems or deaths were reported in the surveyed population.

GPS tracking of sheep and goat herds in Big Pamir

Overview

We retrieved uneventfully the five GPS units provided to herders of Nakchirshitk, Qabal Gah, Darah Big, Kund-a-Thur and Mulung Than settlements. We downloaded 1819 locations; 739 collected in Nakchirshitk, 258 in Qabal Gah, 269 in Darah Big, 293 in Kund-a-Thur and 260 in Mulung Than. When reported to the number of days of deployment, it translated into 8.7, 2.9, 3.1, 3.5, and 3.0 locations/day for Nakchirshitk, Qabal Gah, Darah Big, Kund-a-Thur and Mulung Than, respectively. GPS units used in Nakchirshitk, Kund-a-Thur and Mulung recorded date and time for each location while those deployed in Qabal Gah and Darah Big only recorded locations. Upon examination of the files downloaded from the GPS recording date and time, we realized that: 1– Locations were missing for a number of days, 2– Locations were not systematically recorded at recommended times (6, 9 and 3), and 3– On several occasions, series of locations could be marked within couple of minutes. We homogenized datasets by deleting all fixes taken less than one hour apart and recorded the number of days with no data (Table 18).

Work evaluation

We compared the quality of the work of data collection performed in Nakchirshitk, Kund-a-Thur and Qabal Gah. The herder of Kund-a-Thur performed a better effective deployment of the GPS than other two herders; however the corrected database was slightly better in Mulung Than than in Kund-a-Thur (Table 18). We also examined the times of recording. Only 40/165 (24.2%) of the locations in Nakchirshitk were taken within 10 minutes of the recommended times, 137/184 (74.4%) for the locations of Kun-a-Thur and 124/178 (69.7) for the locations of Mulung Than (Figure 4).

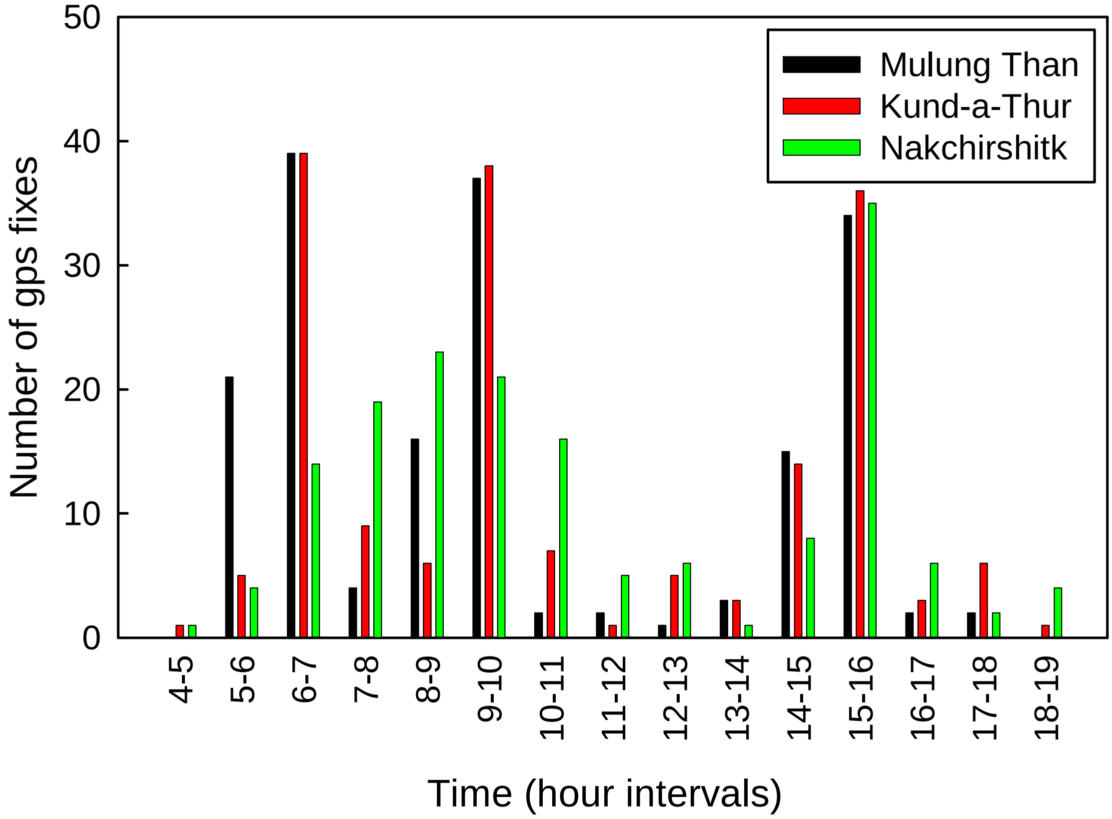

Figure 4. Daily temporal distribution of GPS locations of adult herds of sheep and goats from Nakchirshitk, Kund-a-Thur, and Mulung Than settlements, between mid June and mid September 2007 in Big Pamir pastures. The dataset includes 427 locations.

Range used by sheep and goat herds and grazing altitudes

In summer 2006 we visited the pasture areas indicated by herders during their interviews. If we noted livestock actively foraging in the area or found recent signs of their presence, the pasture was “confirmed”. Pastures that we could not visit were referred to as “provisional”. This year, we report about pasture use by evaluating qualitatively the data collected with the GPS units. Calculation of polygon surface estimates of the areas grazed by sheep and goats will be done after full completion of the study which we should conclude at the end of summer 2008.

Nakchirshitk — The collected data set shows the extent of the range used by a herd of c. 610 adult sheep and goats in summer 2007 (Figure 5). The herd visited sites located outside the global grazing area tentatively described in 2006 report (Ostrowski, 2006). The summer grazing area used by sheep and goats from Nakchirshitk seems to stretch significantly further to the south-east than previously hypothesized. This is noteworthy as the closest summer sightings of Marco Polo sheep in the area have been done in the southeast of the tentative grazing area. The northern part of the grazing area, at a relatively lower altitude, was less grazed during the study period. Lower altitude pastures may be grazed in spring. The average grazing altitude during the three summer months (July, August, and September) was 4390±243 m asl (min=3580 m, max=4946 m, N=165).

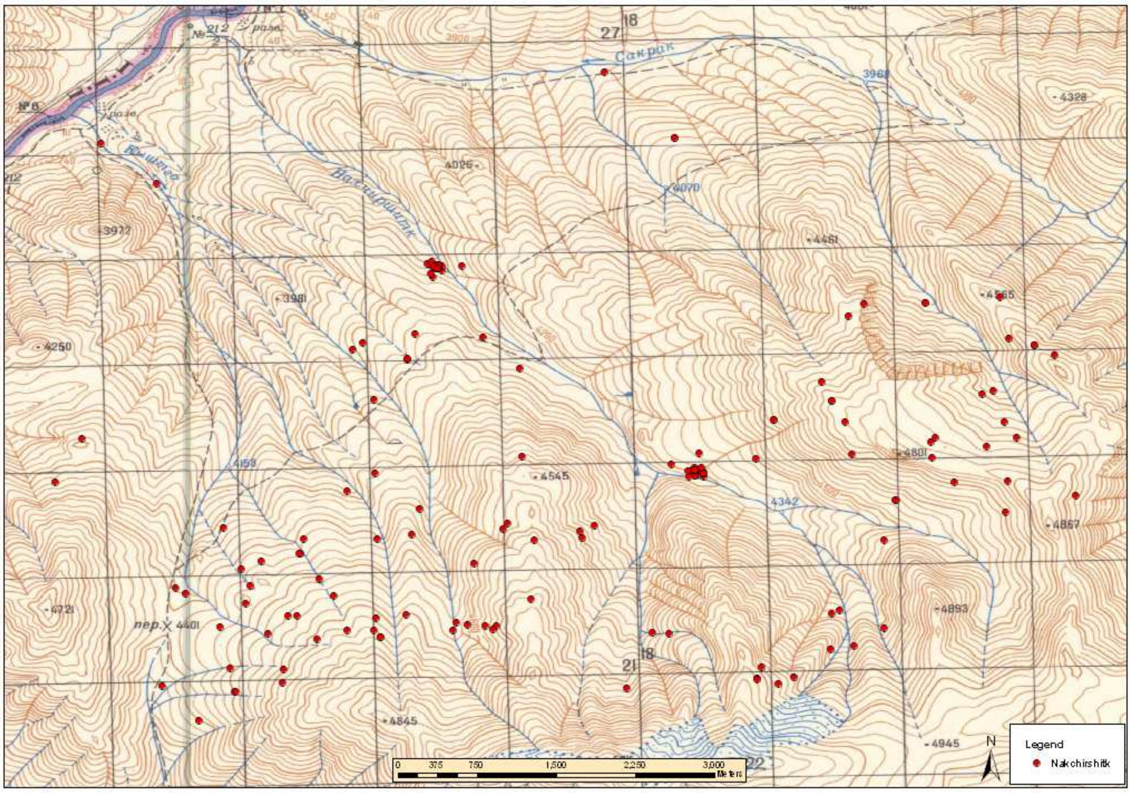

Figure 5. Map of the Manjulak area showing the geographic range used by the adult herd of sheep and goats of Nakchirshitk settlement between mid June and mid September 2007. The dataset represents 165 locations.

In Nakchirshitk, locations taken at recommended times were on average lower in altitudes than those taken randomly (4311±255 m vs. 4417±234 m; Wilcoxon Rank Sum Test, $P<0.04$). Although data collected at scheduled times account for less than 25% of the dataset, the effect of record time biases to some extent our estimation of average grazing altitude of this herd.

Kund-a-Thur — Data collected show that the range used by the herd of c. 350 adult sheep and goats was poorly estimated from 2006 discussions with herders. This herd grazes on the right side of the Istimoch River, in west Shikargah valley. The actual range use, drawn from GPS locations, stretches further down in the valley than previous estimate, as well as on the south-west facing slopes of the adjacent mountain mass (Figure 6). The average grazing altitude during summer was 4319±115 m (min=4142 m, max=4739 m, N=184). The average altitude of fixes taken at recommended times did not differ from that of fixes randomly taken (4317±106 m vs. 4320±124 m; Wilcoxon Rank Sum Test, $P=0.62$). Altitudes varied significantly with time (i.e. 6, 9, 3, random; Kruskal–Wallis one way AOV, 20.91, $P<0.01$). A post-hoc pair-wise comparison ($\alpha=0.05$) showed that the herd used significantly lower pastures at 9 (4269±124 m).

Mulung Than — The collected data set shows the range used by c. 260 adult sheep and goats during summer 2007 (Figure 7). The grazing area approximated from discussions with herders in summer 2006 matched fairly well the grazing area drawn from GPS data.

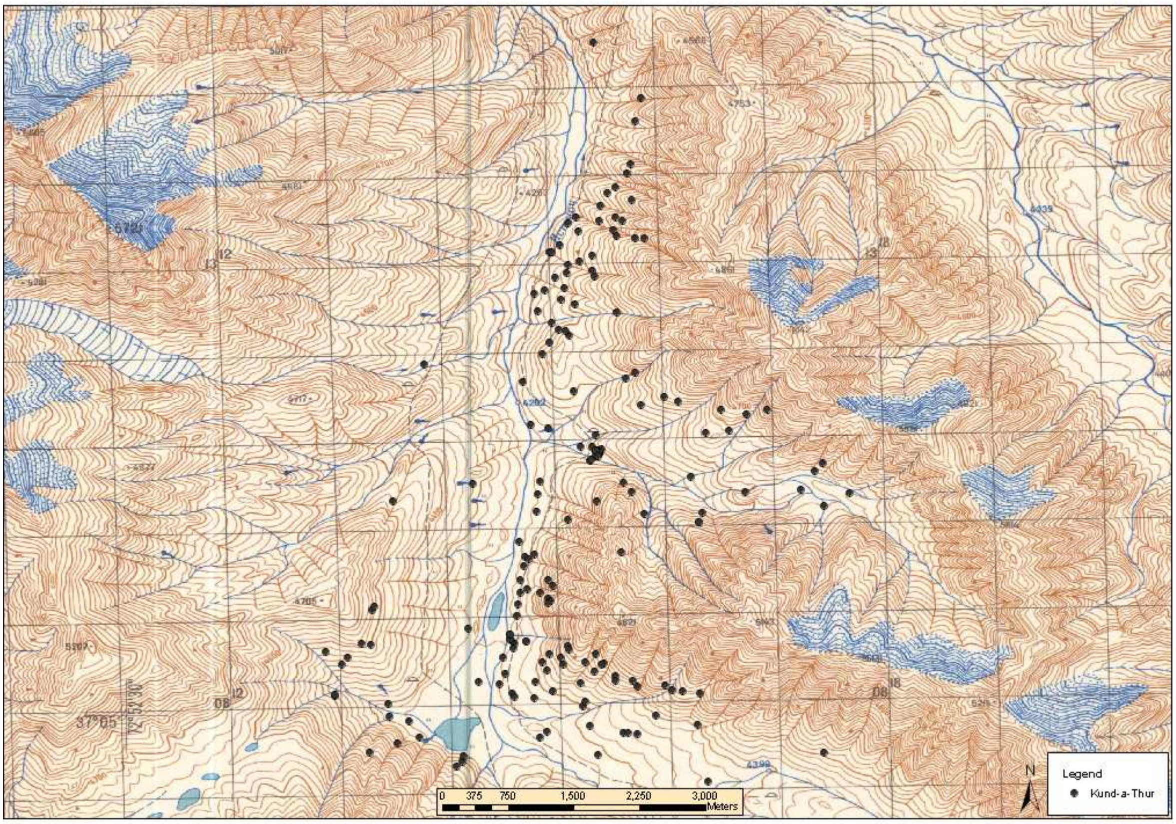

Figure 6. Map of west Shikargah area showing the geographic range used by the adult sheep and goats of Kund-a-Thur settlement between mid June and mid September 2007. The dataset represents 184 locations.

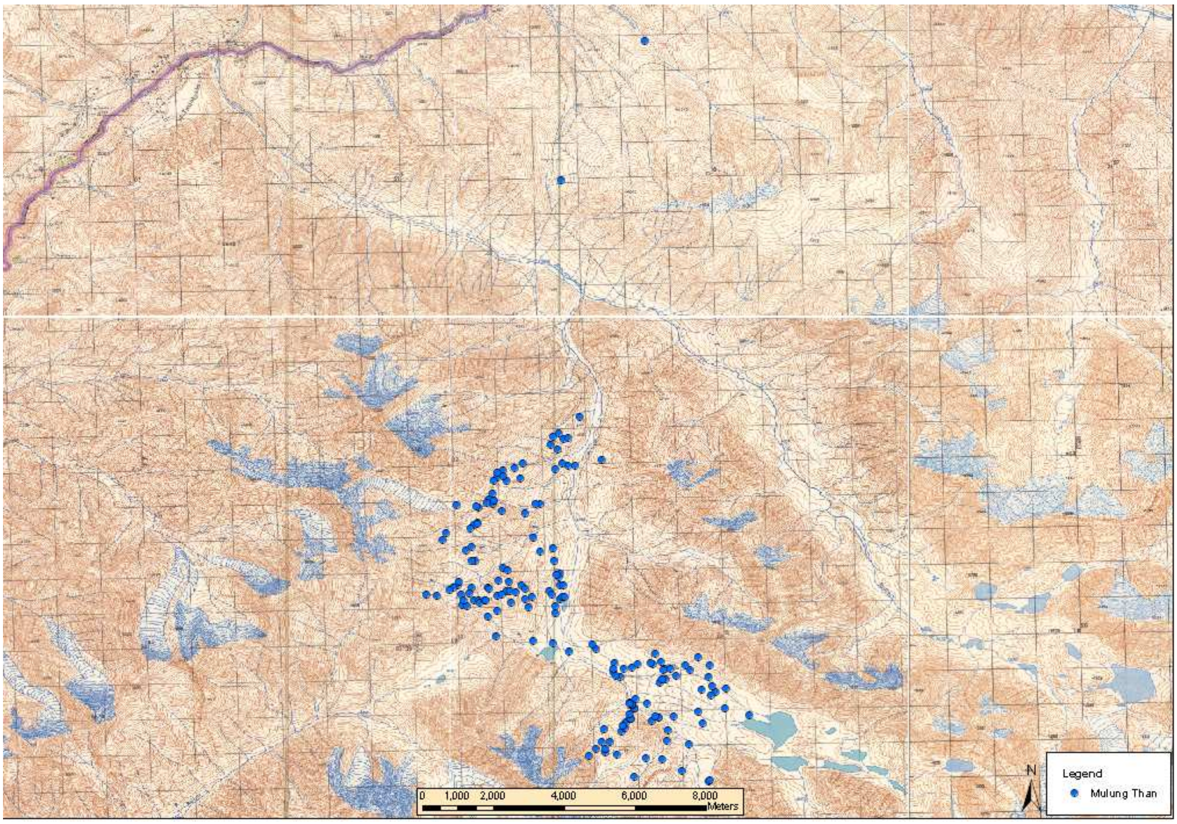

Figure 7. Map of west Shikargah area showing the geographic range used by the adult herd of sheep and goats of Mulung Than settlement between mid June and mid September 2007. The dataset represents 178 locations.

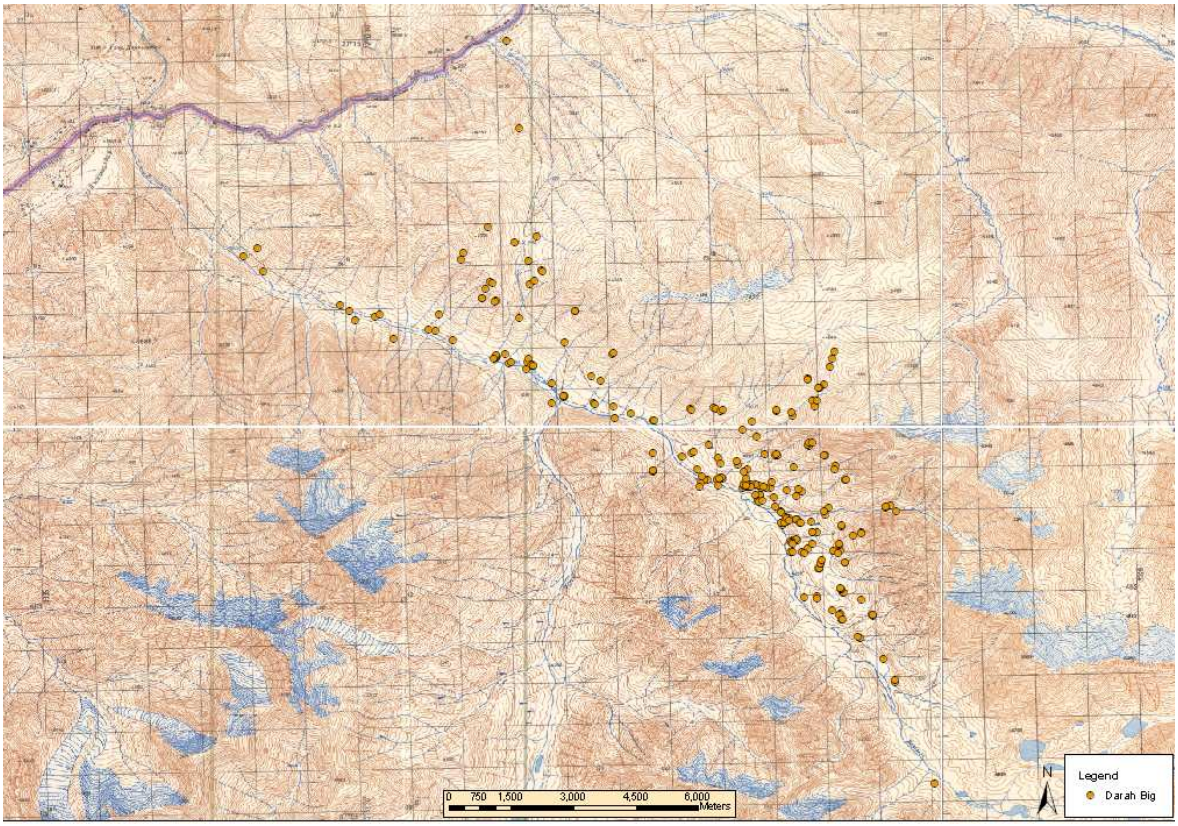

Figure 8. Map of east Shikargah area showing the geographic range used by the adult herd of sheep and goats of Qabal Gah settlement between mid June and mid September 2007. The dataset represents 258 locations.

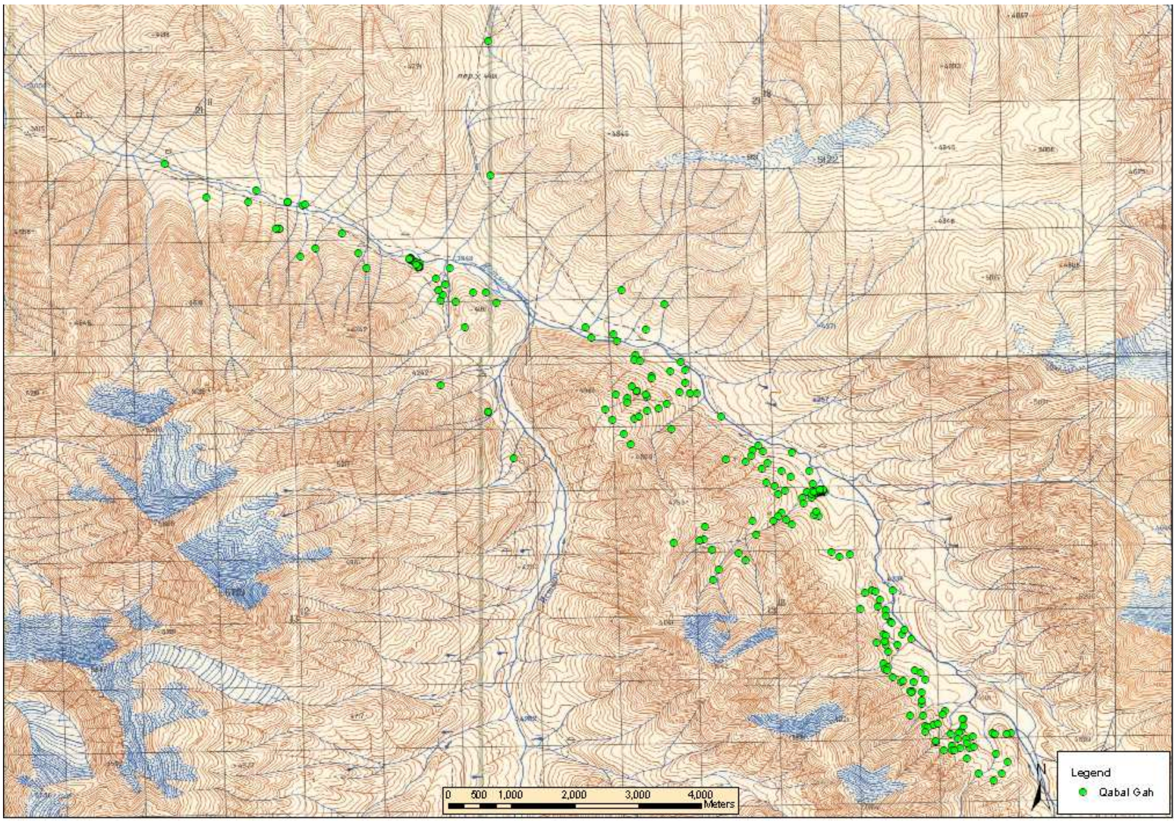

Figure 9. Map of east Shikargah area showing the geographic range used by the adult herd of sheep and goats of Darah Big settlement between mid June and mid September 2007. The dataset represents 268 locations.

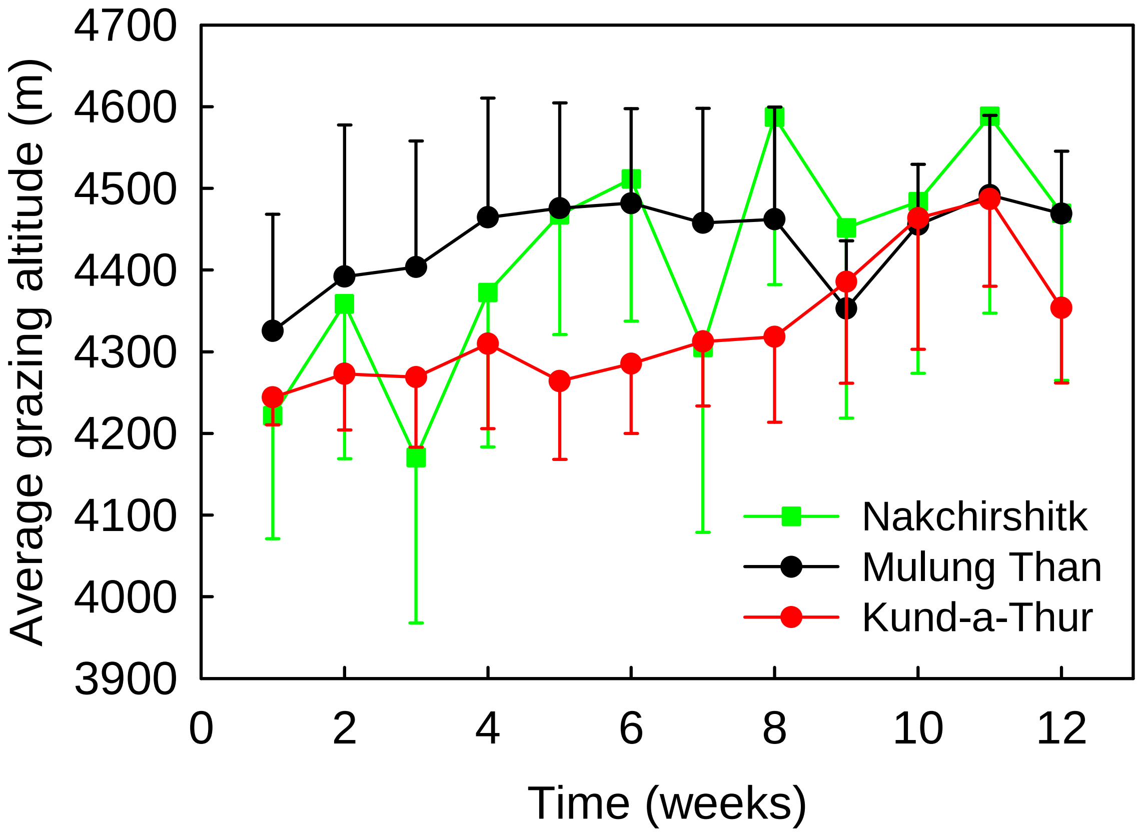

Figure 10. Average grazing altitudes of 3 herds of adult sheep and goats during summer 2007 (12 weeks).

Thanks to the collected data, the upper grazing area (c. 6 km^2) considered as "provisional" in earlier estimates is upgraded to "confirmed" status. The average grazing altitude was 4432±133 m (min=4052 m, max=4732 m, N=178). Locations taken at recommended times were on average at lower altitudes than those taken randomly (4419±126 m vs. 4470±146 m; Wilcoxon Rank Sum Test, $P<0.03$). As for the dataset of Nakchirshitk the effect of record time may bias to some extent our estimation of average grazing altitude of this herd. Altitudes varied significantly with time (i.e. 6, 9, 3, random; Kruskal-Wallis one way AOV, 14.2, $P<0.03$). A post-hoc pair-wise comparison ($\alpha=0.05$) showed that the herd used significantly higher pastures at 9 (4474±120 m) than at 6 (4403±104 m) and 3 (4392±148 m).

Darah Big and Qabal Gah — Range use of sheep and goat herds in these two areas is less thoroughly described, as GPS units provided to herders did not record date and time of location fixes. Both herds use pastures in the relatively narrow Istimoch valley. Darah Big herd of c. 550 sheep and goats uses the right side of the river and the south-western slopes of the valley to a larger extent than previously described (Figure 8). In particular the lower reaches of the valley are also used during summer and not exclusively reserved to winter grazing as initially thought. Similarly, upper reaches of the western tip of the Manjulak grazing area seem also exploited by this herd. Similar observations are made for the c. 800 animal herd of Qabal Gah but on the other side of the river and on north-east facing slopes of the mountain massif (Figure 9). During the study period, these two herds made no use of the upper Istimoch valley, described as a "provisional" grazing area (c. 12 km^2) in 2006 report (Ostrowski, 2006). This is an important observation because Marco Polo sheep were observed in this area during summer 2006 (Habib, 2006). Average grazing altitudes in Darah Big and Qabal Gah were 4266±227 m (min=3578 m, max=4862 m, N=269) and 4202±194 m (min=3819 m, max=4595 m, N=258), respectively.

When comparing grazing altitudes of the different herds, we recognized a general trend of grazing altitude increasing with time in summer (Figure 10). On average sheep and goat herds were using higher pastures at the end of summer. Although the trend was similar in different herds, the average grazing altitude in summer was significantly higher in Mulung Than and Nakchirshitk than in Kund-a-Thur and Darah Big, livestock from Qabal Gah grazing at lowest average altitude of all surveyed herds (Pair-wise comparison of Kruskal-Wallis one way AOV, 163.2, $P<0.01$).

DISCUSSION

Number of livestock in Big Pamir during summer

Accurately estimating the number of livestock present in Big Pamir is central to our understanding of grazing pressure, possible competition with wild ungulates and risk of disease transmission between livestock and wild ungulates. Two estimates of the overall number of livestock pasturing in Big Pamir were so far available, both drawn from studies carried out during summer 2006. The first was proposed by the WCS Community Conservation mission (Mock et al., 2006). It is based on interview estimates and doest not take into account livestock sold to traders but still present in the area, or livestock present in the Senin/Zarnaw grazing area. The second was proposed by the WCS Ecosystem Health team (Ostrowski, 2006). It is based on direct counts except for herd sizes in Kund-a-Thur, Mulung Than and Asan Katich, which were estimated from interviews. It does not include livestock present in Senin/Zarnaw grazing area or in Dest Ghar. The Community Conservation team estimated the livestock population present in Western Big Pamir at 6808–6858 small ruminants and 693 yaks (Mock et al., 2006), whereas, discriminating between sheep and goats we came up with estimates of 6179–6327 sheep, 1596–1709 goats (overall 7775–8036 small ruminants) and 702–722 yaks (Ostrowski, 2006). Our estimates were on average 20% for small ruminants and 3% higher for yaks.

In view of the data we collected during summer 2007, several retrospective adjustments to our 2006 livestock population estimates can be done. For livestock in Asan Katich (present in Vagd Boi settlement at the time of our visit in 2007), we estimated the population at 248–251 sheep, 64 goats and 67 yaks in summer 2007. This is slightly lower than the estimates provided by the Community Conservation team for Asan Katich in summer 2006: 370 sheep and goats, and 78 yaks (Mock et al. 2006). However their results also included animals from the households of Rorung village whom we met this year in Sargez valley. When we sum the number of animals herded in Vagd Boi and in Dariah Sargez in summer 2007, we reach a total of 328–331 sheep, 106 goats and 84 yaks, figures close to those proposed by Mock et al. (2006) for summer 2006. Concerning the livestock population in Kund-a-Thur, we did not visit this settlement in 2006 and based our estimates of 250 sheep, 90 goats and 41 yaks on interviews of livestock owners carried out in late autumn 2006. Our summer 2007 counts recorded 358–372 sheep, 202–217 goats and 61–64 yaks for this settlement. These numbers are significantly higher than our 2006 estimates, but again very close to Mock et al. (2006) interview estimates of 580 sheep and goats and 60 yaks in summer 2006. This suggests that our 2006 estimates for this settlement may have been underestimated. Eventually concerning livestock from Mulung Than, our estimates suggested 203 sheep, 56 goats and 61 yaks whereas Community Conservation estimates were significantly higher for small ruminants, with 580 sheep and goats, and 60 yaks. We assume that the discrepancy between these two estimates of sheep and goats came from the fact that respondents reported inadequately to us about the number of juvenile animals in this herd (Dr Ali Madad pers. obs.). Although we acknowledge that comparing livestock numbers one year apart is perilous, given that mass mortality episodes are not unusual in winter in the area, Wakhi interviewed during the present survey denied having lost unusually high numbers of livestock during winter 2006–2007. Taking into account this observation, we hypothesize that livestock in summers 2006 and 2007 were comparable in numbers, authorizing some level of extrapolation. We therefore propose that our interview estimates for livestock numbers in Asan Katich, Kund-a-Thur and Mulung Than in summer 2006 were likely less accurate than those collected by Mock et al. (2006) and recommend to use their estimates for these three settlements.

When we correct our 2006 livestock population estimates for Big Pamir (Ostrowski 2006) using the livestock estimates proposed by Mock et al. (2006) for Asan Katich, Kund-a-Thur, and Mulung Than, we obtain a total number of 8200–8461 sheep and goats and 728–743 yaks in Big Pamir in summer 2006. Combining data from Mock et al. (2006), Ostrowski (2006) and our present study is probably one way to better approximate the population size of Wakhi livestock using Big Pamir. We propose to use: 1– Community Conservation team estimates based on summer 2006 interviews for livestock in Asan Katich, Kund-a-Thur, Mulung Than and Dest Ghar settlements (Mock et al., 2006), 2– Ecosystem Health team estimates based on summer 2006 direct counts for livestock of all other settlements in Jermasirt, Manjulak and Shikargah grazing areas based on the assumption that direct counts provide more accurate data than interview results (Ostrowski et al., 2006), 3– Ecosystem Health team estimates based on summer 2006 direct counts for livestock purchased by traders (Ostrowski et al., 2006); and 4– Ecosystem Health team estimates based on summer 2007 direct counts for livestock in Senin/Zarnaw grazing area (present study), assuming no significant changes in numbers occurred between summers 2006 and 2007 in this population (Wali Jon, per comm.). Our final estimate for the total number of sheep and goats present in western Big Pamir in summer 2006 are 9258–9533 sheep and goats: 5973–6127 sheep, 1561–1682 goats, and 1724 sheep or goats (undetermined). For yaks, total estimate is 787–807 animals. These estimates are probably the most accurate figures ever produced for this population of livestock. For sheep and goats they are on average 19% and 37% higher than Ecosystem Health team and Community Conservation team 2006 estimates, respectively.

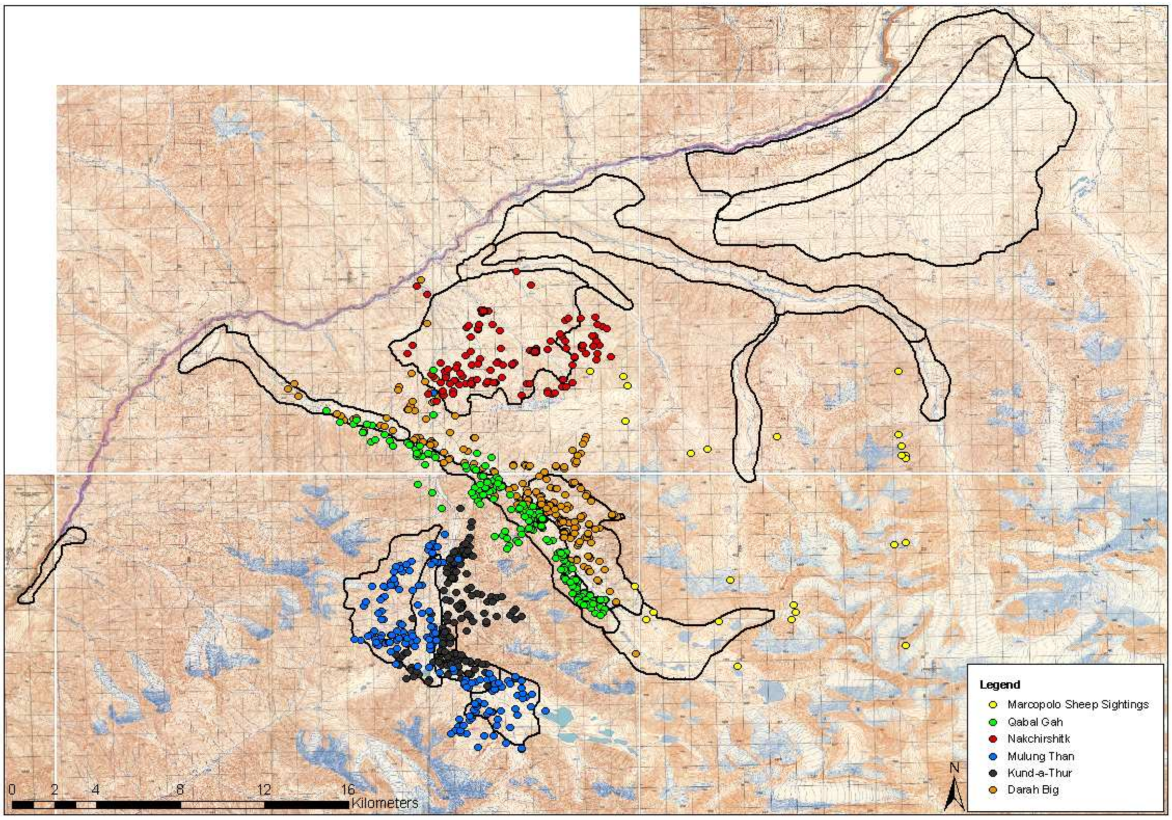

Figure 11. Map of Wakhi pasture areas in Big Pamir showing the geographic range used by adult herds of sheep and goats of five major settlements reported by Wakhi herders. Pasture areas, as hypothesized from interviews carried out in summer 2006, are shown in slid contour lines. The most northern pasture area corresponds to Jermasirt where no livestock was tracked during summer 2007. Locations of Marco Polo sheep sightings (*N*=25) were recorded in summer 2006 and 2007 by Drs Habib and Harris (WCS).

Livestock mortality due to predation

Annual predation mortality in Wakhi livestock pasturing in Big Pamir was estimated at 18.3% for the 15 households interviewed in 2007 (Table 17). Overall, predators killed 28 sheep, 6 goats and 14 yaks in a year. This is much higher than our 2006 estimate (<2.5%) based on a subset of 55 households. It is also higher, although less strikingly, than the 11.7% of annual predation mortality estimated for Wakhi livestock in Little Pamir through the 42 household interviews carried out in September 2007 (Part II). When comparing predation mortality in Wakhi livestock estimated from our surveys, one every 43 sheep was predated in 2006–2007 in Big Pamir (15 interviewed households), one every 69 sheep in 2007 in Little Pamir (42 interviewed households), and one every 260 sheep in 2005–2006 in Big Pamir (55 interviewed households). Those rates are remarkably low compared to that estimated in Kirghiz livestock of Big Pamir in 2007 where 1 every 27 sheep was killed by a predator.

What are the reasons underlying the high discrepancies in predation mortality reported in Wakhi livestock? One may speculate that Wakhi interviewed during our second survey may have voluntarily inflated the number of livestock lost through predation because they hope for some compensation. Predator densities may have also varied significantly between study periods and study areas but we lack information on that issue. We have also envisioned that livestock surveyed in Big Pamir and Little Pamir in 2007 might have been more exposed to predators than those surveyed in Big Pamir in 2006. If we assume a higher risk of wolf predation for livestock staying in Pamirs during winter and a uniform distribution of predators throughout mountain ranges, our predictions would be that livestock from Little Pamir should suffer the highest level of predation. However, this hypothesis is not supported by the data we have collected in 2007. While about 65% of Wakhi livestock in Little Pamir stay in high altitude pastures during winter, predation mortality was estimated at 11.7% versus 16.4% for Wakhi livestock in Big Pamir, although only 30–35% of them winter in Pamir. Another explanation for the observed discrepancies and particularly for the very low livestock predation level recorded in 2006 in Wakhi livestock may come from our methodology. Since our 2006 survey, we have markedly improved the formulation of the questions documenting cases of predation. Indeed, we have had some indications, from the answers of duplicated questionnaires proposed to the same people three months apart (see Ostrowski, 2006) that predation cases in winter 2005–2006 had been either inconsistently reported or incorrectly transcribed. This would suggest that the mortality due to predation in Wakhi livestock of Big Pamir was probably underestimated in 2006. The question of carnivore predation on livestock in the Pamir ecosystem will need more investigations, ideally spanning over longer periods of time, in order to accurately discriminate between spatio-temporal variability and genuine trends.

Range use of livestock

None of the herders committed to record the position of their herds with GPS units failed in their duties. They did it with variable efficacy but always to the best of their availability. During the re-deployment of the GPS units at the end of October 2007 we tried to adjust a number of problems we diagnosed from analyzes of summer downloaded files. Especially we provided guidance to the involved herders to improve data recording consistency between days, and increase the number of effective data recording days per deployment session. Winter will perhaps prove easier for herders to record data consistently as the level of extra-herding activities is reduced.

Data collected during summer 2007 extend our knowledge and understanding of the range used by livestock in Big Pamir. All but one grazing area proved significantly larger than hypothesized in 2006 from interviews with herders (Figure 11). In particular we have discovered that summer occupation extends much further into the lower reaches of the main valleys than initially projected. Indirectly it suggests that winter pastures are probably at lower altitudes than we thought. Although they are too few to provide an accurate understanding of their range use, observations of Marco Polo sheep in summer 2006 (Habib, 2006) and summer 2007 (Harris, pers. comm.) suggest that domestic small ruminants and wild sheep do not share the same grazing areas at least in summer (Figure 11). This hypothesis is based on several debatable assumptions, an important one being that Marco Polo sheep avoid livestock grazing areas in summer even at night. In winter, the meager amount of remaining accessible forage may increase the level of competition with livestock and bring domestic and wild ungulate populations to interact more directly. It is also possible that wild sheep move to the south-eastern facing slopes of Big Pamir in Tajikistan where competition with livestock may be lower. As a matter of fact we know very little about possible winter interactions and it therefore appears primordial to document as soon as possible the winter range used by livestock and as far as possible by Marco Polo sheep.

CONCLUSION

We improved the accuracy of estimates of Wakhi livestock populations in Big Pamir. These estimates will be useful when comparing the impact of different populations on the range and the risk of disease transmission to wild ungulates. Next step would be to accurately evaluate the number of livestock remaining in Big Pamir during winter, when likelihood of contacts between wild and domestic ungulates may increase. We should also try to improve our knowledge of the range use of free-ranging cattle and yaks in Big Pamir. Cattle and yaks are reported to roam free in Pamirs during summer and may be in closer contacts with wild ungulates than attended livestock. Eventually we have shown that the works achieved by the Community Conservation team and the Ecosystem Health team —who use two different methodological approaches to estimate livestock population sizes— bring complementary information and can actually be used in conjunction to better understand livestock demography in Big Pamir.

Data on range use of sheep and goats as collected with hand-held GPS units are promising. We redeployed GPS units between 30 October and 2 November 2007 with herders of seven livestock populations using Big Pamir in winter. We hope to learn about the range used by small ruminants during this season and perhaps to extend these investigations to spring and summer 2008. Results will help assess grazing densities, disease risk and indirect impact on Marco Polo sheep distribution. The next step is to fix GPS collars on 6 to 8 free-ranging yaks in spring 2008 to assess their movements, privileged grazing areas and level of encroachment into what is known of wild ungulate territory in Big Pamir.

PART IV. AMBIENT TEMPERATURES IN WAKHAN IN 2007

INTRODUCTION

Climate in Afghanistan is typical of semiarid steppe climates in Central Asia. It is characterized by extremely cold winters and hot summers. There are many regional variations, however. The mountain regions of the northeast have among the coldest weather conditions in the country, as is observed in subarctic climate with dry and very cold winters. The weather in the Wakhan Valley and Pamirs is poorly known, but it is said to be arid and continental, and marked by great differences in seasonal and diurnal temperatures (Shahrani, 2002). There is unfortunately no meteorological station in Wakhan District (Badakhshan Province). Summers are apparently short with daytime summer temperature reaching commonly 30°C to 40°C in July and August (Shahrani, 2002). In winter, temperatures are remarkably cold, falling as low as –25°C to –30°C during night, while during day temperature usually remain at around –15°C (Olufsen, 1969 cited in Shahrani, 2002). Weather conditions directly affect Kirghiz strict pastoralists and to a lesser extent Wakhi agro-pastoralists. During very severe winters both groups may lose large numbers of livestock, which affects directly their economy and in turn pasture recovery and range use. Extreme temperatures may also impact wildlife, and when coupled to other limiting factors such as overhunting or overgrazing, may bring small threatened populations to the brink of extinction. It is therefore important to learn about weather in Wakhan and Pamirs and in particular about seasonal average temperature and range of temperature variations.

Plate 14. Electronic data logger (#6) installed in Ilgonak Valley, Big Pamir, on 9 July 2007. Note the white radiation shield. WCS Ecosystem Health team camp is visible in the foreground surrounded by hundreds of livestock.

Table 19. Information on electronic temperature loggers deployed in upper Wakhan and Big Pamir since 2006.

#	Period of deployment	Location	Coordinates	Altitude (m)	Remarks
1[3]	1 Dec. 06 – 16 Jul. 07	Kret village	43S 318756 4091134	2971	Near WCS facility
2[3]	16 Jul. 07 –	Kret village	43S 318756 4091134	2971	Replacing #1
3	5 Dec. 06 – 16 Jul.07	Avgarch village	43S 297568 4096187	3178	Removed definitively 16 July 07
4[3]	29 June 07 –	Upper Aba Khan Valley	43S 326184 4115198	4458	Deployed by Dr. R. Harris
5	14 Dec. 06 – 19 May 07	Tila Bai Valley	43S 345997 4131044	4050	[1]Provided to Kirghiz on 2 Dec. 06
6	9 July 07 -	Ilgonak Valley	43S 350092 4137191	4230	[2]It is #5 redeployed at a new location

[1]This logger was provided to Mr. Mengi Boy, Kirghiz, on 2 Dec 06 at Goz Khun. It reached Tila Bai wintering site on 7/8 December and was effectively deployed near the camp on 14 Dec 2006. [2]Logger #6 is actually logger #5 that was redeployed in Ilgonak the summer grazing site of Mr. Mengi Boy. The logger was moved from Tila Bai to Ilgonak on 7 July 07. [3]Measure both air and ground temperatures.

OBJECTIVES AND METHODS

Objectives

The objective of the study is to document with reliable quantitative data the air temperatures prevailing in upper Wakhan and Big Pamir at different seasons. We plan to record air temperatures for three consecutive years. Raw data will be made available to the public as soon as possible after the completion of the study.

Methods

We deployed three electronic thermometers coupled to a data logging system (Hobo Pro Series, Onset, Pocasset, MA, USA) in upper Wakhan and Big Pamir in December 2006. A fourth logging system was set up in June 2007 by Dr. R. Harris (Marco Polo Conservation team) in Big Pamir (Table 19 and Figure 12). The loggers have a recording range of –30°C to +50°C, an accuracy of ±0.2% at 25°C, and a resolution of 0.02°C at 25°C. We programmed the loggers to record temperatures every 15 minutes. The three loggers deployed in 2006 were protected in a standard white plastic radiation shield (Onset, Pocasset, MA, USA) (Plate 14), whereas the logger deployed in 2007 was fixed on the north side of a rock so as it never receives direct sunlight. The four loggers measured ambient air temperature at shade, two of them also measuring ground temperature via an external thermistor inserted 1.5 cm deep in the ground and connected to the logger by a 2-m cable. We assume that three loggers were still operating at the end of 2007. One logger (#3) located in upper Wakhan in December 2006 was removed in July 2007 (Table 19). Data of logger #3 and ground temperatures are not provided in this report.

We downloaded loggers via a serial port connection with a laptop computer. Data were first stored in .dtf format using Boxcar 4.3 software, and then transferred into .xls format files before being analyzed with Statistix 8.1 software. Figures were prepared with Sigma Plot 2000 software.

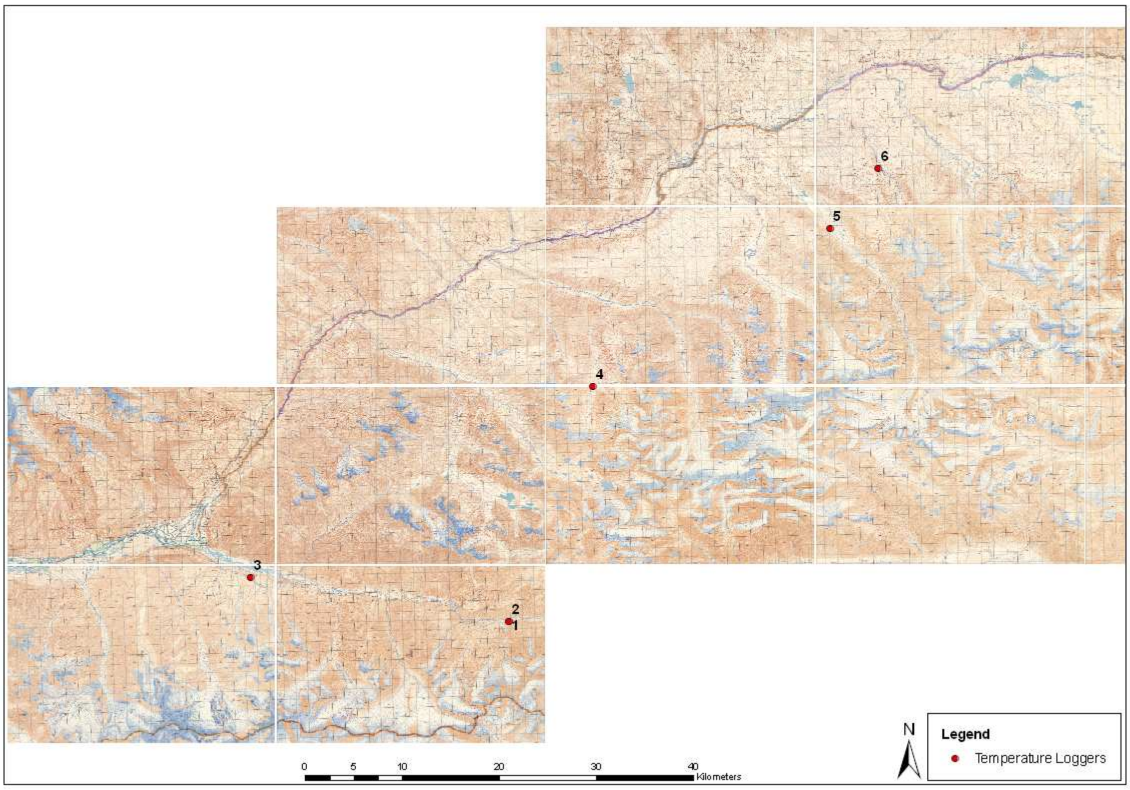

Figure 12. Map of upper Wakhan and Big Pamir showing locations of electronic temperature loggers deployed in 2006 and 2007: 1-Wakhi village of Kret, upper Wakhan; 2-Wakhi village of Kret, upper Wakhan (redeployment of logger #1); 3-Wakhi village of Avgarch, upper Wakhan; 4-Higher reaches of Aba Khan Valley, Big Pamir (Marco Polo Sheep summer area); 5-Kirghiz settlement of Sang-e-Kalan, Tila Bai Valley, Big Pamir; 6-Kirghiz settlement of Ilgonak Valley, Big Pamir (redeployment of logger #5).

RESULTS

Upper Wakhan

Temperature logger #1 was deployed in Kret village, upper Wakhan (2971 m asl) in Wakhan district, at the beginning of winter, on 1 December 2006, at 00:11. It stored without discontinuity 21847 data points for 156 days 18 hours and 15 minutes (32 weeks rounded down) until 16 July 2007 at 14:41 when we downloaded the data set. We immediately re-launched the logger (#2) at the same location and it stored an additional set of 9700 data points for 101 days 0 hours and 45 minutes (14 weeks) between 16 July 2007 at 15:49 and 25 October 2007 at 16:34. Again we retrieved the data on 25 October 2007 upon our visit to Kret village and re-launched it. Monthly descriptive statistics of nearly 11 months of continuous temperature recording (total 31547 data points) are provided in Table 21.

Average T_a reached minimal values in January 2007 with an absolute minimum at –20.3°C recorded on 5 January at 7:11. From January to August, average T_a increased progressively (Figure 13) with an absolute maximum at 29.6°C recorded on 16 July at 13:56.

Table 20. Monthly air temperatures (°C) recorded in Kret, upper Wakhan between 1 December 2006 and 25 October 2007.

Month	Mean T_a±SD	Mean day T_a±SD	Mean night T_a±SD	Min. T_a (Date - Time)	Max. T_a (mm/dd – hh:mm)
December	-8.5±4.9	-6.8±4.6	-9.4±4.7	-18.8 (12/11 – 05:26)	1.2 (12/29 – 13:56)
January	-10.2±4.7	-8.1±5.0	-11.7±3.8	-20.3 (01/05 – 07:11)	2.8 (01/29 – 13:56)
February	-3.2±3.6	-1.4±3.8	-4.6±2.8	-12.4 (02/16 – 06:56)	9.7 (02/02 – 13:26)
March	-0.1±4.6	1.8±4.6	-2.1±3.6	-13.0 (03/02 – 06:41)	13.7 (03/28 – 13:41)
April	7.7±6.1	9.8±6.2	5.0±4.6	-6.1 (04/02 – 05:11)	22.3 (04/14 – 16:11)
May	11.1±5.0	12.2±5.3	9.4±4.0	1.9 (05/25 – 05:26)	25.0 (05/15 – 16:11)
June	15.4±4.9	16.2±5.1	14.2±4.3	5.4 (06/06 – 04:56)	27.6 (06/24 – 16:41)
July	16.4±4.2	17.3±4.6	15.2±3.3	7.7 (07/08 – 06:11)	29.6 (07/16 – 13:56)
August	16.8±3.7	17.8±4.1	15.6±2.8	8.8 (08/18 – 05:34)	25.9 (08/11 – 16:19)
September	12.9±5.0	14.0±5.3	11.7±4.3	-1.2 (09/29 – 07:19)	24.8 (09/16 – 15:49)
October[1]	5.1±3.6	6.3±4.1	3.9±2.7	-2.6 (10/22 – 07:04)	14.5 (10/19 – 14:19)

[1]Measurements for the first 25 days only.

During the recording period, T_a was on average below freezing point between December 2006 and February 2007. T_a was consistently above 0°C only after the end of March, but could occasionally drop to below-freezing point values until the end of April (Figure 13). By the end of the recording period, in October 2007, T_a was still above 0°C.

In January, minimum air temperature ($T_{a,min}$; mean=–13.9±3.5°C) occurred 15 minutes before dawn at 6:45, and maximum air temperature ($T_{a,max}$; mean=–4.1±3.6°C) occurred at 15:00, on average 2.5 hours before sunset (Figure 14). In April, minimum air temperature ($T_{a,min}$; mean=1.6±2.9°C) occurred at 6:15 just less than an hour before dawn, and maximum air temperature ($T_{a,max}$; mean=14.9±5.7°C) occurred at 15:30 on average 1.5 hours before sunset (Figure 14). In July, minimum air temperature ($T_{a,min}$; mean=11.5±1.8°C) occurred at 5:45 an hour fifteen minutes after dawn, and maximum air temperature ($T_{a,max}$; mean=21.8±3.3°C) occurred at 16:15 on average 2 hours before sunset (Figure 14). Eventually in October, minimum air temperature ($T_{a,min}$; mean=0±1.0°C) occurred between 6:15 and 6:30 just less than an hour after dawn, and maximum air temperature ($T_{a,max}$; mean=10.1±2.8°C) occurred between 14:30 and 15:30 on average 1.5 hours before sunset (Figure 14). Mean diurnal T_a , $T_{a,max}$ and $T_{a,min}$, were higher in July than in January, April and October, lower in January than in July, April and October, and not significantly different in April and October (Kruskal–Wallis one way AOV, $P<0.001$; with post-hoc pair-wise comparison, $\alpha=0.05$). Mean amplitude of daily T_a variation was higher in April (14.5±4.2°C) than in January (10.8±4.4°C), July (11.2±3.0°C) and October (10.9±3.0°C) ($P<0.001$).

Like Kirghiz, Wakhi from Kret considered winter 2006–2007 as “normal” in term of harshness.

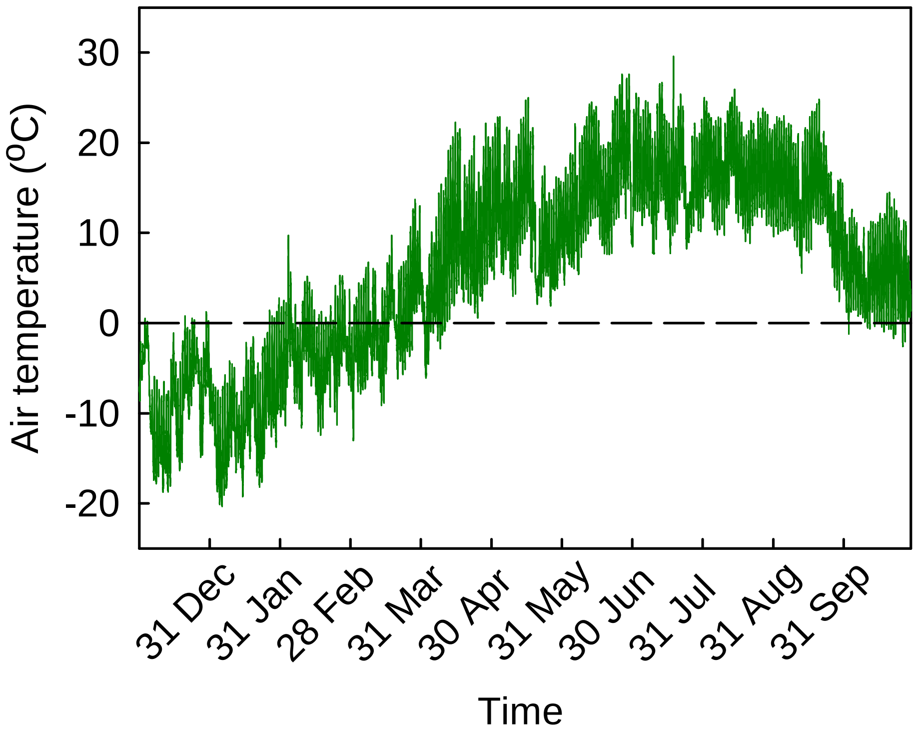

Figure 13. Air temperature recorded every 15 minutes in Kret, upper Wakhan between 1 December 2006 and 25 October 2007. The dotted line represents freezing-point.

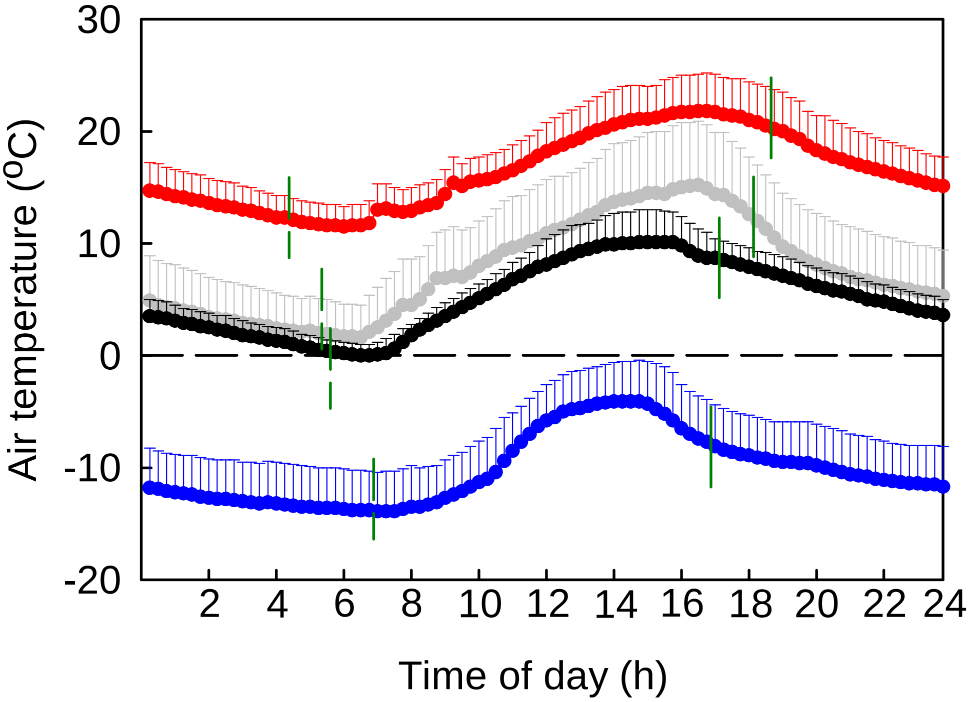

Figure 14. Average air temperature versus time of day in Kret, upper Wakhan for January (blue), April (grey), July (red) and October (black) 2007. Vertical dotted lines and solid lines represent sunrise and sunset times, respectively. Values are means +SD.

Table 21. Monthly air temperatures (°C) recorded in Sang-e-Kalan, Tila Bai Valley, Big Pamir between 14 December 2006 and 19 May 2007.

Month	Mean T_a ±SD	Mean day T_a ±SD	Mean night T_a ±SD	Min. T_a (Date - Time)	Max. T_a (mm/dd – hh:mm)
December[1]	-14.9±4.9	-13.2±4.7	-16.1±4.8	-26.4 (12/19 – 05:41)	-5.2 (12/15 – 12:41)
January	-19.4±4.5	-17.4±4.6	-20.9±3.8	-29.1 (01/03 – 07:41)	-7.2 (01/18 – 13:11)
February	-12.8±4.4	-11.2±4.3	-14.1±3.9	-24.1 (02/16 – 06:41)	-1.8 (02/02 – 12:56)
March	-9.1±5.7	-7.6±5.6	-10.7±5.4	-26.3 (03/02 – 07:41)	6.1 (03/30 – 13:41)
April	-0.6±6.0	0.8±6.3	-2.4±5.1	-16.5 (04/03 – 03:41)	13.4 (04/28 – 15:11)
May[2]	5.3±5.0	6.7±5.4	3.4±3.6	-7.7 (05/09 – 5:56)	17.7 (05/06 – 13:41)

[1]Measurements for the last 18 days only. [2]Measurements for the first 19 days only.

Big Pamir

Temperature logger #5 was deployed in Sang-e-Kalan Kirghiz settlement (4050 m asl) in Tila Bai Valley, Big Pamir, at the beginning of winter, on 14 December 2006, at 00:11. It stored without discontinuity 15047 data points for 156 days 18 hours and 15 minutes (22 weeks rounded down) until 19 May 2007 at 18:26 when memory capacity was full. We retrieved the data on 29 June 2007 upon our visit to this Kirghiz settlement. Monthly descriptive statistics of the dataset are provided in Table 20.

Average T_a reached minimal values in January 2007 with an absolute minimum at –29.1°C recorded on 3 January at 7:41. From January to May, average T_a increased progressively (Figure 15) with an absolute maximum at 17.7°C recorded on 6 May at 13:41. During the recording period, T_a was never above freezing point until the 18 March at 12:20 (94.5 days since 14 December) (Figure 15). Temperature averaged values consistently above freezing point only after 15 April, but could occasionally drop to below-freezing point values in May, including the very last day of measurement with –0.9°C recorded at 11:56. We also have indications that it can occasionally snow during summer, temperature dropping sometimes below 0°C. We experienced such events in July 2007 (Plates 15 & 16).

In January, minimum air temperature ($T_{a,min}$; mean=–23.2±3.9°C) occurred 15 to 30 minutes after dawn around 7:00, and maximum air temperature ($T_{a,max}$; mean=–14.0±2.3°C) occurred at 15:00, on average 2 hours before sunset (Figure 16). In April, minimum air temperature ($T_{a,min}$; mean=–6.2±4.4°C) also occurred at 7:00 but nearly 2 hours after dawn, and maximum air temperature ($T_{a,max}$; mean=5.4±5.3°C) occurred at 15:00, on average 1.5 hours before sunset (Figure 16). Mean diurnal T_a, $T_{a,max}$, and $T_{a,min}$ were higher in April than in January (Wilcoxon matched pairs signed-rank test; $P<0.001$). Mean amplitude of daily T_a variation was higher in April (13.1±3.2°C) than in January (11.4±3.4°C) ($P<0.01$).

Kirghiz interviewed in Sang-e-Kalan settlement about their perception of winter 2006–2007 harshness said they considered it as "normal" (i.e. not excessively cold). The group of Kirghiz using this camp in winter moved to Ilgonak valley on 7 July 2007. We relaunched the logger on 9 July (#6) and will hopefully retrieve the stored data in late spring 2008.

Plate 15. A frozen rivulet in the early morning testifies that air temperature can occasionally drop below 0°C in summer, Shaur Valley, Big Pamir, 8 July 2007.

Plate 16. In high-altitude Kirghiz pastures it is not unusual to observe snow falls in summer, Shaur Valley, Big Pamir, 8 July 2007.

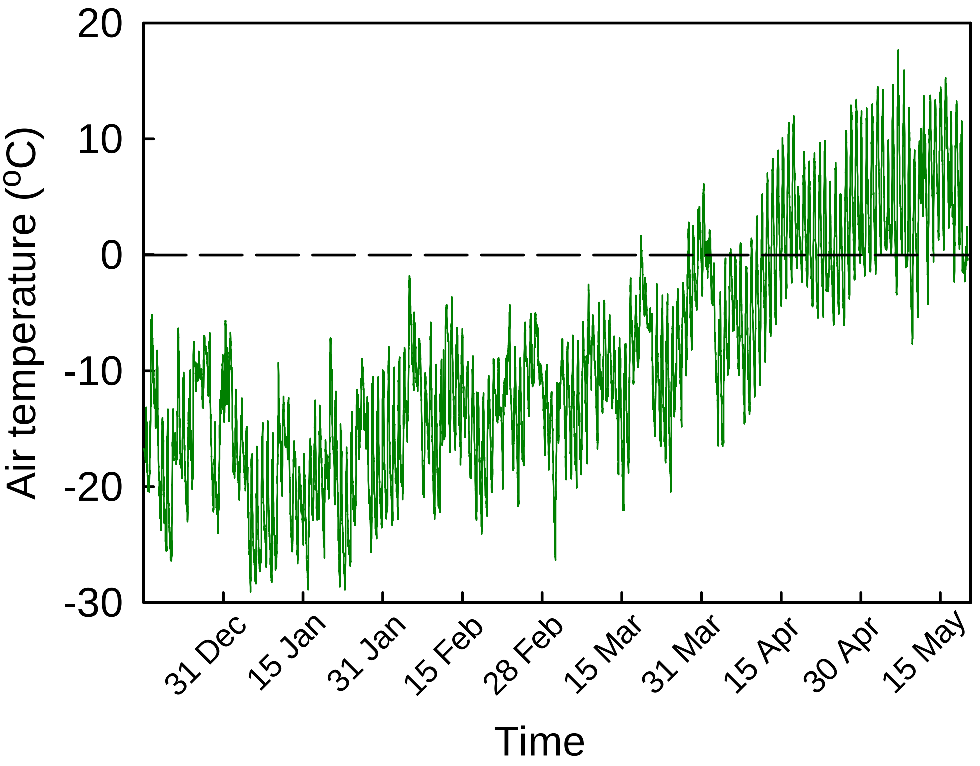

Figure 15. Average air temperature recorded every 15 minutes in Sang-e-Kalan, Tila Bai Valley, Big Pamir between 14 December 2006 and 19 May 2007. The dot line represents freezing-point.

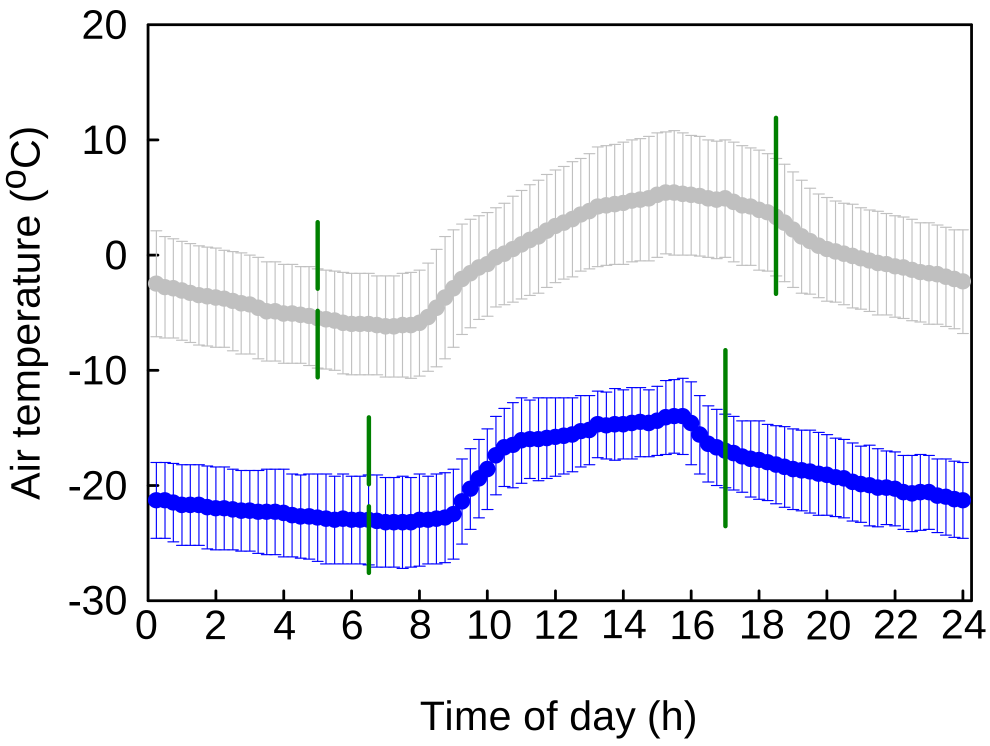

Figure 16. Air temperature versus time of day in Sang-e-Kalan, Tila Bai Valley, in January (blue) and April (grey) 2007. Vertical dotted and solid lines represent sunrise and sunset times. Values are means ± SD.

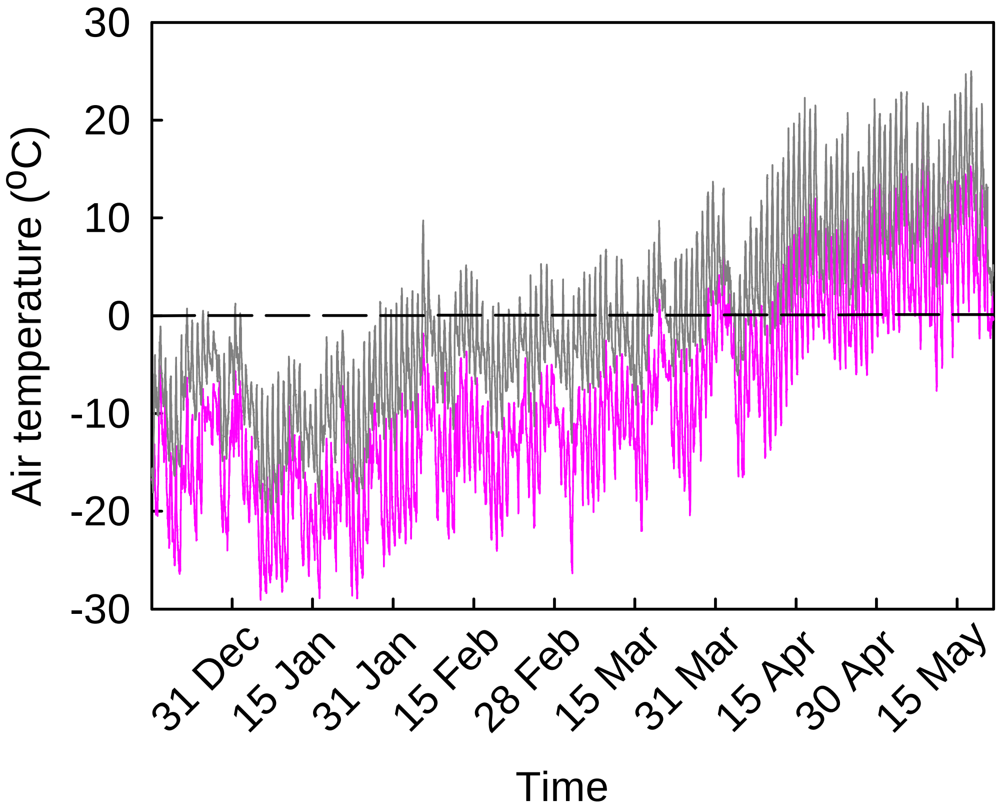

Figure 17. Average air temperature recorded in Sang-e-Kalan, Tila Bai Valley, Big Pamir (pink) and in Kret, upper Wakhan (grey) between 14 December 2006 and 19 May 2007. The dot line represents freezing-point.

DISCUSSION

To our knowledge this is the first longitudinal set of continuously-recorded climatic data for Wakhan and Pamir. As mentioned in the introduction we hope to compile information on air temperature during at least three consecutive years. From this first analyze, based on only 5 months of recording in Big Pamir and 11 months in upper Wakhan, we can confirm that temperatures in winter are remarkably cold, falling in Pamir in January 2007 as low as –25°C to –30°C in early morning (and not night). During day in January temperature remained around –17°C to –20°C (lower than –15°C). In summer 2007, August was the hottest month but daytime temperature never reached 30°C in Kret, upper Wakhan. Temperatures above 30°C are presumably uncommon and possibly unknown in Pamirs. In this regard, upper Wakhan and Big Pamir are exposed to very different thermal conditions. From December to April 2007 average temperatures were 6–10°C lower in Tila Bai than in Kret (Figure 17), a discrepancy explained by the 1000 m difference in elevation between these two sites. Amplitude of daily temperature variations were very close in the two recording sites in January (10.8±2.7°C in Kret versus 11.4±3.4°C in Tila Bai, P=0.28), but differed slightly in April (14.5±4.2°C in Kret versus 13.1±2.2°C in Tila Bai, P=0.03). Temperature in Big Pamir was sampled near a Kirghiz settlement which was installed in an area less exposed to winds. Livestock grazing around the camp are presumably exposed to even harsher conditions, especially during windy days. Such harsh weather means many livestock may die of coldness each winter. Indeed, Kirghiz of Big Pamir reported having lost more than 750 sheep and goats and at least 100 yaks during winter 2006–2007. Presumably the meager forage available was insufficient to cover the cost of daily energetic requirements, which compared to summer, have to cover higher expenditures for thermoregulation. We speculate that the significantly lower winter air temperatures in Tila Bai compared to those recorded in upper Wakhan during the same period may explain the significantly higher mortality rate recorded in Kirghiz livestock in 2006–2007.

CONCLUSION

We have presented preliminary data on air temperatures in upper Wakhan and Big Pamir. They are useful in many ways. They improve our knowledge of weather conditions in the area, but also provide indirect indications on snow melting and ice thawing timing. They can even have a predictive value regarding infectivity periods for an array of pathogens and parasites. Below a threshold temperature, which varies according to species and environmental conditions, most parasites cannot develop to infective stage. For example, Ixodidae ticks can hardly move below 7–9°C, making them ineffective disease transmission agents in Kirghiz Pamir before early May and probably only during the warmest hours of the day. Many pathogens can survive at temperatures below freezing point in vitro, but how they support such thermal conditions in the natural environment is largely unknown. Data on air temperature must be included in our general thinking on the health of the ecosystem, provided they are measured for a long enough period of time to be statistically meaningful.

APPENDIX 1. SUMMARY OF DAILY ACTIVITIES FOR PART I

Summer survey among Kirghiz of Big Pamir (27 June to 9 July 2007)

- Wednesday 27 June: Big Pamir — After visiting Wakhi summer pastures (see Appendix 3), the team walked to Gormatek, where one can see the first track of Kirghiz presence (tombs) along the Pamir River. We camped at Gormatek.
- Thursday 28 June: Big Pamir — The team walked from Gormatek near the Pamir River to Tila Bai valley. Ambient temperature dropped and rain felt during the afternoon. We camped overnight in the area
- Friday 29 June: Big Pamir — We met with Mr. Egan Berdi from the corps of border police and received from him a letter that authorized our stay in Big Pamir near Tajikistan border. We investigated Kirghiz families and their livestock still present in this winter grazing area, and downloaded a temperature logger we had provided to Mr. Mengi Boy when we met his caravan at Goz Khun village on December 2, 2006. Then we moved to Ilgonak grazing area where we met with Mr. Kok Aslam, one of the two leaders of Kirghiz in Big Pamir, and surveyed households and livestock in this area. We camped overnight at Ilgonak.
- Saturday 30 June: Big Pamir — We moved to Beshkunak grazing area. We surveyed households and livestock in this area. We camped overnight at Beshkunak.
- Sunday 1 July: Big Pamir — We walked to Shaur valley. We surveyed households and livestock in this area. We camped overnight near one Kirghiz settlement in Shaur Valley.
- Monday 2 July: Big Pamir — We stayed in Shaur valley. We tried to count livestock. Mr. Naqibullah surveyed Ghaznikol Lake for birds and the rest of the team investigated Shaur River for fresh water fishes. We camped overnight in Shaur Valley.
- Tuesday 3 July: Big Pamir — The team joined Zorkul Lake, we installed the camp nearby. We visited households in Istik settlement and surveyed livestock for health condition. We tried to count livestock numbers. We camped overnight near Zorkul Lake.
- Wednesday 4 July – Friday 6 July: Big Pamir — The team surveyed the lake for birds and several inflowing rivulets for fresh water fishes. We visited again Istik settlement to take blood-samples from livestock.
- Saturday 7 July: Big Pamir — The team moved back to Shaur valley under severe south-western winds that eventually brought snow during night and a temperature dropping just below freezing point in the early morning of Sunday. The team camped overnight in Shaur valley.
- Sunday 8 July: Big Pamir — In the morning we surveyed the several remaining households from a larger group of Kirghiz that had moved to Moola grazing area on July 6. Then we moved to Beshkunak grazing area, where we carry on clinical examination of livestock and assisted to a shearing operation.

- Monday 9 July: Big Pamir — The team walked to Ilgonak and completed the livestock survey work initiated in this area on June 29.
- Tuesday 10 July: Big Pamir — The team moved to Tila Bai, we did not meet any Kirghiz in the area and carry on walking to Gormatek before re-entering Wakhi pastures the following day.

APPENDIX 2. SUMMARY OF DAILY ACTIVITIES FOR PART II

Summer survey among Wakhi of Little Pamir (4 September to 12 September 2007)

- Wednesday 4 September: Little Pamir — The team hired two horses, two yaks and one donkey as pack animals and walked to Daliz pass, and further to Borak that was reached at 5. We camped at Borak.
- Thursday 5 September: Little Pamir — We met with the range assessment team and pursued our progression first to Limil where lunch was taken and then to Shpodkis grazing area. The settlement of Sang Nevishta was reached at 4. Four households were interviewed in the evening, livestock health evaluated and animals counted. We camped overnight in the area
- Friday 6 September: Little Pamir — The team took blood samples from livestock in Sang Nevishta, then traveled within Shpodkis grazing area, first to the settlement of Sot Vijeetk where we interviewed four households, counted animals, took blood-samples from livestock, then to Ghareen Shpodkis settlement where we again interviewed four households, counted animals, took blood-samples from livestock and eventually had lunch. The afternoon we moved to Barnoz settlement and camped overnight.
- Saturday 7 September: Little Pamir — We first interviewed the two households present in Barnoz, counted their animals and took blood samples. At 9 we walked to Warm grazing area and reached the settlement of Chanaq Zherav.
- Sunday 8 September: Little Pamir — The team divided in two. Team 1 went to Kashch Goz, interviewed one household and went to Bai Qara settlement at 4. In the meantime team 2 interviewed the three households in Chanaq Zherav, took blood-samples from livestock and counted them. Then this team moved to Ghareen Warm settlement, interviewed the two households, counted the animals, took blood-samples and had lunch. On the afternoon this team moved to Aqbelis settlement where it camped overnight.
- Monday 9 September: Little Pamir — Team 1 interviewed five households in Bai Qara, took blood samples from their livestock and counted them. Then the team walked back to Gharmdeh settlement to meet team 2. This later team interviewed two households in Aqbelis, took blood-samples and counted livestock. Then it moved to Gharmdeh settlement where both teams re-unified.
- Tuesday 10 September: Little Pamir — The two households in Gharmdeh were interviewed, animals counted and blood-sampled. The re-unified team moved to Barnoz settlement again that was reached at 5:30.
- Wednesday 11 September: Little Pamir — We walked to Chapdara grazing area and stopped at Wutsir settlement with five households. We interviewed them, counted and blood-sampled their livestock. After lunch we moved to Mulungik Kshun settlement, and stayed overnight in this camp.

- Thursday 12 September: Little Pamir — In the morning we surveyed the five households in Mulungik Kshun, counted their animals and took blood-samples. We them moved to Uwee-e-ben Kshun settlement still in Chapdara grazing area, interviewed the three households and took blood samples. Eventually we walked down to Sarhad-e Broghil village in Wakhan valley that we reached at 6.

APPENDIX 3. SUMMARY OF DAILY ACTIVITIES FOR PART III

Summer survey among Wakhi of Big Pamir (17 June to 27 June 2007, 12/13 July 2007 and 15 to 19 September 2007)

- Sunday 17 June: Big Pamir — The team drove to Goz Khun village in Wakhan from Ishkeshim. Pack animals were hired for the next morning and Mr. Attam Beg, a Wakhi from Kret village joined us as the cook of the mission. We stayed at the guest house of Mr. Wali Jon in Goz Khun.
- Monday 18 June: Big Pamir — The team walked from Goz Khun to Briqarv, a winter grazing camp near the Pamir river. We camped overnight in the area
- Tuesday 19 June: Big Pamir — We walked from Briqarv to Frakchakor camp in lower Istimoch valley and camped in the area.
- Wednesday 20 June: Big Pamir — We moved from Frakchakor to Nawabad in mid Istimoch valley. We met with Wakhi using Qabal Gah camp during summer. We trained a herder at using GPS unit. We camped overnight at Nawabad.
- Thursday 21 June: Big Pamir — The team walked to Kund-a-Thur camp, western Shikargah, trained a herder at using GPS unit. We also surveyed households and livestock in this area. We camped overnight in the area.
- Friday 22 June: Big Pamir — We moved during the day to Mulung Than camp, western Shikargah and trained a herder at using GPS unit. The evening we came back to Kund-a-Thur. We camped overnight in the area.
- Saturday 23 June: Big Pamir — The team moved from Kund-a-Thur to Dost Honah camp in mid Istimoch valley and met the Wakhi who use Darah Big camp during summer in eastern Shikargah. We trained one herder at using GPS.
- Sunday 24 June: Big Pamir — We moved from Dost Honah camp to Nakchirshitk camp in Manjulak grazing area. We trained one herder at using GPS.
- Monday 25 June: Big Pamir — The team moved from Nakchirshitk camp to Qal Mayeen camp in Jermasirt grazing area. Qal Mayeen is the spring camp of people using Buqbun camp during summer. We camped overnight in the area.
- Tuesday 26 June: Big Pamir — The team rested in Qal Mayeen.
- Wednesday 27 June: Big Pamir — The team walked from Qal Mayeen camp to Gormatek in Kirghiz area. From this place the team started another mission among Kirghiz of big Pamir (see Appendix 1).
- Thursday 12 July: Big Pamir — After visiting Kirghiz of Big Pamir and on our way out of Big Pamir, Dr. Ali Madad and Mr. Inayat Ali visited Nakchirshitk camp to evaluate the progress of GPS recording work in this camp. They stayed overnight in the camp. In the same time the rest of the team joined lower Istimoch valley and Dr. Hafizullah and Mr. Naqibullah surveyed households and livestock in Zarnaw area.

- Friday 13 July: Big Pamir — The team moved from lower Istimoch valley to Briqarv and was joined by Dr. Ali Madad and Mr. Inayat Ali at this location in early afternoon. We camped in Briqarv.
- Saturday 14 July: Big Pamir — The team moved to Goz Khun in Wakhan valley.
- In September 2007 the Ecosystem Health team performed a survey of Wakhi livestock in Little Pamir (see Part II and Appendix 2). When completed the team moved down to Kret village in Wakhan Valley.
- Saturday 15 September: Big Pamir — We walked from Kret to Sargez village and then ascended Sargez valley. We reached Vagd Boi settlement late in the evening and collected the GPS unit from Mulung Than herder who had moved with the rest of this camp at this location for late summer grazing. We camped overnight at this place.
- Sunday 16 September: Big Pamir — We walked to Kund-a-Thur camp but failed to retrieve the GPS unit because the herder using it was high-up in pastures. We continued to Qabal Gah and Darah Big settlements where we collected GPS units. We camped overnight in Darah Big.
- Monday 17 September: Big Pamir — Dr. Ali Madad went to Nakchirshitk settlement, collected the GPS unit and came back to Darah Big settlement.
- Tuesday 18 September: Big Pamir — The team moved back to Kund-a-Thur, collected the GPS unit and headed to Vagd Boi settlement where they surveyed livestock via questionnaires. The team stayed in Vagd Boi during night.
- Wednesday 19 September: Big Pamir — While on the way back to Kret in Wakhan valley, we surveyed livestock in two households using Sargez Zherav settlement in Sargez Valley. The WCS Community Conservation house at Kret was reached the evening of the same day.

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