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Source: Mountain Research and Development, 32(3) : 324-336

Published By: International Mountain Society

URL: https://doi.org/10.1659/MRD-JOURNAL-D-12-00001.1

Mountain Research and Development (MRD)
An international, peer-reviewed open access journal
published by the International Mountain Society (IMS)
www.mrd-journal.org

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The Nexus of Pasture Use, Pasture Potential, and Property Rights

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This paper deals with the relations between grazing practices, pasture potential, and property rights in the Eastern Pamirs of Tajikistan 10 years after the privatization of 1999. It provides an overview of the spatiotemporal variability of current pasture use and livestock numbers. Assumptions about pasture potential are reconsidered in relation to animals' forage needs in order to draw field-based conclusions regarding over- or underuse in particular areas. Data are derived from interdisciplinary research on post-Soviet pastoralism and associated human–environment interactions. We show that pastoralists in the Eastern Pamirs face several problems: As the land cover resources are meager and variable and hay meadows for winter fodder are rare, herd mobility or external forage inputs are necessary to compensate for weather-related shortages. The current multiseasonal pasture use—a change from the mono-seasonal use of Soviet state farms—discourages plant regeneration. Competition between pastoralist groups is exacerbated by unresolved questions about formal user rights. Conflicts seem inevitable, limiting the sustainable use of natural resources. Based on 2 telling examples, we show that pastures close to villages are used year round, particularly in winter, and are heavily overgrazed. There is less grazing pressure on summer pastures, but some distant and hardly accessible summer pastures show high livestock numbers in summer, contradicting former opinions about their underuse.

Keywords: *Pasture use; pasture potential; pasture tenure; carrying capacity; grazing pressure; transformation processes; Pamirs; Tajikistan.*

Peer-reviewed: *May 2012* ***Accepted:*** *June 2012*

Introduction

The dissolution of the Soviet Union and the independence of Tajikistan in 1991 resulted in significant political and socioeconomic changes. The people of the Eastern Pamirs, a peripheral mountain region with a harsh climate that was highly subsidized in the Soviet era, have been particularly affected by change (Breu and Hurni 2003).

For many centuries, pastoralism with extensive livestock herding has been a prime land use strategy in the region. Therefore, the Soviet administration set the production of meat as the region's main economic task and installed collective farms (*kolkhozy*) and state farms (*sovkhozy*). There, a well-balanced and sustainable utilization of all pastures of the Pamirs was fostered by substantial imports of transport and forage resources (Breu et al 2005).

The allocation of pastureland was subject to a management plan, usually with seasonal pasture camps—winter (*kishto*), spring (*barlo*), summer (*dzhailo*), and autumn (*kuzdoo*)—in order to use the entire area of the farm. In the subdistrict of Kuna Kurgan, highlighted in this work, most summer pastures were more than 100 km from the permanent settlement (Domeisen 2002). Since privatization in 1999, new collective structures called associations of *dekhan* farms (ADFs; literally, a *dekhan* farm is a "peasant farm," indicating private and heritable land; see Robinson et al 2010: 7) have inherited the *kolkhozys'* land titles and are responsible for distributing pasture use rights in order to ensure more sustainable pasturing, which they are often not able to do (Kraudzun 2012).

Today, without the external inputs from the Soviet economy, traveling long distances between seasonal pastures is a major problem for most smallholders (Hangartner 2002; Ludi 2003), as can be observed in other Central Asian countries as well (Maselli and Arynova 2010; Wolfgramm et al 2010). As a result of this change, some authors have observed an overexploitation of easy-to-reach pastures near permanent settlements, while vast but remote areas lie fallow (Domeisen 2002; Breu and Hurni 2003; Robinson et al 2010). However, according to Breu (2006), even if all pastures are included in the calculation,

FIGURE 1 A typical *pamer* (plain and wide valley) in the Eastern Pamirs. (Photo by Tobias Kraudzun)

the potential carrying capacity of the Eastern Pamirs' pastures is limited and would supply the subsistence needs of only 3000–5000 people living exclusively on livestock breeding. This would be far below the current population of about 14,000.

The aim of this paper is to provide an overview of the spatiotemporal variability of current pasture use and associated livestock numbers, as well as to reconsider and substantiate common assumptions about pasture potential in relation to animals' forage needs (cf. Breu 2006; Sedik 2009). It is based on interdisciplinary data collected over 3 years of extensive intermittent fieldwork, which yielded evidence on grazing pressure in specific locations and allowed us to model possible over- or underuse in particular areas.

This study addresses a need recently expressed in a review paper on research on Central Asian mountain pastoralism, which noted that "authors are often repeating each other's assumptions and preconceptions" about pasture mismanagement and degradation and "there is a clear need to do more in-depth field work" (Kerven et al 2011: 38–39). It also offers a prime example of the governance problems of common-pool resources (Ostrom et al 1999) in regions undergoing economic transformation from state control to individual initiative (Bichsel et al 2010).

The following hypotheses constituted the point of departure for this paper:

1. Multiseasonal use is the main threat to sustainable pasture use and the preservation of pasture productivity.
2. The intensity of pasture use decreases with distance from permanent settlements; however, distant pastures are still heavily used.
3. Economic conditions and lack of administration of pasture rights cause inflexible grazing schemes and stocking rates that are inappropriate to ecological conditions.

Study area

The Eastern Pamirs are a mountain area with high plateaus in Central Asia, predominantly located in Tajikistan. A *pamer* is a plain or wide valley covered with productive meadows (Figure 1) and separated by ranges (Kreutzmann 1996). The valuable pastures of these high plateaus are about 3500 to 4600 masl. The high altitude causes low temperatures throughout the year, with an annual average of only -1° C in the valleys (Miehe et al 2001). The region is also arid, with precipitation in some areas below 100 mm per year, because the high mountain ranges shield it from the westerlies and the Indian summer monsoon. The Eastern Pamirs can be described as a cold high-mountain desert with scattered, slow-growing vegetation (Agakhanjanz 1979; Walter and Breckle 1991; Breu and Hurni 2003; Abdullaev and Akbarzadeh 2010).

Given these conditions, extensive and mobile herding of yaks, sheep, and goats seems to be the only agricultural option. The population density is low, with an area of 37,900 km^2 but only 14,000 inhabitants, of 77% Kirghiz

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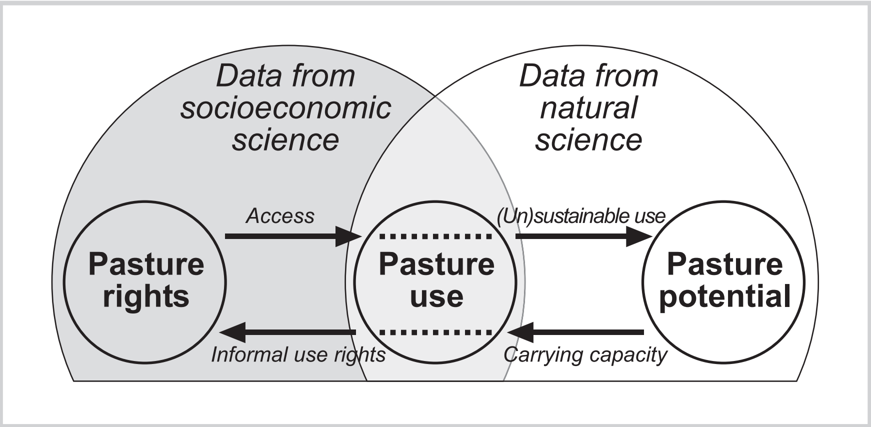
FIGURE 2 Conceptual and methodological framework of the study. (Figure by Kim Vanselow)



and 23% Tajik origin. Half of the population lives in the district capital and economic center, Murghab, the other half in far-flung villages and hamlets (Statkom GBAO 2002; Statotdel Murgab 2008).

Methodology

To appraise the grazing impact of herds on pastures, it is essential to quantify the pasture potential and the patterns of current livestock densities in space and time. An interdisciplinary approach is required that combines data and methods from the socioeconomic and natural sciences (Figure 2). These were elaborated during extensive fieldwork between 2007 and 2010, for a total of 14 months in the communities of Alichur and Kuna Kurgan in Murghab district.

Pasture access and use and livestock numbers

In a first step, the access to pastureland for mobile husbandry was assessed. Starting from the results of the baseline studies of the Pamir Strategy Project (Breu and Hurni 2003; Breu et al 2005), pasture utilization was surveyed and its spatiotemporal variations were mapped. The pasture camps were repeatedly visited and the pastoral practices of 280 pasture users were recorded over 3 years, using a standardized, pretested questionnaire. Information was gathered on previous and present use rights, pastoral practices, and provision of winter fodder, as well as composition, size, and ownership of the herds. Livestock numbers were summarized as small livestock units (SLU). This measure consists of the small livestock (SL; sheep and goats) headcount plus the number of big livestock (BL; yaks and occasionally cows) multiplied by 3, which best reflects the animals' grazing impact (Dong et al 2006; Committee on Nutrient Requirements of Small Ruminants 2007). Information about conflicts over pasture access was sought in problem-centered interviews.

Pasture potential

Data on land cover, species composition, phytomass, and forage quality were collected to estimate the pasture potential. These data were then compared to the seasonal numbers of livestock in the pastures, allowing an appraisal of the grazing impact and thus an evaluation of possible overuse (Samimi and Kraus 2004). All calculations that involved pasture potential and herd size were based on growing animals of average weight and standard range of pasture that a herder and herd would cover in a day, as described in Vanselow (2011).

The method of assessing pasture potential is as follows: initially, two hundred sixty-two 60 × 60-m plots were set up in selected valleys, distributed over the entire study area, with at least 1 plot on the valley bottom and 1 on each of the 2 slopes wherever possible. The size of the plots was determined in relation to the remotely sensed data used in this study. Then, the cover of each plant species was estimated during the growing season according to an adjusted Braun–Blanquet scale on 4 randomly selected 4 × 4-m plant survey plots within each large plot. The data from the 4 plots were aggregated and their median considered as representative for the related larger 60 × 60-m plot.

After this, the species data were classified by hierarchical cluster analysis (isopam; Schmidtlein and Collison 2010). Subsequently, 11 variables were extracted for each plot from different sources of remotely sensed raster data and used to model the land cover as defined by the classification (Table 1). Topographic variables were extracted from the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) Global Digital Elevation Map. Spectral and texture variables were computed from images of the satellite RapidEye (RapidEye AG 2010). The model used in this work is a random forest (Breiman 2001). To distinguish between all types of dwarf shrub vegetation, a second, focused model was created and merged with the initial one. Finally, the model accuracy was evaluated by out-of-bag validation.

TABLE 1 Explanatory variables used in the land cover model.[a)]

Explanatory variables	Description
Topography	Derived from 30-m ASTER Global Digital Elevation Map
1	Elevation (masl)
2	Slope (°)
3	Elevation (m) above isobath
Spectral characteristics	Derived from RapidEye images
4	Mean of Band 5 (near infrared, 760–880 nm)
5	Modified NDVI based on the ratio between band 5 (near infrared, 760–880 nm) and band 4 (red-edge, 690–730 nm)
6	Soil-adjusted vegetation index (according to Huete 1988)
Texture	Derived from RapidEye images by a range filter of 3 × 3 pixels; the resulting standard deviation is used as texture value
7	Texture value of filtered band 1 (blue, 440–510 nm)
8	Texture value of a modified NDVI based on the ratio between band 4 (red-edge, 690–730 nm) and band 3 (red, 630–690 nm)
9	Texture value of the filtered soil-adjusted vegetation index
Location	Derived from the UTM grid (zone 43N)
10	UTM easting
11	UTM northing

[a)]NDVI, normalized difference vegetation index; UTM, universal transverse mercator.

Phytomass availability was estimated on one hundred nine 1-m^2 plant survey plots within the large plots, using a point-intercept method (Mueller-Dombois and Ellenberg 1974; Samimi and Kraus 2004). During the growing season (mid-June to mid-August 2007 and 2008), 72 plots were recorded, and 37 were examined at the end of the cold season (March and April 2009). Woody plant parts and hard cushions were excluded from the estimation as they are only rarely consumed. To assess knowledge about the animals' diet, we observed livestock and interviewed 30 herders about favorite forage species. Then, samples of the identified fodder plants were collected and analyzed for their nutritive value by the Weender–van-Soest method in order to draw conclusions about forage quality. The results of the analysis were used to calculate the total digestible nutrients, which were converted to metabolizable energy (van Soest 1994). Taking into account that fodder values are season dependent, samples were taken whenever possible both during the growing season and during dormancy. The estimated phytomass values and the average nutritive values of the dominant pasture plants were combined to calculate the availability of metabolizable energy (MJ/ha) in each vegetation unit, which determines the pasture potential; this was compared to the temporal and spatial patterns of livestock numbers.

Historical and current conditions

Data on current pasture use, pastoral production, and economic conditions were supplemented by information about the Soviet era and the subsequent transition period, collected in topic-specific interviews with 30 key informants. Regional archives also provided historical information, which shed additional light on the current situation. The conditions of the pastoral economy were identified by analyzing legal and administrative documents and statistical data.

Results and discussion

As the study area is too large to visualize and discuss in detail, we focus here on 2 representative examples. Example A is in the northeast part of the study area, covers 1790 km^2, and contains the district center (Murghab) and the nearby settlement of Kuna Kurgan (the administrative center of the subdistrict), as well as the surrounding pasture areas, primarily in the Pshart and Kara-Suu valleys. Example B is in the southern part of the study area and encompasses the distant pasture areas of Jang-Davan, Shakarak, and Chesh-Debe, with an area of 1702 km^2. A comparison of the 2 areas is presented in Table 2.

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TABLE 2 Comparison between Examples A and B.

Subject matter	Example A (Figure 4)	Example B (Figure 6)
Location	Northeast of the study area (Murghab town, Kuna Kurgan village, Pshart and Kara-Suu valleys)	South of the study area (pasture areas of Jang-Davan, Shakarak, and Chesh-Debe)
Distance to settlement	Predominantly close to settlements	Predominantly remote
Use patterns		
Use during the Soviet era	• Hay meadows • Reserve pastures (predominantly for the winter season)	• Pastures for 1 season (spring, summer, or autumn)
Current use	• No spared areas • Hay meadows also used as pastures in winter and spring • Used in at least 2 seasons; partly used year-round • Maximum use in winter	• Predominantly used only in 1 season (sometimes 2 seasons) • No year-round use • Maximum use in summer
Users	Predominantly smallholders	Predominantly affluent livestock owners with large herds
Area (km^2)	1790	1702
Land cover classes (%)		
Degraded deserts	16	<1
Dwarf shrub deserts	30	9
Teresken steppes	30	57
Meadows	4	4
Rocks and scree	14	9
Snow and ice	1	1
Water	1	<1
Cloud cover (%)	4	19
Livestock numbers (SLU)		
Spring	16,334	3889
Summer	11,380	9325
Autumn	11,300	3459
Winter	18,193	1118
Conclusion	Heavy overgrazing on pastures in the vicinity of settlements and on winter pastures	Sufficient forage for current livestock numbers; no extensive overgrazing

During the Soviet era, the farms used pastures only for 1 season and shifted all herds 4 times a year (Figure 3). In contrast, today most pasture users do not relocate their livestock. In the Kuna Kurgan subdistrict, from 2007 to 2009, 55% to 64% of the interviewed herders shifted their livestock to a separate autumn pasture, whereas only 26% to 38% followed a similar pattern for separate spring pastures. Thus, animals use pastures longer and the recovery period for the vegetation is limited.

Use and potential of pastures close to settlements

The pattern described above is particularly true for the pastures in Example A (Figure 4), located close to a settlement. In the Soviet period, pastures near Murghab town were spared from use; now they are grazed in all seasons. Based on the land cover classification, many of these pastures are degraded deserts, amounting to 16% of the area of Example A. In this class, forage productivity and quality are lowest (a median of 376 MJ/ha in summer

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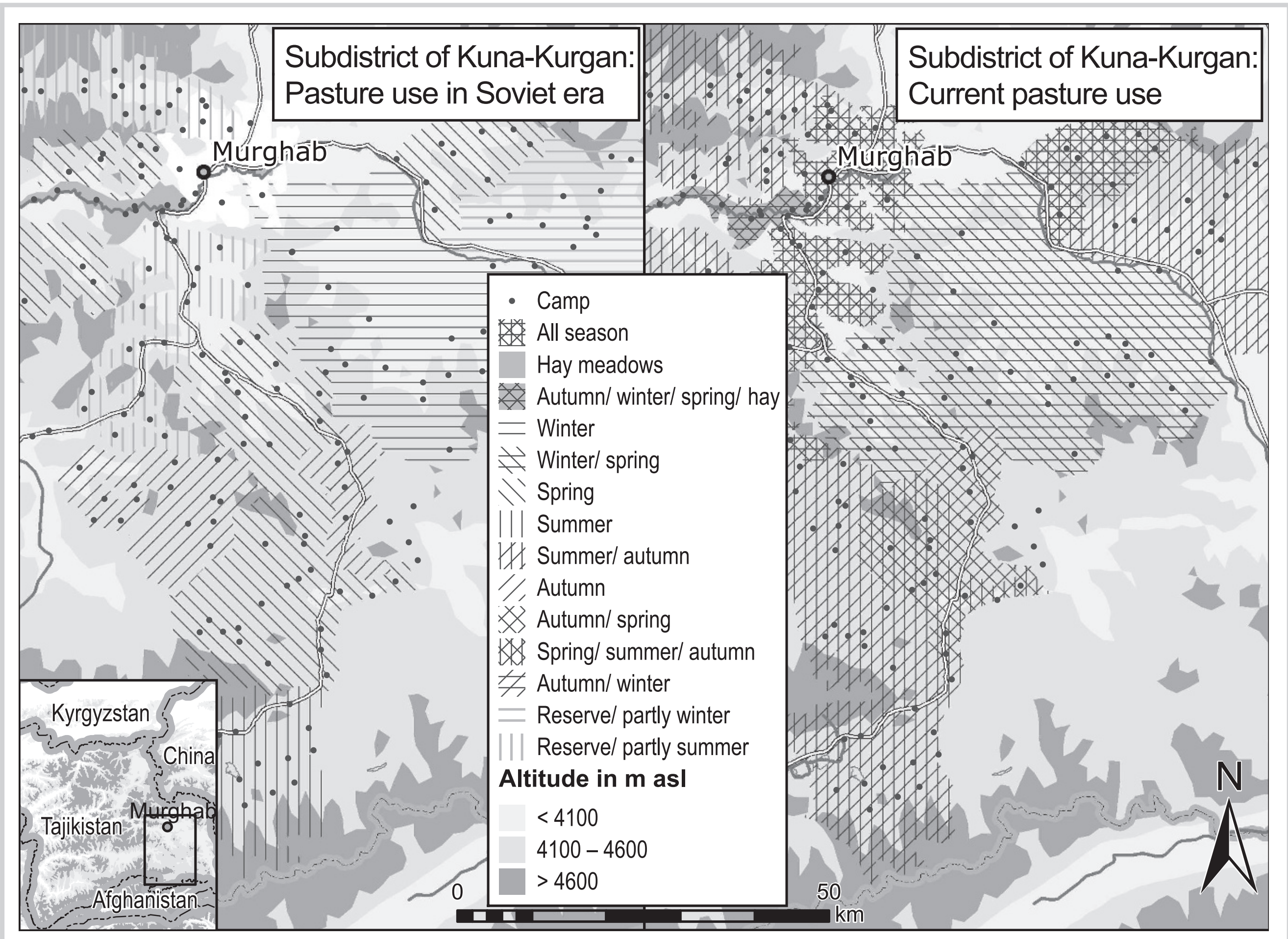
FIGURE 3 Comparison of Soviet and current pasture use schemes. (Map by Tobias Kraudzun)



and 381 MJ/ha in winter—see Figure 5 and *Supplemental data*, Table S1; http://dx.doi.org/10.1659/MRD-JOURNAL-D-12-00001.S1). Based on interviews with pasture users, this degradation appears to be caused by heavy gathering of firewood and overgrazing. The former is due to the enormous amounts of energy needed to heat poorly insulated buildings that were erected during the Soviet period, when energy efficiency was not a priority (cf. Wiedemann et al 2012, in this issue). The latter is obvious when comparing the pasture's restricted use in the Soviet period and its heavy use, by 2600 SLU daily in summer and up to 7000 in winter, around Murghab town and Kuna Kurgan village.

At higher elevations and in side valleys, the vegetation consists of dwarf shrub deserts (30%) and *teresken* steppes (30%) that are dominated by *Krascheninnikovia ceratoides*. Both classes show a comparable pasture potential, with medians of 1422 and 1404 MJ/ha in summer and 957 and 1258 MJ/ha in winter. In particular, the pastures in the Pshart Valley in the north, the Kara-Chabyr region of winter pastures in the southeast, and the pastures in the mountain ranges west of Murghab town show these vegetation types. Today, the pastures of the Pshart Valley and the side valleys of the Madian Valley, spared under Soviet management plans, are used in summer and autumn, and the former winter pastures in the southeast are grazed until the end of spring.

The highest amount of forage energy per hectare was detected for meadows, with a median of 7365 MJ/ha in summer and 4274 MJ/ha in winter. However, this is the most limited resource, covering only 4% of the example area, predominantly in the Madian Valley along the Murghab River. During the Soviet era, these pastures were used exclusively as hay meadows. Today the area is spared only during the summer months in order to harvest more hay at the end of the growing season. However, it is used as pasture in the remaining seasons, particularly in winter (3158 SLU) and spring. Finally, 14% of land cover in Example A consists of rocks and scree, 1% is snow and ice, and less than 1% is water. The remaining 4% could not be assessed because it was covered by clouds.

FIGURE 4 Land cover and livestock numbers in Example A (pastures close to settlements). (Map by Kim Vanselow and Tobias Kraudzun)

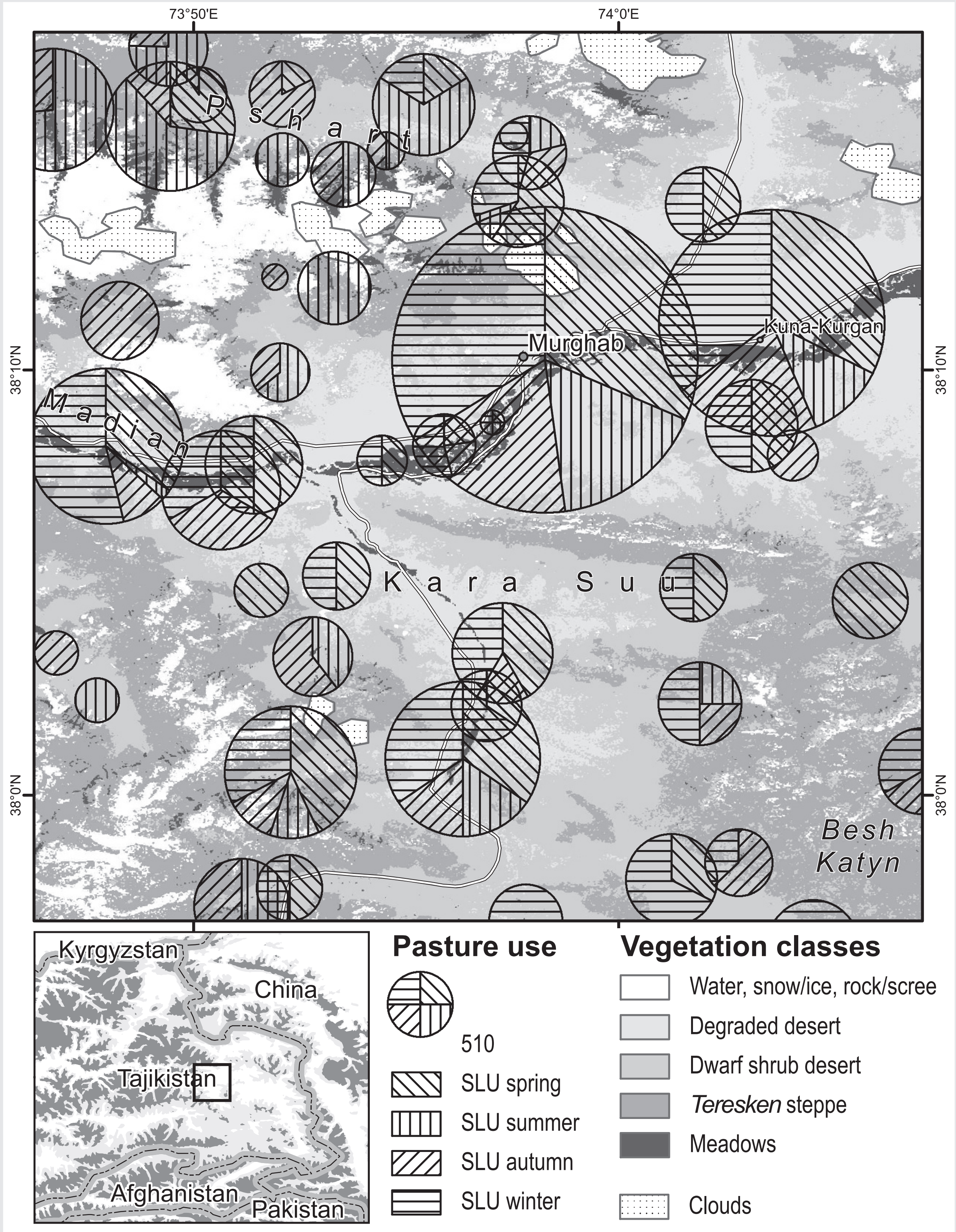


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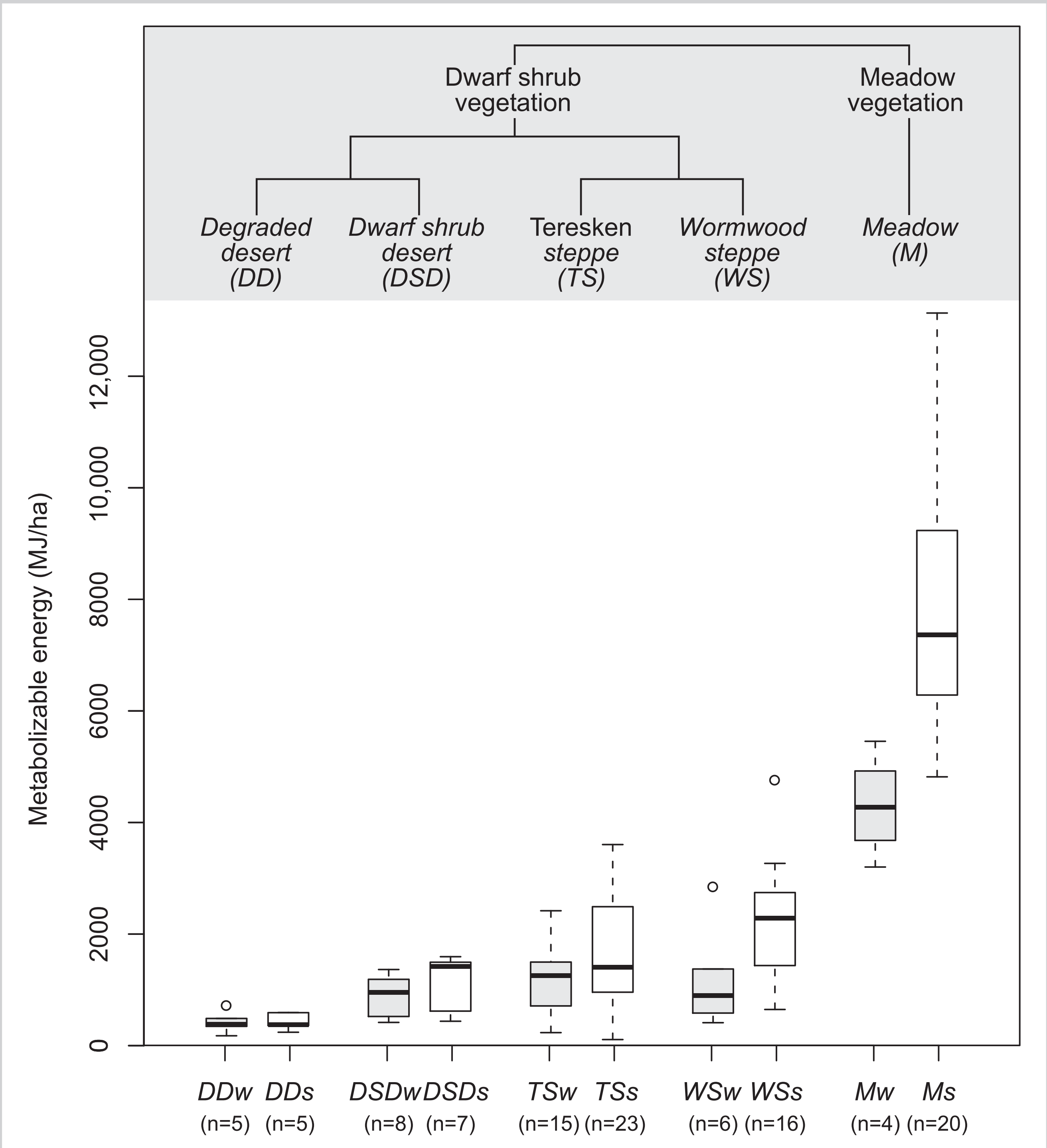
FIGURE 5 Classification and metabolizable energy of vegetation. (Figure by Kim Vanselow)



Use and potential of remote pastures

In Example B (Figure 6, distant pastures), pasture utilization is significantly lower, even though our survey shows that 9325 SLU are pastured in summer. In winter, the number decreases to 1118 SLU. Historical management plans show that this area was allocated as exclusively spring pasture (east) and autumn pasture (northwest) during the Soviet era. Only the outermost southern part of the example area was used as summer pasture.

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FIGURE 6 Land cover and livestock numbers in Example B (distant pastures). (Map by Kim Vanselow and Tobias Kraudzun)

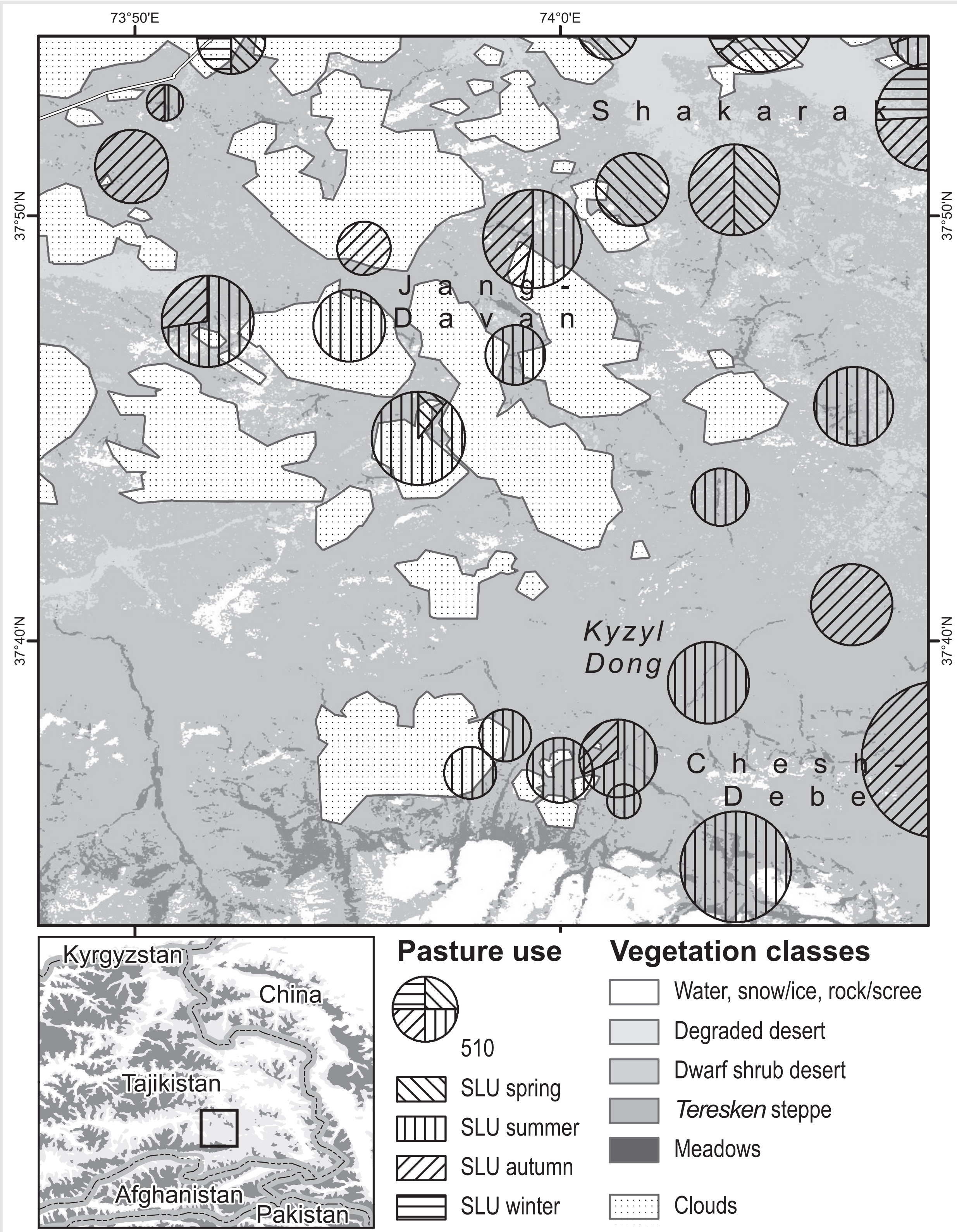

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TABLE 3 Evaluation of the land cover and phytomass model (see also Table S1, *Supplemental data*; http://dx.doi.org/10.1659/MRD-JOURNAL-D-12-00001.S1).[a)]

Land cover	Class	OOB accuracy (%)
Model 1	Overall	87.4
	Degraded deserts	73.8
	Intact dwarf shrub vegetation	87.6
	Meadow	92.1
	Rocks and scree	83.3
	Snow and ice	100
	Wormwood steppes	100
Model 2	Overall	81.8
	Dwarf shrub deserts	79.4
	Teresken steppes	78.8
	Wormwood steppes	86.3
Phytomass model	**Forage type**	**R^2 ($P < 0.01$)**
	HGg	0.75
	HGw	0.7
	DSg	0.66
	DSw	0.48

[a)]OOB, out-of-bag validation; HGg, green herb and grass phytomass; HGw, withered herb and grass phytomass; DSg, green dwarf shrub phytomass; DSw, withered dwarf shrub phytomass.

The vegetation in this area is dominated by *teresken* steppes (57%). Compared to Example A, it is characterized by significantly smaller proportions of degraded desert (<1%) and dwarf shrub desert (9%). The shares of meadows (4%) and snow and ice (1%) are similar to those in Example A. In contrast, water (<1%) and rocks and scree (9%) make up a considerably smaller portion than in Example A. However, 19% of the area was covered by clouds and could therefore not be classified. (For more details, see *Supplemental data*, Table S1; http://dx.doi.org/10.1659/MRD-JOURNAL-D-12-00001.S1. The model accuracies are presented in Table 3.)

Regarding the current use of distant pastures, a closer look at the area adjacent to the southern part of Example B might be helpful. The territory of Chong Pamir belongs to Kuna Kurgan, but its pastures are at least 100 km away from this settlement. According to the ADF representative, in the first year after privatization in 1999, none of the herders were present here. In summer 2007, however, we counted herds totaling almost 3000 SL and 1400 BL on these pastures, and in summer 2008 the livestock numbers rose further, to more than 4000 SL and 1650 BL.

Winter pastures and winter forage: the scarcest resources

Winter pastures are a much scarcer resource than summer pastures, as the pasture utilization survey shows. The main reason is that in the Eastern Pamirs only a few valleys have pastures that remain snow free on a regular basis. These pastures are now in great demand. Hence, in Kuna Kurgan subdistrict, only 193,000 ha—one third of all accessible pastures—can be used without risk of weather-related problems in winter and spring, whereas 358,000 ha, double that area, are available as summer and autumn pastures.

During the Soviet era, the *sovchozy* accessed even more unreliable and far-flung areas, thus facing a higher risk of snowfall. They were able to do this as they could compensate for shortfalls by using stored dried forage and highly nutritious imported feed or by emergency removal of herds to reserved pastures. As a result, the seasonal pattern in the Soviet era was almost the opposite of the current one: 274,000 ha (61%) was used as winter and spring pastures and 175,000 ha (39%) as summer and autumn pastures (Figure 3).

In the Soviet era, according to key informants and historical management plans, the supply of winter forage was enlarged with forage crops from adapted grain seeds, augmenting the hay harvested on the natural meadows. Forage was also supplemented by imports from the Kyrgyz Soviet Socialist Republic. Valuable support originated from an exclave territory in the productive Alai Valley that was allocated to the Pamirian *kolkhozy* and *sovkhozy*: an additional 2000–5400 tons of winter fodder was grown there yearly. Today, most herders have to rely solely on their own scarce forage reserves, if they can afford any at all, and these are used first to feed weak and pregnant sheep and goats. The few adapted winter pastures have to suffice until the summer pastures are snow free and green enough to feed the livestock. Given climate variability, such pressure can easily lead to severe degradation of winter pastures or loss of animals.

An example that highlights the current scarcity of and competition for viable winter pastures is Besh Katyn (Figure 4), southeast of Murghab town in the area of Example A. In 2007, 2 users with 590 SLU wintered here. The following year, a third herder also used this pasture because he wanted to escape the severe forage shortage elsewhere. This increased the livestock numbers to 794 SLU, far beyond the area's calculated carrying capacity of 323 SLU.

The nexus of pasture use and pasture rights

Overstocking is not restricted to winter pastures. Our study revealed that today, animal numbers are often inadequate with regard to the pasture potential. In particular, adjustments to yearly weather variations are hardly possible, as the herders have no flexibility in their range. One reason mentioned by herders and key informants is that small-scale farmers use pastures where they have succeeded in getting informal use rights, irrespective of the size of their herds. This practice is not challenged because the responsible ADF has not developed mechanisms for pasture administration and control. In contrast, during the Soviet era, the integrated management of all animals on a *sovkhozy* or *kolkhozy's* territory enabled the adjustment of herd sizes to varying forage conditions. Appropriate herd sizes for placement on seasonal pastures were assessed by a visual, on-the-spot inspection by farm specialists. Now, herd sizes are determined primarily by the wealth of the owner and are thus not adapted to ecological conditions.

Above all, present-day use patterns differ according to the socioeconomic status of the livestock owners, as shown in the initial survey. A first small group of successful breeders secured use rights for a well-defined set of large, productive pastures for each season. An illustrative example is the distant summer pasture of Kyzyl Dong, located in the area of Example B (Figure 6). In 2007, we counted 3 users on this pasture with 977 SLU. Underfed livestock led the principal user who claims this pasture to deny access to the third user, so that in 2008 only 2 breeders with 714 SLU were counted.

A second group of herders with medium-sized flocks reported that they have to agree among themselves and negotiate their stakes with the influential group of affluent owners; another option would be to switch to pastures that are less contested.

However, the major share of all users is constituted by the group of small owners. For them, practicing mobile pastoralism on an individual basis would have economically detrimental effects because of their limited livestock assets. They reported that most of them are now organized in herding groups and take turns grazing their animals throughout the year on pastures close to their settlements.

The nexus of pasture use and pasture potential

This pattern was confirmed by our observations of the pastures surrounding Murghab town. In winter 2007–2008, 3220 SLU were kept on these pastures. Their energy requirement for 1 season of 90 days amounts to $4 * 10^6$ MJ. However, as these pastures are used in all seasons, the forage demand is about 4 times higher, and could only be met by an unrealistic day range for pasturing of at least 14 km around Murghab. Therefore, it can be concluded that the vicinity of Murghab town is heavily overgrazed.

According to our survey, the livestock numbers grazed on the pastures in the area of Example A stay above 11,000 SLU in all seasons (Figure 4). The maximum is reached in winter with 18,193 SLU, consisting of 13,603 SL and 1530 BL. According to our calculations, in Example A livestock can access approximately 40,000 ha with a median available forage energy of $30 * 10^6$ MJ during the winter months. The present livestock would require $20 * 10^6$ MJ during 90 winter days. However, these pastures are used during at least 2 seasons, which clearly shows that the winter pastures in Example A are severely overgrazed. This result is consistent with the large extents of degraded vegetation shown in Figure 4.

In the area of Example B, livestock is present mainly during 1 season and only in some parts during 2 seasons (Figure 6). The numbers are much lower than in Example A, varying between 1118 SLU in winter (1013 SL, 35 BL) and 9325 SLU in summer (6493 SL, 944 BL). Our calculations show that the area accessible by livestock amounts to 40,000 ha as well, with a median available energy of $49 * 10^6$ MJ during the summer months. However, as 23% of the area assessed was covered by clouds, we corrected the values and concluded that the energy value should reach around $60 * 10^6$ MJ. The energy required for the livestock numbers in 2008 during 90 summer days totaled $10 * 10^6$ MJ. The numbers in the other seasons are far less than in summer; therefore, it can be concluded that the amount of forage in Example B is sufficient to feed the current livestock numbers. Consequently, as shown in Figure 6, only small areas were classified as degraded deserts.

Conclusions

The pastoralists of the Eastern Pamirs face several problems. Land cover resources are meager, and highly productive pastures are very limited. Furthermore, yearly variations in weather conditions control forage resources.

Therefore, adequate herd mobility and/or sufficient external forage inputs are necessary to compensate for weather-related shortages. Optimally, grazing in the Eastern Pamirs would be spread across 4 seasonal pastures. However, unlike in the Soviet era, pastures today are subject to multiseasonal use.

The number of livestock grazing on the pastures in the area of Example A, around Murghab and Kuna Kurgan, is far beyond an optimal stocking rate based on existing pasture potential, even assuming that animals are moved after 1 season. The share of the vegetation classed as degraded deserts in Example A around Murghab and Kuna Kurgan further supports the conclusion that multiseasonal use, which limits the time vegetation has to recover, has a severely damaging effect. A comparison of the extent of degraded vegetation in both example areas shows that multiseasonal pasture use is a significant threat to the preservation of the pasture productivity.

Our results generally confirmed the pattern of decreasing use intensity with increasing distance from settlements. However, the main causes for intensive pasture use include mesoclimatic conditions that control abundance of forage and water. This goes far beyond a simple center–periphery phenomenon based on the owner's economies of scale, which has been repeatedly argued by other scholars (Undeland 2005; Kerven et al 2006). Pastures close to villages are used year round, particularly in winter, and are therefore heavily overgrazed. In general, summer pastures are subject to much lower grazing pressure than winter pastures. However, distant summer pastures in particular are increasingly used, as the example of Chong Pamir illustrates. As for winter pastures, both near and distant, they are extremely overgrazed. In sum, the assumption that distant pastures are generally underused no longer holds true.

Since the privatization of the collective farms' assets in 1999, livestock numbers have increased considerably, which has boosted demand for pastures. As a consequence, competition between users has grown, as well as the pressure on fodder resources. Competition is exacerbated by unresolved questions about formal user rights. Land use regulations related to the privatization were not sufficiently enforced to settle disputes about pasture tenure. Four of the 5 collective farms were transformed into ADFs. They inherited the land titles for the pastures and are responsible for allocating pasture rights to their members according to the forage needs of their livestock; however, they often lack assertiveness because of the legal pluralism that has developed during the transformation process.

The delay in formally resolving land rights resulted in the establishment of customary law that fostered personalized use for almost a decade and led to the widespread assumption that the pastures are owned by specific users. This legacy complicates the process of reallocating pasture rights, which is overdue. The juxtaposition of 2 competing sets of rights—official land titles and informal user rights—has led to overgrazing and inappropriate claims. Pastures near settlements or without strong user claims are heavily used, whereas extensive areas are claimed by powerful livestock owners and are used less. Conflicts seem inevitable in such situations, making the sustainable use of natural resources more difficult. The prevailing informal structures and the lack of implementation of official pasture rights have resulted in inflexible grazing schemes and high stocking rates that are inappropriate to ecological conditions.

In sum, the various transformation processes following the breakdown of the Soviet Union prevented the establishment of viable institutions to implement effective pasture management. For sustainable pasture use given the still-growing livestock numbers, it is necessary to increase the flexibility of pasture use schemes. To prevent the fragile high-mountain desert ecosystem of the Eastern Pamirs from becoming completely degraded, an improved and assertive management of pastures as a common-pool resource is required. Livestock breeders will soon face the effects of what Hardin (1968) called "the tragedy of the commons"—a declining productivity of their herds—if this organizational change is not implemented.

ACKNOWLEDGMENTS

The authors are grateful to the Volkswagen Foundation, which made research in the Pamirs possible with a grant supporting the project Transformation Processes in the Eastern Pamirs of Tajikistan: Changing Land Use Practices, Possible Ecological Degradation and Sustainable Development (AZ I/81 976). The authors would also like to thank Dr. W. Bernhard Dickoré for the identification of plant species, and 2 anonymous reviewers who provided helpful remarks on an earlier draft of this article.

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Supplemental Data

TABLE S1 Phytomass, nutritive value, and energetic potential of the different vegetation classes.

Found at DOI: http://dx.doi.org/10.1659/MRD-JOURNAL-D-12-00001.S1 (45 KB PDF).