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# MONITORING AND ASSESSMENT OF PASTURE LAND IN KYRGYZSTAN

## A CASE STUDY ON PASTURE LANDS OF THE JERGETAL AND ON-ARCHA LOCAL SELF GOVERNMENT AREA, NARYN

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## ABSTRACT

The Naryn district is one of the largest pastoral regions in Kyrgyzstan with extensive pasture resources. Assessment of current pastureland condition was carried out in four community types with substantial grazing potential, namely Jergetal and On-Archa AO. The community types are meadow, meadow-steppe, steppe and semi-desert. About 40 sites were selected for data collection. The objective of the study was to assess the pasture potential of the four community types in the Jergetal and On-Archa AO. The sampling of the vegetation was conducted from May to September in 2009 and 2010. Biomass production was collected using standard 1 $m^2$ sampling plots and all vegetation clipped and separated into palatable and unpalatable parts. To gain a better understanding of pasture condition and compare the effect of grazing on biomass production two identical demonstration plots were fenced off and biomass compared to the adjacent grazed area. The mean biomass production was not different between community types and years ($p>0.05$). In 2009 there was high precipitation resulting in high biomass production within the four community types (1.3±0.44 t/ha). The biomass production between 2009 and 2010 was not significantly different ($p>0.05$). There was a significant difference observed in the palatable biomass ($p<0.05$). The meadow type vegetation cover was 95% in both years. In the steppe and semi-desert types, vegetation cover was different between years (48-57%). The vegetation cover within the fenced plots increased compared to the grazed controls and the vegetation composition changed. Furthermore, unpalatable species increased in the meadow vegetation type. The results underline the importance of a grazing plan and good pasture monitoring.

**Key words:** pasture condition, biomass production, vegetation type, grazing management

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# 1. INTRODUCTION

## 1.1 A brief historical background

Historically, pasture management in the Kyrgyz Republic has undergone significant changes since the beginning of the Soviet Union and after independence in 1991 (Bussler 2010).

Traditions and collective use of the pasture changed and the collective farms and livestock have been privatized, including decentralization and democratization of decision-making in the use of pastures (Steimann 2010).

After independence realization of the agrarian and land reforms was begun, and livestock numbers decreased dramatically from 9.5 million animals to 3.5 million as state support diminished (Brylski et al. 2001). This forced people to sell their animals to increase their household income (Shamsiev 2006).

The situation for traditional herding was further affected in 2002 by the introduction of legislation that permitted traditional communal pastures to be leased. This resulted often in skirmishes between pasture users and the authorities (Undeland 2005).

The situation was radically changed in 2009 by the introduction of new legislation on pasture use. The new legislation called for the formation of Pasture User Associations with Pasture Committees as executive bodies which now control the use of pasture land. There are 454 Pasture Committees in the Kirgiz Republic today (Bussler 2010).

## 1.2 Current situation

Kyrgyz pasture lands cover approximately 9.1 million hectares. They are the basis for livestock breeding which is a nationally important income source in many rural parts of the country and thus crucial economically (Bussler 2010).

The pasture lands fall into three categories depending on their seasonal use: summer pastures from 2,500 to 3,500 meters above sea level (m.a.s.l.), spring-autumn pastures from 1,500 to 2,500 m.a.s.l., and winter pastures, often near settlements located below 1,500 m.a.s.l. The three zones account approximately for 45%, 32%, and 23% of the total pasture area, respectively (Brylski et al. 2001; Penkina 2004).

Changes in herding practices have resulted in changes in local grazing intensities, even though total livestock numbers have not increased (Fig. 1) (Mamytov 1987; Ahmadov et al. 2006). The traditional knowledge of pasture use, where land condition was an important factor in decision making, has disappeared or been forgotten, often resulting in unsustainable pasture management (Shamsiev 2007).

According to official data from the Kyrgyz State Project Institute of Land Management (Kyrgyzgiprozem) more than 3,222 ha, or 29% all pastureland, are degraded (Penkina 2004).

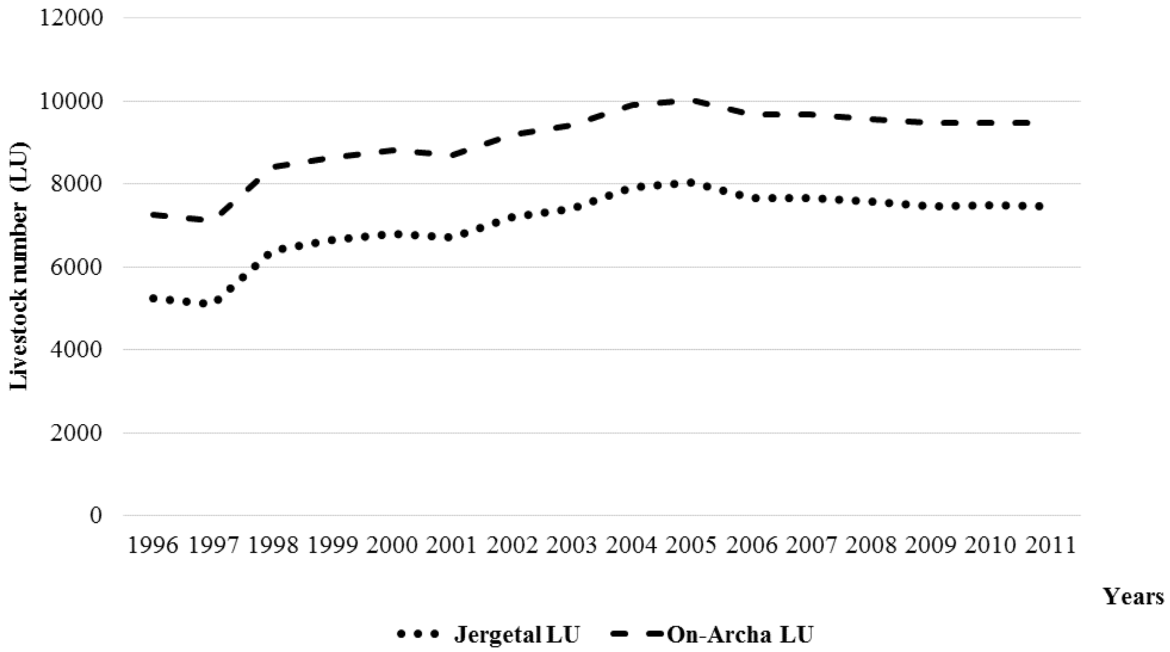



Figure 1. Trends in livestock numbers (LU = 5 sheep) in Jergetal and On-Archa AO from 1996 to 2011 (Source: adopted from Baseline study report (Rahim et al. 2008)).

The average pasture yield has decreased by 25% over the last four decades. This has contributed to changes in annual land use patterns as grazing pressures on locally accessible pastures have increased and resulted in an inadequate winter feed harvest (Kerven et al. 2011).

The mismanagement of land, intensive utilization of the spring and autumn pastures and the winter pastures near the villages, with corresponding underutilization of the remoter summer pastures, have become a major environmental problem (National Report 2008; Rahim et al. 2011).

These are considered the main reasons why pasture land efficiency in Kyrgyzstan has been reduced from 64% to 33% since the collapse of the Soviet system (World Bank 2007; Ludi 2004; Shamsiev 2007).

To understand pasture condition it is necessary to carry out regular monitoring and support awareness by the pasture users about their condition. (Feng et al. 2009).

Women play important roles in the rural areas and have equal rights with men in access to agricultural land. Women don't hold land in their own name, a situation often connected with traditional values. Even though the land and livestock belong to the men, the women are often responsible for making meals for the family’s subsistence as well as general household management (Undeland 2008).

Women are also often in charge of the grazing animals from early spring to late autumn, thus overseeing dairy production such as cheese, yogurt, kumyz, and kurut, as well as the manufacturing of wool products. Women also, traditionally, harvest medicinal herbs. Their contribution to the family income is therefore important and often considerable.

Improving both land use and land condition, and concurrently increasing production per head of livestock, will thus potentially decrease women's workload and increase their quality of life, while increasing the household's income at the same time, all of which may contribute to their personal economic independence.

Knowledge of land use and pasture condition is critical for all land management and the key tool for pasture management and pasture land use planning. Pasture management and land use planning have so far been hampered by a lack of knowledge and data. This project, however, may help improve the situation.

### 1.3 Aim and objectives of the study

The aim of this study was to assess the pasture potential of four community types in the Jergetal and On-Archa AO administration units in the Naryn district

**Objectives**

- to analyse vegetation biomass in the grazing land cover in different community types,
  to compare different community types at various altitude ranges and to assess the direct grazing effect, using enclosures.

## 3. MATERIALS AND METHODS

### 3.1 Study area and land use

The study areas are located in the Naryn region, which is situated in the Inner Tien Shan of the Tien Shan mountain system in Kyrgyzstan. Two watersheds, comprising two municipal administration units Jergetal and On-Archa Aiyl okrug (AO[1]), were chosen for the study area based on data availability. Livestock numbers have been relatively steady in the selected areas since 2000 (Fig. 1). The location of the study areas is shown in Figure 2.

The climate in the Naryn area is continental. In the period from 1993 to 2006 the average temperature was +18°C in July and -15°C in January, and the annual precipitation 55 mm (Fig. 3).

[1] Aiyl Okmoty (AO) The Local Self-Government structure according to the current law (2008) consists of two types of organs: - 1) representative councils, or local Keneshes, at the levels of rayon, cities of Republican significance, Ayil Okrug, and cities of oblast and rayon significance. In the past all levels of sub-national government had locally elected Keneshes but the oblast level was eliminated in 2007, when there was an attempt to introduce a two-tier budget system in the country; - 2) executive organs of LSG: Mayor's offices in the cities of national and oblast significance, city councils in cities of rayon significance, township councils in the townships, aiyl okmotu in aiyl districts.

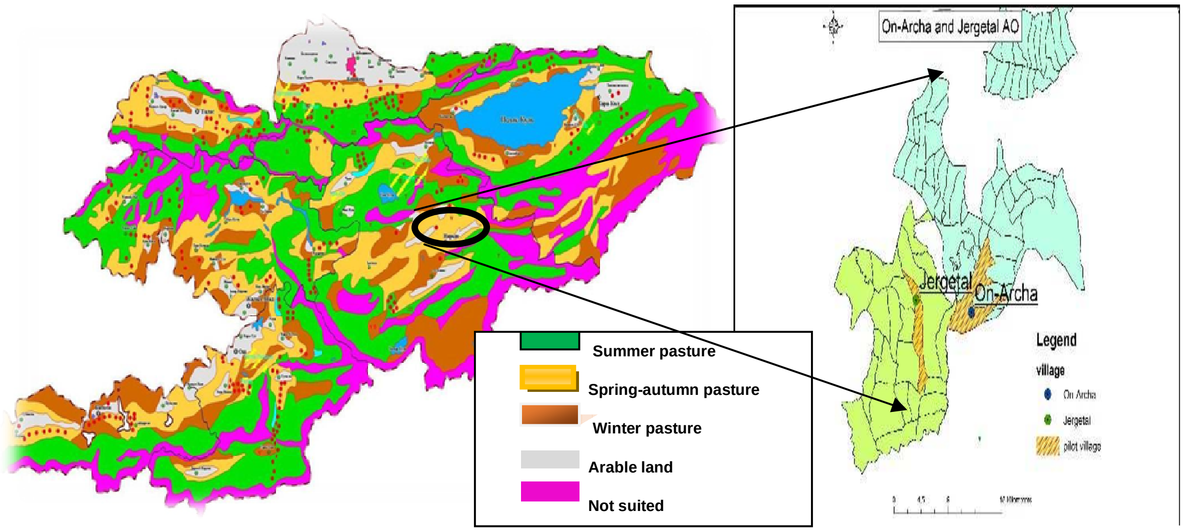



Figure 2. Left map showed location of Jergetal and On-Archa AO. The black circle shows the location of Naryn district. Right: Map showing pastures in Jergetal AO and On-Archa AO (pasture Jergetal AO green colour; pasture On-Archa AO blue colour). (Source: Map from Kyrgyz Institute of Geography).

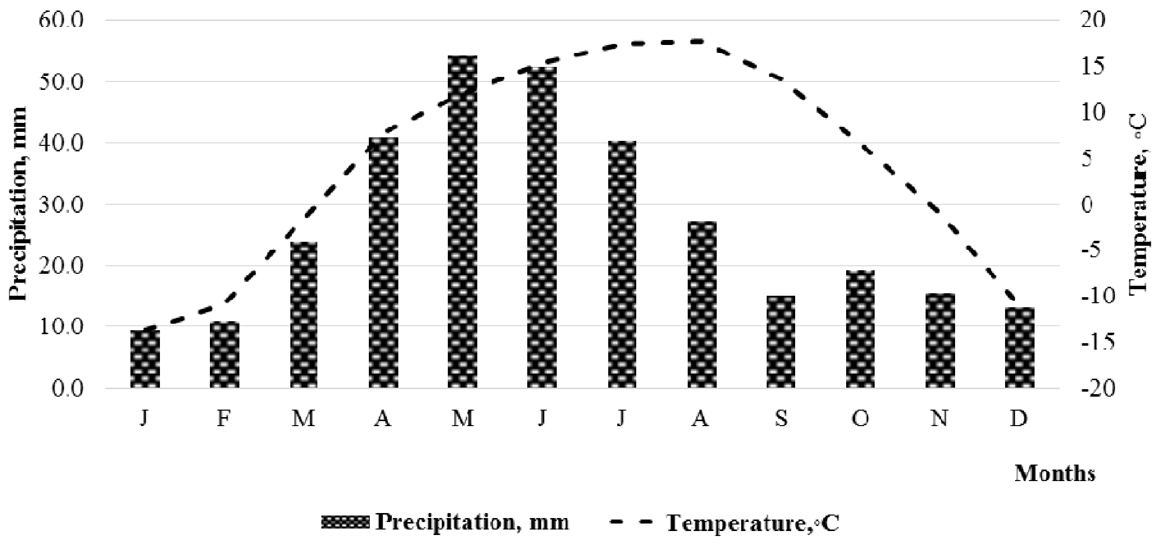



Figure 3. Mean monthly precipitation and temperature for the study area of Jergetal AO and On-Archa AO for 1993-2006. (Source: adapted from the Naryn Regional Meteorology Station).

The total pasture area allocated to the Jergetal AO covers 91,579 ha, out of which summer pastures cover 49,278 ha, spring-autumn pastures 24,179 ha and 11,643 ha winter pastures. On-Archa AO has 20,244 ha of pasture lands, but there are no winter pastures (Bussler 2010).

Today, most herders use the winter pastures (near villages) or spring-autumn pastures all year round. Traditional summer pastures are not utilized due to bad infrastructure and low profitability, leaving the meadows, meadow-steppes and steppes underused or totally unused, and this is reflected in the vegetation and soil condition (Alimaev et al. 2008).

Vegetation in the region is characterized as meadow or meadow-steppe (dominated by *Carex stenophylla*, *Carex stenocarpa*, *Festuca valesiaca*, *Geranium collinum*) at an altitude of < 2,400 m, and steppe and semi-desert located at an altitude of 1,500-2,300 m (dominated *Stipa caucasica*, *Artemisia tianschanica* and *Artemisia serotina*) (Fig. 4) (Rahim et al. 2008).


Figure 4. Community types on the study area: semi-desert is located at altitudes between 1,500–2,500 m (dominated by *Artemisia tianschanica* and *Artemisia serotina*); the steppe community types are found at altitudes between 2,000 and 2,700 m (dominated by *Festuca valesiasa*, *Stipa caucasica*). The meadow and meadow-steppe are found at altitudes between 2,400 and 3,.000 m (dominated by *Carex stenophylla*, *Carex stenocarpa*, *Festuca valesiaca*, *Geranium collinum*). (Photos: S. Bussler, 2009).

The pasture season begins in April when the spring pasture grazing starts. After 40-50 days the livestock are moved to the summer pastures. The summer season starts on the 1st of June and continues till the end of September. In September all animals are moved to the autumn pasture and arable lands (Rahim et al. 2008).

### 3.2. Data collection and sampling

The sampling of the vegetation was conducted every season from May to September in 2009 and 2010. Biomass production was measured within 1 m² plots, using the Braun-Blanquet-scale (Braun-Blanquet 1965). All vegetation was then clipped and separated into palatable and unpalatable parts. The clipped samples were dried at room temperature and weighed.

The plant samples were collected from four community types: semi-deserts (1,500-2,500 m), steppes (2,000-2,700 m) and meadow-steppes and meadows (2,400-3,000 m). In addition to sampling these four community types, demonstration plots were established at two sites in the Jylandy-Too at semi-desert types (Jergetal AO) (Bussler 2010). The plots were fenced with a metal net, thus allowing for comparison of grazing and no-grazing in that area.

Data were analysed using SPSS 16.0 (SPSS Inc.). Tests applied were one-way Analysis of Variance (ANOVA) followed by Bonferroni post-hoc tests where appropriate. Data were tested for normality before analyses were carried out.

## 4. RESULTS

### 4.1 Biomass production for different community types

Biomass production differed by community type and in both years. The year 2009 was wet, and the biomass production was high in the four community types. The meadow type of biomass production was 1.3±0.44 t/ha, followed by the meadow-steppe with 1.1±0.21 t/ha, steppe 1.2±0.17 t/ha and semi-desert 0.9±0.22 t/ha. The results 2010 showed the highest biomass production in the vegetation season in the semi-desert type 1.3±0.22 t/ha compared with the other community types (Fig 5). Biomass production did not differ significantly between community types and year ($p>0.05$). The biomass between years decreased 12% but the difference was not statistically significant (Table 1, Fig. 5). Palatable biomass decreased between years ($p<0.05$), but was not significant between community types ($p>0.05$) (Fig. 6).

### 4.2 Cover and height change in the different community types

Figure 7 shows the mean cover. It was not significantly different between years and community types ($p>0.05$). The mean cover for the meadow and meadow-steppe consisted of two layers, and grasses had more density. The meadow type cover was 95% in both years and meadow- steppe cover was about 75%. In the meadow and meadow-steppe types the height of grass varied between 20.0 cm - 26.5 cm. In the steppe and semi-desert types it ranged from 36.0 cm - 39.3 cm. (Table 2, Fig. 7). There was a two-layer with *Artemisia tianschanica* dominating. In the steppe and semi-desert types, vegetation cover differed between the years, ranging from 48 - 57%.

### 4.3 Changes in vegetation composition on the grazed and non-grazed plots

An increase in vegetation cover occurred due to the changes in composition of the grass vegetation. The number of plant species in the fenced area increased with a change in dominance between *Artemisia tianschanica, Carex turkestanica, Kochia prostrata,* and *Bromus tectorum* (Table 3, Fig. 8).

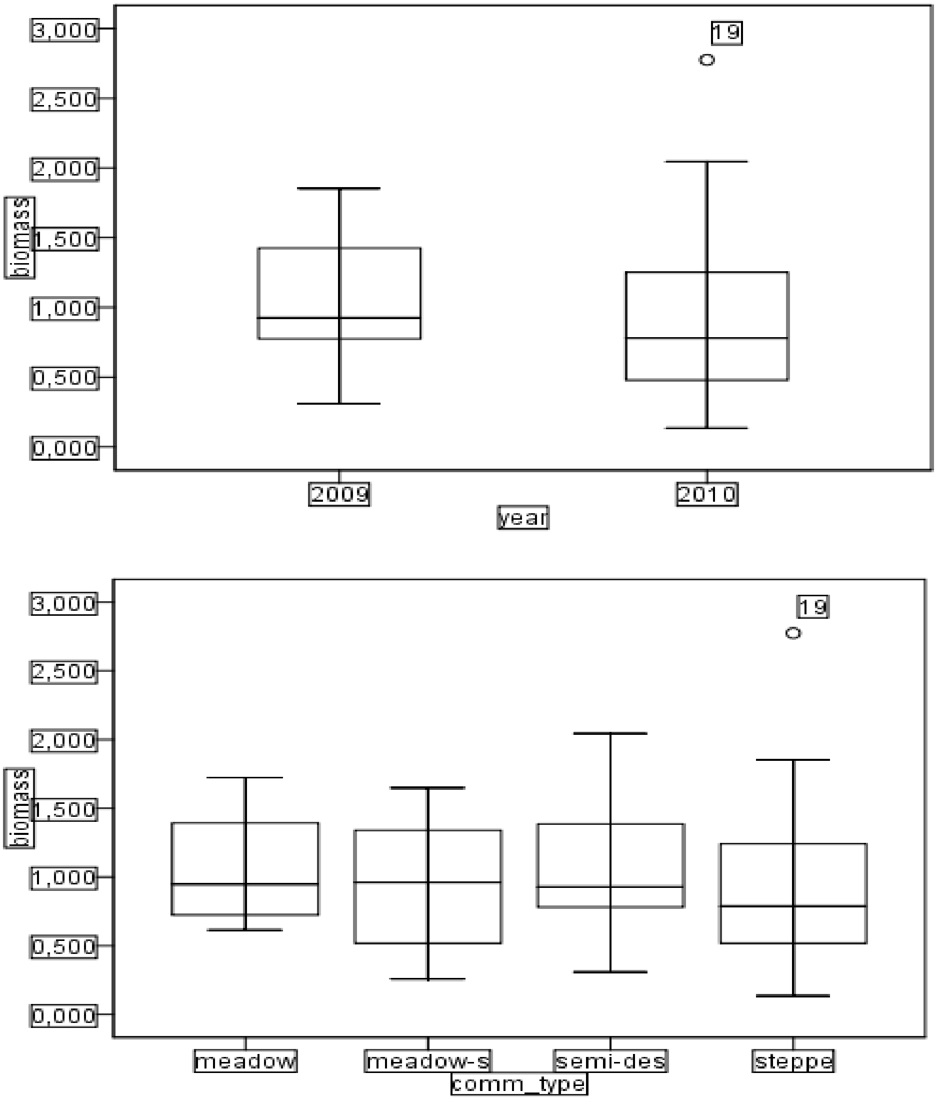



Figure 5. Box plots showing biomass production (%) for 2009 and 2010 (upper) and community types (lower). The difference is not significant ($p>0.05$)

Table 1. Mean ±standard error of total vegetation cover (%), vegetation height (cm), biomass (t/ha), palatable biomass (t/ha) of the four community types for 2009 and 2010.

| | **Community type** | | | |
|---|---|---|---|---|
| | **Semi-desert** | **Steppe** | **Meadow-steppe** | **Meadow** |
| Biomass (t/ha) | 1.07±0.15 | 0.989±0.18 | 0.928±0.20 | 1.05±0.23 |
| Palatable biomass (t/ha) | 0.675±0.13 | 0.576±0.11 | 0.711±0.13 | 0.635±0.15 |
| Cover (%) | 52.5±44.8 | 51.4±26.6 | 76.8±51.8 | 95.0±0.0 |
| Height (cm) | 37.5±34.5 | 34.5±31.6 | 22.3±48.7 | 23.0±38.3 |

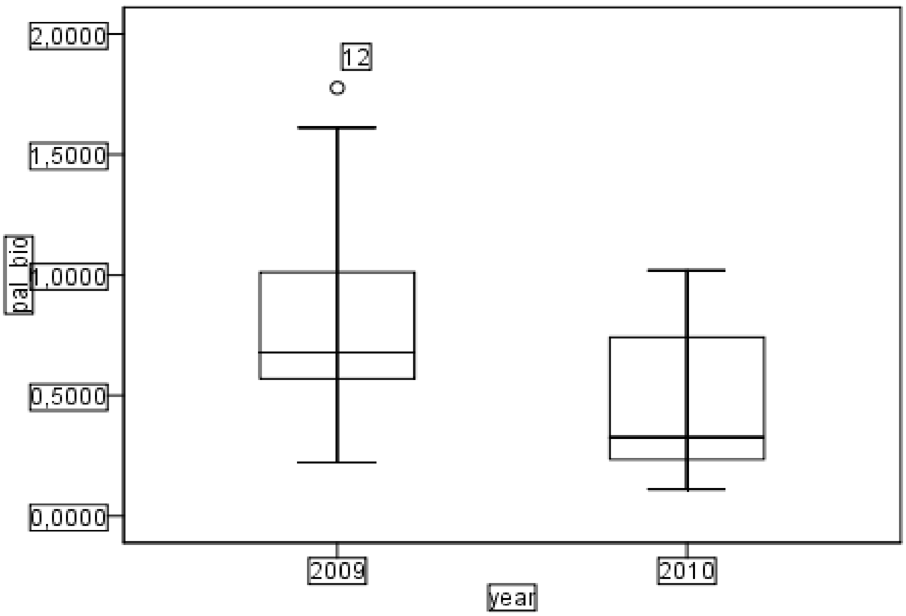



Figure 6. Box plot showing palatable biomass (t/ha) of the meadow, meadow-steppe, steppe and semi-desert community types for 2009 and 2010.

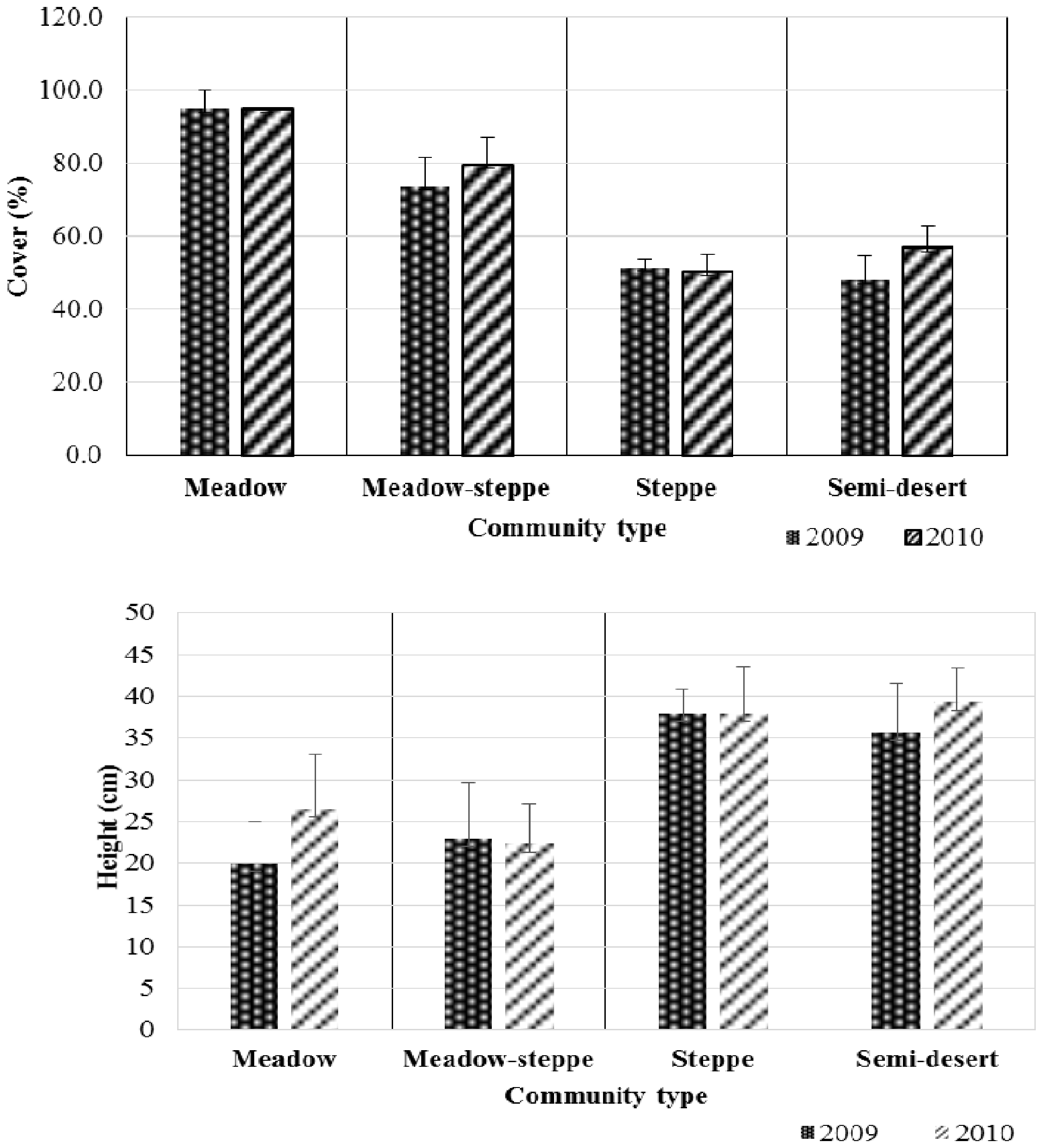



Figure 7. Mean cover (%) and grass height (cm) of the meadow, meadow-steppe, steppe and semi-desert community types in 2009 and 2010. Vertical bars represent ±SE.

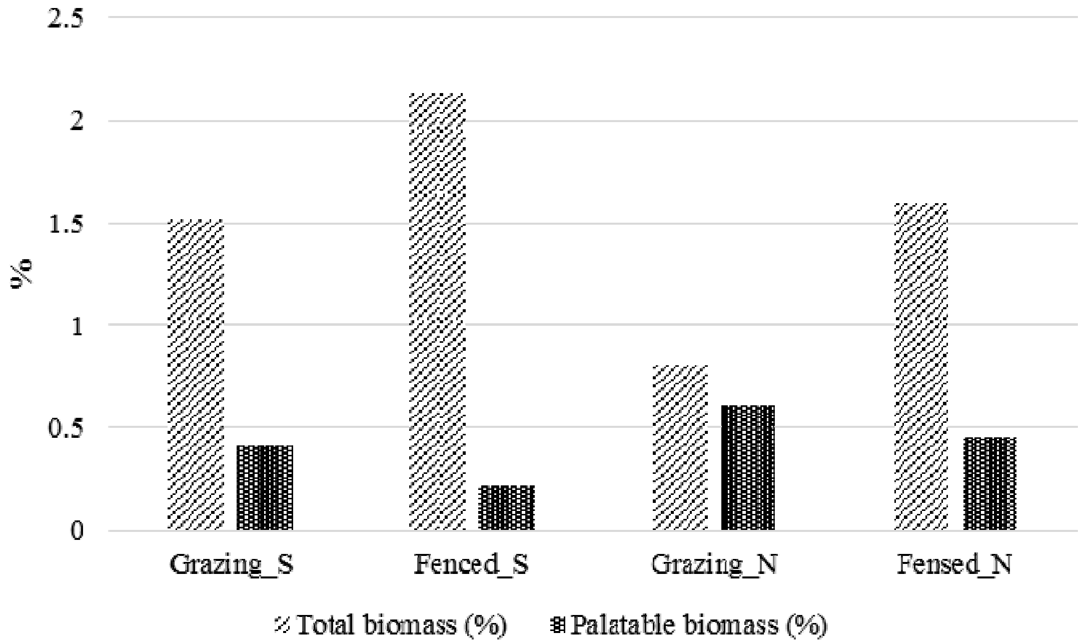
Table 2. Mean ±standard error and standard deviations, max and min of total cover (%), height (cm), biomass (t/ha), palatable biomass (t/ha) of community type in 2009 and 2010 respectively

| Parameters | **2009** | | | | **2010** | | | |
|---|---|---|---|---|---|---|---|---|
| | **Mean±SE** | **SD** | **Max** | **Min** | **Mean±SE** | **SD** | **Max** | **Min** |
| Cover* | 60±4.5 | 19.6 | 100 | 35.0 | 65.2±4.6 | 20.2 | 98.0 | 32.5 |
| Height* | 28.6±2.7 | 12.1 | 50.0 | 8.0 | 33.1±3.0 | 13.2 | 60.0 | 14.0 |
| Biomass* | 1.04±0.1 | 0.45 | 1.8 | 0.309 | 0.956±0.1 | 0.6 | 2.775 | 0.134 |
| Palatable biomass** | 0.816±0.9 | 0.42 | 1.7 | 0.222 | 0.471±0.6 | 0.3 | 1.01 | 0.111 |

Table 3. Distribution of species variation on demonstration plots of Jylandy-Too (Fenced_S, Fenced_N), Jergetal AO.

| Point | Covera-ge, % | Height, cm | Palatable plants | Cover Braun-Blanquet | Unpalatable plants | Cover Braun-Blanquet |
|---|---|---|---|---|---|---|
| **2009** | | | | | | |
| | | | *Artemisia tianschanica* | 1 | *Trigonella sp.* | 3 |
| | | | *Artemisia serotina* | r | *Meniocus linifolius* | 2 |
| | | | *Kochia prostrata* | + | *Lappula sp.* | 2 |
| **Fenced_S** | 80 | 20 | *Carex turkestanica* | 1 | *Roehelia leiocarpa* | 2 |
| | | | *Bromus sp.* | + | *Ceratocarpus utriculosus* | 3 |
| | | | *Stipa sp.* | r | *Heteracia szovitsii* | r |
| | | | | | *Lallemantia royleana* | + |
| | | | *Artemisia tianschanica* | 1 | *Astragalus sp.* | + |
| | | | *Stipa sp.* | + | *Centaurea sp.* | + |
| | | | *Carex turkestanica* | 1 | *Meniocus linefolius* | 1 |
| **Fenced_N** | 65 | 35 | *Ceratoides papposa* | r | *Astragalus sp.* | r |
| | | | *Kochia prostrata* | r | *Lappula sp.* | + |
| | | | *Agropyron sp.* | 1 | *Tulipa sp.* | r |
| | | | *Scaligeria allioides* | + | *Centaurea sp.* | 1 |
| ***2010*** | | | | | | |
| **Fenced_S** | 70 | 13, 4 | *Artemisia tianschanica* | 2a | *Trigonella sp.* | 1 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | *Allium sp.* | | *Meniocus sp.* | + |
| | | | *Kochia prostrata* | 2a | *Roehelia leiocarpa* | 2a |
| | | | *Carex turkestanica* | 2a | *Ceratocarpus utriculosus* | 3 |
| | | | *Bromus sp.* | 2m | *Lallemantia sp.* | 1 |
| | | | *Cerastium sp.* | 1 | *Tulipa sp.* | 1 |
| | | | | | *Malcolmia africana* | + |
| | | | | | *Ceratocephala sp.* | + |
| | | | *Hedysarum songaricum* | 2b | *Malcolmia africana* | + |
| | | | *Artemisia tianschanica* | 1 | *Meniocus linifolius* | 1 |
| | | | *Artemisia sp.* | 2a | *Roehelia leiocarpa* | 1 |
| | | | *Carex sp.* | 2a | *Leptaleum filifolium* | + |
| | | | *Potentilla sp.* | + | *Tulipa sp.* | + |
| **Fenced_N** | 75 | 25, 10 | *Kochia sp.* | 1 | *Aseracea sp.* | 1 |
| | | | *Polygonum sp.* | 2m | *Astragalus sp.* | r |
| | | | *Agropyron sp.* | + | | |
| | | | *Allium sp.* | + | | |
| | | | *Scaligeria sp.* | 2m | | |
| | | | *Festuca sp.* | 1 | | |
| | | | *Koeleria sp.* | 1 | | |
| | | | *Rosularia sp.* | + | | |
| | | | *Daucus sp.* | 1 | | |



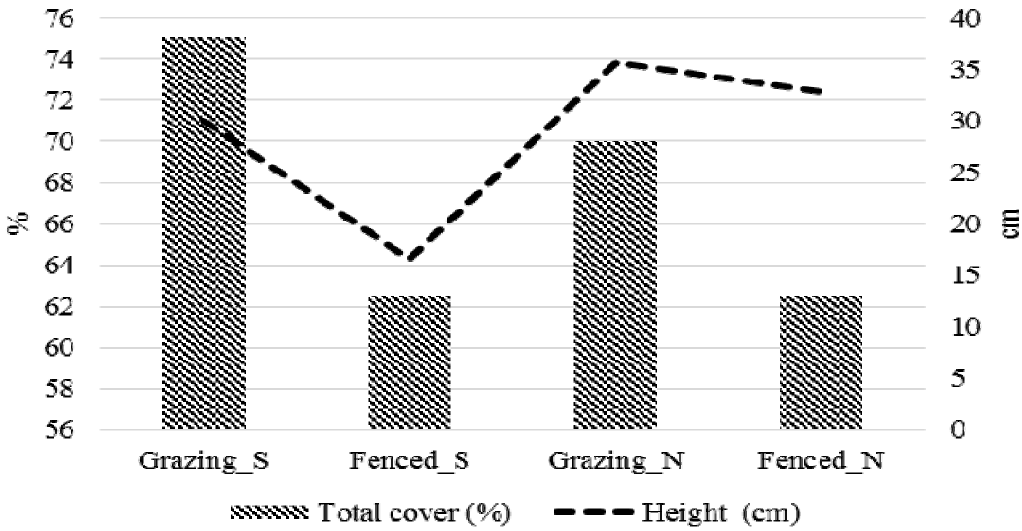




Figure 8. Changing of biomass (t/ha), palatable biomass (t/ha), total cover (%) and height (cm) of the grazing and fenced plots (2009-2010). (Grazing_S, Fenced_S represent plots with and without livestock grazing on the South slope, Grazing_N, Fenced_N represent plots with and without livestock grazing on the North slope). Vertical bars represent ±SE.

## 5. DISCUSSION

The quantity assessment of pasture productivity was performed based on the method "Monitoring of pastures" developed by The CAMP (Central Asia Mountain Partnership) Alatoo Public Foundation together with the Kyrgyzgiprozem for the Pasture Committee.

The data for the assessment of pasture condition included only two years. This has limited the temporal span of the study and the data are therefore difficult to interpret, but this is the first available information on pasture condition in decades. On the plus side, the study covered pasture resources found in the different altitudinal zones.

The biomass production was different between years in the all community types. The meadow type vegetation cover was 95% in both years. In the steppe and semi-desert types, vegetation cover was different between years (48-57%).

Vegetation cover is an important ecological characteristic and reflects the land condition. Vegetation cover varied between seasons and years. The assessment of pasture range is difficult because of the high degree of variability in plant biomass.

Biomass production, cover and height of grass were variable, and quality and quantity of pasture production differed between the community types. The meadow type (summer pasture) biomass production and vegetation cover were very high, but it included more unpalatable plants.

According to Shigaeva et al. (2007) unbalanced placement of livestock and intensive use of spring-autumn pasture has caused forage productivity to increase from 5 to 22% since 1978. However, the unbalanced placement of livestock in winter and spring-autumn pastures increases the risk of pasture degradation (Baibagushev 2011).

Graf (1988) indicated that the impacts of grazing animals can be confused with, or compounded by, the effects of climate on the landscape because severe drought, especially in arid and semi-arid areas, can also cause the deterioration of the vegetation cover.

For early detection of the negative changes monitoring should be carried out in time in order to help find alternative approaches (Westoby et al. 1989). To assess measures to restore degraded land monitoring is also needed. In order to prevent degradation of the land it is necessary to have a set of indicators sensitive to environmental stresses (Herrick et al. 1995).

## 6. CONCLUSION

A total of 40 sites were established for each vegetation type. This study showed that pasture productivity depends on climate variation and community types. A good pasture user and management plan will lead to improved pasture production. Furthermore, this study showed that the meadow type had a high biomass production and there was change in composition of herbage on the unpalatable plants.

The research on monitoring of pastures in the community types should continue by taking temperature and precipitation into account. The Pasture Committee has developed a pasture user plan which includes making use of remote pastures and strengthening control over the use. The kind of data used in this study will help them in their quest for sustainable land management.

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## LITERATURE CITED

Akhmadov K, Breckle S, Breckle U (2006) Effects of grazing on biodiversity, productivity and soil erosion on alpine pastures in Tajik mountain. Pages 253-256 In: Spehn E, Liberman M, Körner C (eds) Land use change and mountain biodiversity 2006: Boca Raton, Taylor, Francis

Alimaev I, Kerven, C, Torekhanov A, Behnke R, Smailov K, Yurchenko V, Sisatov Z, Shanbaev K (2008) The Impact of livestock grazing on soils and vegetation around settlements in south-east Kazakhstan. Pages 81-112 In: Behnke R (eds) The Socio-economic causes and consequences of desertification in Central Asia, NATO and Springer Dordrecht

Baibagushev E (2011) Recent changes in pastoral systems: Case study on Kyrgyzstan. Pages102–118 In: Kreutzmann H, Abdulalishoev K, Zhaohui L, Richter J (eds) Pastoralism and rangeland management in mountain areas in the context of climate and global change 2010. Regional workshop in Khorog and Kashgar, Bonn, Germany, 14–21 July 2010, Springer, Berlin

Braun-Blanquet J. (1965) Plant Sociology: The study of plant communities. Hafner, London

Bussler S (2010) Community based pasture management in Kyrgyzstan, Bishkek

Brylski P, Schillhorn-van Veen T, Eliste P (2001) Kyrgyz Republic. Mountain Rangeland and Forest Sector Note. Environmentally and Socially Sustainable Development Working Paper 33. 10 Sept 2001. World Bank, Washington, DC

Feng Y, Lu Q, Tokola T, Lui H, Wang X (2009) Assessment of grassland degradation in Guinan country, Qinghai Province, China, in the past 30 years. Land Degradation Development 20:55-68

Graf W (1988) Fluvial Processes in Dryland Rivers. Springer, New York.

Herrick J, Whitford W, Soyza A, Van Zee J (1995) Soil and vegetation indicators for assessment of rangeland ecological condition. Pages 157-166 In: Celedonio A, (eds) North American workshop on monitoring for ecological assessment of terrestrial and aquatic ecosystems. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station

Isakov K (1975) Pastures and hay meadow of the Kyrgyz SSR: Classification, use, reclamation and intensification. Kyrgyzstan, Frunze

Kerven C, Steimann B, Ashley A, Dear C, Rahim I (2011) Pastoralism and farming in Central Asia. http://www.ucentralasia.org/downloads/pastoralism_and_farming_in_central_asia_mountains.pdf; (accessed 15 July 2015)

Ludi E (2004) Management of high pastures under changing socio-economic conditions in Kyrgyzstan. Centre for Development and Environment (CDE) Bern, Switzerland

Mamytov A (1987) Utilization and conservation of land resources of the mountains of Central Asia and southern Kazakhstan. Pages 379-427 In: Manzoor A, Habeeb K (eds) Regional imperatives in utilization and management of resources: India and the USSR. Concept Publishing, New Delhi.

Penkina L (2004) Natural pastures and ethno-cultural traditions. Bishkek, Kyrgyzstan

Rahim I, Maselli D, Rueff H, Wiesmann U (2011) Indigenous fodder trees can increase grazing accessibility for landless and mobile pastoralists in Northern Pakistan. http://www.pastoralismjournal.com/content/1/1/2 (accessed 20 August 2015)

Rahim I, Maselli D (2008) Baseline study for project on participatory pasture management in Jerge Tal watershed, Kyrgyzstan. Bishkek, Kyrgyzstan

Shamsiev B (2006) Kyrgyz Republic livestock sector review: Embracing the New Challenges. World Bank, Bishkek, Kyrgyzstan

Shigaeva J, Kollmair M, Niederer P, Maselli D (2007) Livelihoods in transition: Changing land use strategies and ecological implications in a post-Soviet setting (Kyrgyzstan). Central Asian Survey 26:389-406

Steimann B (2010) Making a living in uncertainty: Agro-pastoral livelihoods and institutional transformations in post-socialist rural Kyrgyzstan. PhD Dissertation, University of Zurich, Switzerland

Undeland A (2005) Kyrgyz livestock study: Pasture management and use. World Bank, Bishkek

Undeland A (2008) Women and pastures in the Kyrgyz Republic on a case study of Chong Alai Valley. Case study for IUCN-WISP, Nairobi. 12th Biennial Conference of the International Association for the Study of the Commons. Cheltenham, United Kingdom http://iasc2008.glos.ac.uk/conference%20papers/papers/U/Undeland_231401.pdf (accessed on 24 June 2015)

Westoby M, Walker B, Noy-Meir I (1989) Opportunistic management for rangelands not at equilibrium. Journal of Range Management 42: 266-274