Research on vegetation composition and biomass production in the Ural (Kazakhstan) steppe ecosystem for the solution of Human-Wildlife conflict

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Karaganda, Kazakhstan
2023-2024

Acknowledgements

The outcome of this research has been possible due to the appreciable contribution of various persons and programs. I sincerely thank the Rufford Foundation for their generous support of my research on human-wildlife conflict, which became the foundation of my master's thesis in the field of Landscape Ecology and Nature Conservation at the University of Greifswald. This project would not have been possible without their funding and belief in the importance of conserving wildlife and addressing pressing ecological challenges. Their contribution has been instrumental in enabling the successful completion of this research, which aims to promote coexistence between humans and wildlife.

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1. Introduction

In 2023, Kazakhstan's saiga antelope population was recorded at an estimated 1.9 million individuals, based on the records of the spring aerial survey (Krivosheeva, 2023). This figure surpasses the peak numbers reported during the Soviet period, highlighting a significant triumph in conservation efforts. Despite this success, the rising saiga population has sparked increased instances of human-wildlife conflict, particularly with agricultural activities. Farmers have reported various challenges, including saiga herds encroaching on croplands, hay grounds, and pastures, heightening fears of disease transmission to livestock. Additional issues cited by the agricultural community include saigas monopolizing water resources, livestock newborns being lost among migrating saiga herds, and the hygiene and physical disturbances presented by deceased saigas on agricultural lands. These factors have contributed to a growing anti-saiga sentiment among farmers within the Ural population's range and increasing calls for a controlled reduction in saiga numbers and their restriction to designated protected territories (Michel et al., 2023).

Grachev et al. (2023) have stressed the importance of implementing saiga population management strategies to effectively balance their numbers with human land-use needs. To reconcile the interests of saiga conservation with agricultural necessities in the Ural region, the establishment of protected areas was suggested and subsequently realized with the creation of the “Bokeyorda” State Nature Reserve, encompassing 343,040 hectares, and the “Ashiozek” Nature Sanctuary, spanning 314,504 hectares (Grachev et al., 2023). However, these measures did not fully mitigate the conflicts. Continuous complaints from the agricultural sector in western Kazakhstan led the government to contemplate a regulation (culling of 80,000 saigas) program in October 2022. The proposal faced considerable public resistance, prompting the exploration of alternative solutions. Lacking other viable options to alleviate the rising tensions between human and wildlife populations, the government instituted a population number control program in 2023. This initiative aimed to harvest approximately 300,000 saiga individuals to address the ongoing human-wildlife conflict effectively in the Ural and Betpakdala populations.

Local stakeholders – village leaders, farmers, and the protected areas administration as well as regional nature protection staff – expressed concerns that the high numbers of saiga causes increasing competition with farmers’ livestock and may already exceed the carrying capacity of their habitat. On the other hand, there are large areas of the former saiga habitat in this region are not being used by the animals, although these areas are most likely still suitable for saiga (Michel et al., 2023).

2. Aim of the study

The aim of this study is to examine the ongoing conflict and to identify a resolution path for the favourable coexistence of humans and saigas in Kazakhstan.

The objectives of the research are:

- To study the ongoing conflict between humans and saigas
- To determine the causes of the conflict/complaints from the local population regarding saigas
- To identify areas with an available biomass as a fodder source for the saiga and livestock
- To identify primary data materials for developing recommendations for decision-makers in the Republic of Kazakhstan

The tasks of my study is to find answers to the following questions:

1. Does a conflict between farmers and the Ural population of saigas truly exist?
2. If the conflict exists, what are its characteristics, specifically, frequency and territories?
3. What are the future perspectives of the saiga conservation in Kazakhstan?

3. Methods:

Identification of observation areas

In order to conduct plant surveys on an ecological level, it is necessary to differentiate plant formations. Their spatial extension is shown on a vegetation map (MAP 2), which does in return help to understand and manage our environment (Dieterich, 2014). However, due to the understudied nature of the territory in question and the absence of a detailed vegetation map, this study relied on satellite imagery (USGS Landsat collection 2, Level-2) to identify homogenous landscape patches within the research area. Subsequently, in situ verification was conducted to sample areas with uniform vegetation as identified from the satellite data. The data for my study were collected during fieldwork on 108 plots measuring 5x5 meters. Vegetation abundance assessment was conducted by counting species composition and assessing their dominance on each plot.

Vegetation sampling and biomass assessment plots

Depending on the average size of individual plants, different habitat types require different plot sizes in order to include a representative set of species in a vegetation sample, while at the same time keeping observation efforts at a reasonable level (Etzold et. al., 2017). Given the predominance of pastures and hay meadows in our study area, plots of 5x5 meters (25 m^2) were designated for general sampling of vegetation composition and structure, and smaller plots of 3x3 meters (9 m^2) were used for biomass production assessment. Sampling of vegetation composition and structure mainly conducted in fall (October 2023/2024).

The sampling plots were strategically placed to encapsulate the visually recognizable diversity of the vegetation composition and site conditions present at a specific site. These included areas with uniform vegetation cover, areas with scant or no vegetation, and mixed areas where approximately 50% featured high vegetation cover while the remaining 50% had low vegetation cover (Figure 1).

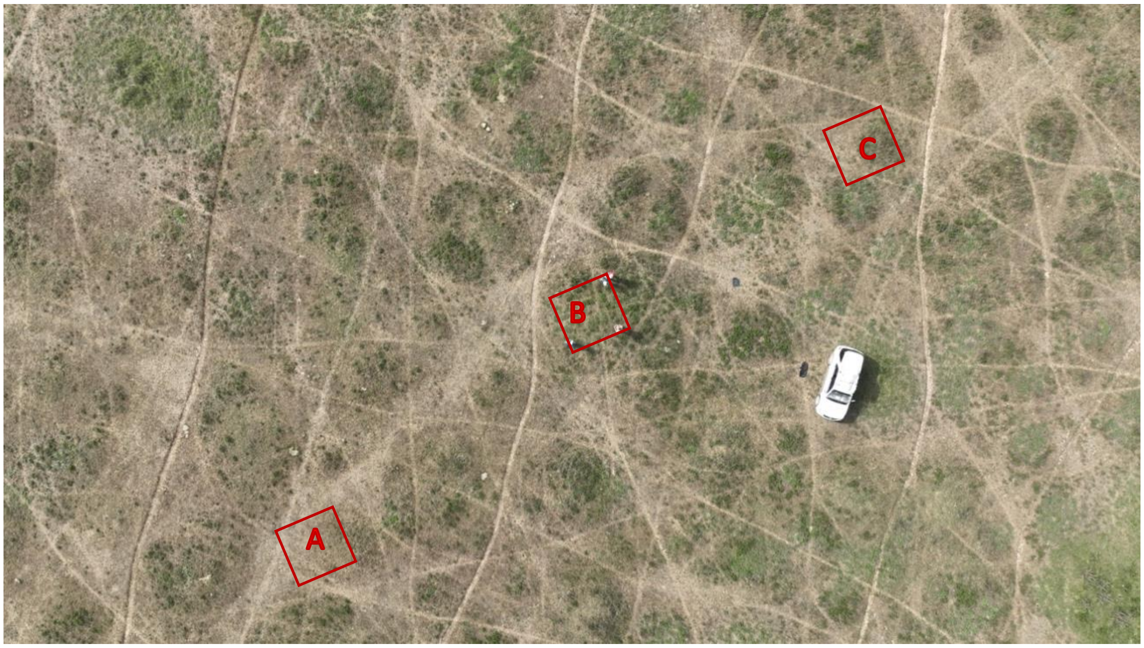

Figure 1. Example of observation sites. A: plot with the minimum vegetation; B: plot with the maximum vegetation; C: mix plot. Elevation 50 m. above the ground. Photo: Aibat Muzbay.

Vegetation composition and structure sampling was conducted according to the ZARCHARIAS/LONDO scale (Table 1) to estimate the species abundance. Moreover, extra information about the height of plants (maximum, minimum and the average mean), litter coverage, saiga/livestock trails, faeces amount (number of droppings), harvest was collected (Annex 1).

Biomass assessment plots were mainly set at the areas which has the most representative value of the site. There were two types of biomass collection plots: open and fenced. Vegetation inside the plots were totally mowed to represent the maximum impact from the herbivores and assess the biomass production in two ways (Figure 2):

1. Biomass growth impacted by herbivory, including separate assessments for the influence of saigas, livestock, and combined grazing pressures.
2. Unimpacted biomass growth, for which plots were fenced to preclude grazing by saigas and/or livestock.

Both types of plots for biomass production assessment were first, described as a standard vegetation sampling plots with collecting all information presented in Annex 1. Then the grass was mowed with scissors and collected with the separation dry and green biomass. All collected biomass were fully dried and weighted.

Figure 2. Examples of fenced and open biomass assessment plots. Poles for the fences were buried at a depth of 50 to 70 cm. Photo: Aibat Muzbay.

Table 1. LONDO AND ZACHARIAS scale for observation plots (Londo 1975, 1984; Zacharias 1996).

ZACHARIAS/ LONDO (1996)	%	Comments
r	<1	1 Ind.
+	<1	2-5 Ind.
0.1	<1	6-50 Ind.
0.1m	<1	>50 Ind.
0.2	1-3	
0.4m	1-3	>50 Ind.
0.4	3-5	
0.4m	3-5	>50 Ind.
1	5-15	
2	15-25	
3	25-35	
4	35-45	
5	45-55	
6	55-65	
7	65-75	
8	75-85	
9	85-95	
10	95-100	

4. Data analysis

The data from the vegetation survey plots were entered into a spreadsheet, with rows representing individual plots and columns representing plant species and their abundance.

Non-metric multidimensional scaling

For analysing these data using Non-metric multidimensional scaling (NMDS), the R programming environment and the RStudio were chosen for their powerful tools for statistical processing and data visualization.

The analysis process included the following steps:

Data Preparation: Data were cleaned of missing values and normalized to eliminate the potential impact of measurement scale differences.

Choice of Similarity Measure: Bray-Curtis distance, well-suited for ecological data on species composition, was chosen as the similarity measure.

Application of NMDS: Using the “metaMDS” function from the “vegan” package in R, NMDS analysis was performed. This stage involved determining the optimal number of dimensions and minimizing stress to achieve the best data representation.

The results of the NMDS analysis were presented as two-dimensional plot, where points represented individual vegetation sampling plots. The placement of points reflected the similarity of plots based on vegetation species composition: the closer the points, the greater the similarity. This allowed for the identification of patterns and grouping of plots with similar characteristics.

Hierarchical clustering

To understand the structural relationships and groupings in vegetation species composition data, the hierarchical cluster analysis method, specifically using the Ward.D2 method, was selected. This approach allows us to identify internal groups (clusters) among sampling plots based on species abundance, similarity, ensuring the minimization of variance within clusters and maximization of differences between them. Additionally, to assess the stability and reliability of the obtained clusters, a cluster consistency analysis was conducted.

Implementing of hierarchical clustering requires:

Data Collection and Preparation: Vegetation sampling plots were assessed based on species composition and other relevant characteristics, abundance. The data were transformed and standardized for further analysis.

Implementing Hierarchical Cluster Analysis with the “Ward.D2” method: The analysis was performed using the R-studio, allowing for the classification of observational plots into a certain number. The Ward.D2 method was chosen for its ability to minimize the sum of squared differences within each cluster, thereby providing high accuracy and relevance to the clustering.

Cluster Consistency Analysis: After the clusters were formed, their consistency was analysed to evaluate the stability and reliability of the grouping. Cluster consistency analysis helps determine how confidently each plant species can be attributed to a specific cluster, which is critically important for understanding ecological associations and relationships between species.

Vegetation map based on semi-automatic classification plugin in QGIS

Based on collected data from the observation plots on dominant species the map was created using the Geographic Information System (QGIS) software. In QGIS the Semi-Automatic Classification Plugin (SCP) was used which allows for the supervised classification of remote sensing images, providing tools for the download, the preprocessing and postprocessing of images. However, the images were downloaded from the webpage of the U.S. Geological Survey (USGS). As most of our vegetation samplings were conducted in fall, the Landsat 8-9 collection 2 level 2 images were downloaded for 09.11.2023 which perfectly shows conditions of land cover during our field work. Supervised classification was conducted based on the reflectance of the bands 4-3-2 (RBG).

Due to large sizes of pixels (30 m) detailed mapping was not possible. Nevertheless, it was possible to create the map based on Dominant Vegetation Formations (DVF) to minimize the classification error. In total 115 training points were used to create the final map, including 85 training points from our vegetation sampling plots (based on dominant species); 10 training points for the salt pans (solonchak), 10 training points for water bodies (rivers, seasonal streams and lakes); 10 training points for the artificial infrastructures (roofs of the buildings).

5. Land use in the region

Livestock management is a driving factor of anthropogenic climate change, vegetation community composition, nitrogen cycling, and biomass production (Wirsenius, 2003; FAO, 2009, 2011; Galloway et al., 2010). Livestock over-grazing caused by overstocking, grazing during unsuitable seasons and/or continuous use of the same pasture over long periods of time is associate with decreased fertility, reduced plant diversity, soil degradation, and an increase in the release of carbon and nitrogen into the atmosphere (Love and Eckert, 2006; Hilker et al., 2013). Livestock-dominated ecosystems also inevitably have impacts on other, wild fauna, from migrating large mammals to small, burrowing rodents (Li et al., 2016; Arrondo et al., 2019; Ventresca-Miller et al., 2020).

Livestock farming is the predominant economic activity in the region, shaping the use and management of the environment to support and enhance livestock conditions. There are two types of pastures within the area: communal pastures where every villager has the right to graze their livestock and the lands rented to peasant farms that can be used for cultivation of crops, pastures and/or hay grounds depending on the type of lease contract. The allocation of land for farming by private individuals or cooperatives began with the country's independence. The primary purpose of the lands granted to peasant farms is agricultural activity, in the study area utilized mainly as pastures and hay grounds. Land tenure terms for farmers varies, with leases ranging from 10 to 49 years.

According to the land cadastre data, the studied territory has been divided among 235 entities (individual farmers, private enterprises, and Limited Liability Partnerships), totalling 991 land parcels in the study area. However, the total number of the land plots leased by farmers is more than 1,500. This research analysed the dynamics of the development of lands leased by farmers in the region (Figures 3; 4; 5; 6; 7).

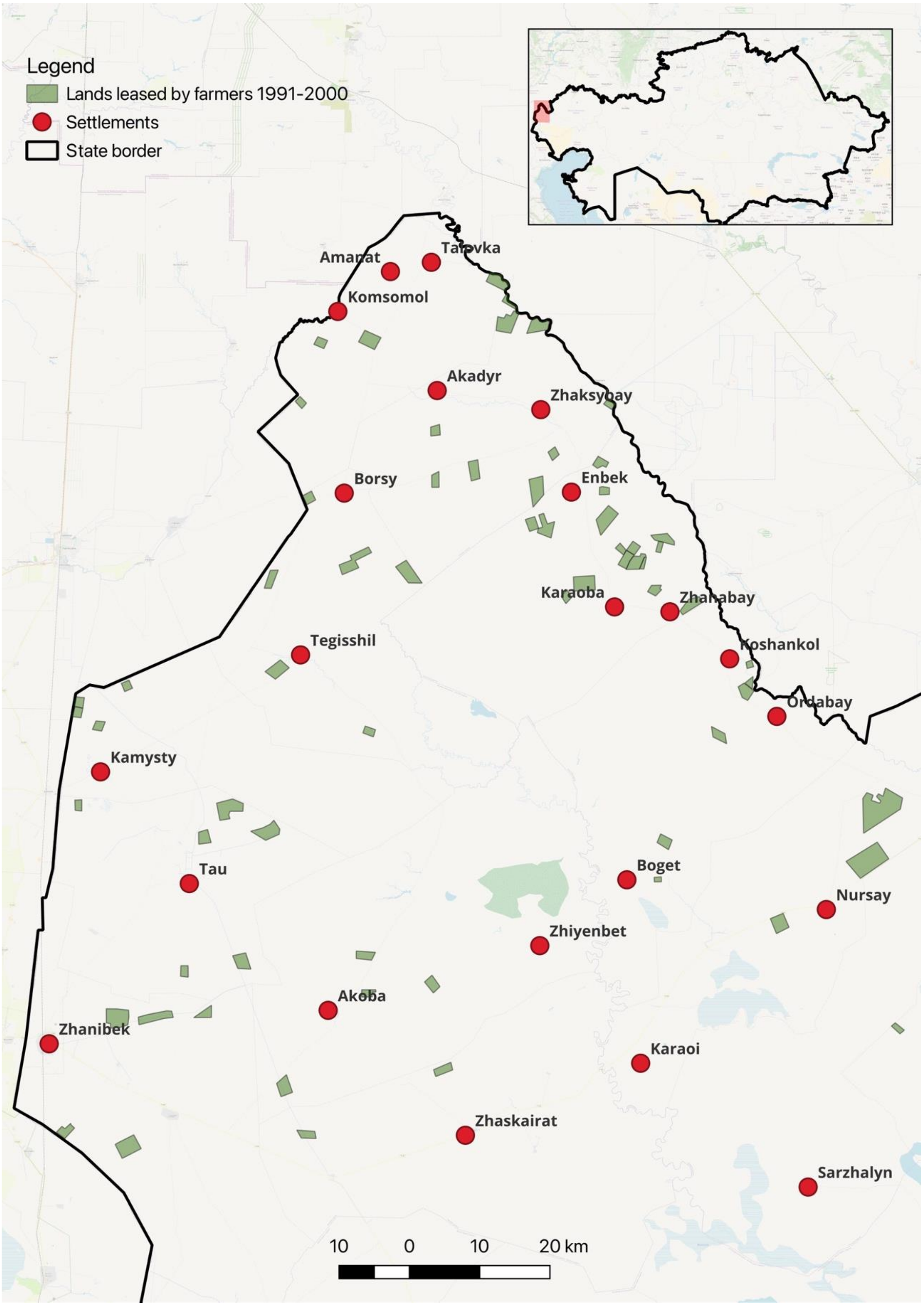

Figure 3. Lands leased by farmers from 1991 to 2000.
Due to a severe economic crisis few farmers were able to rent land.
Map: Aibat Muzbay. Data Source: Land Cadastre.

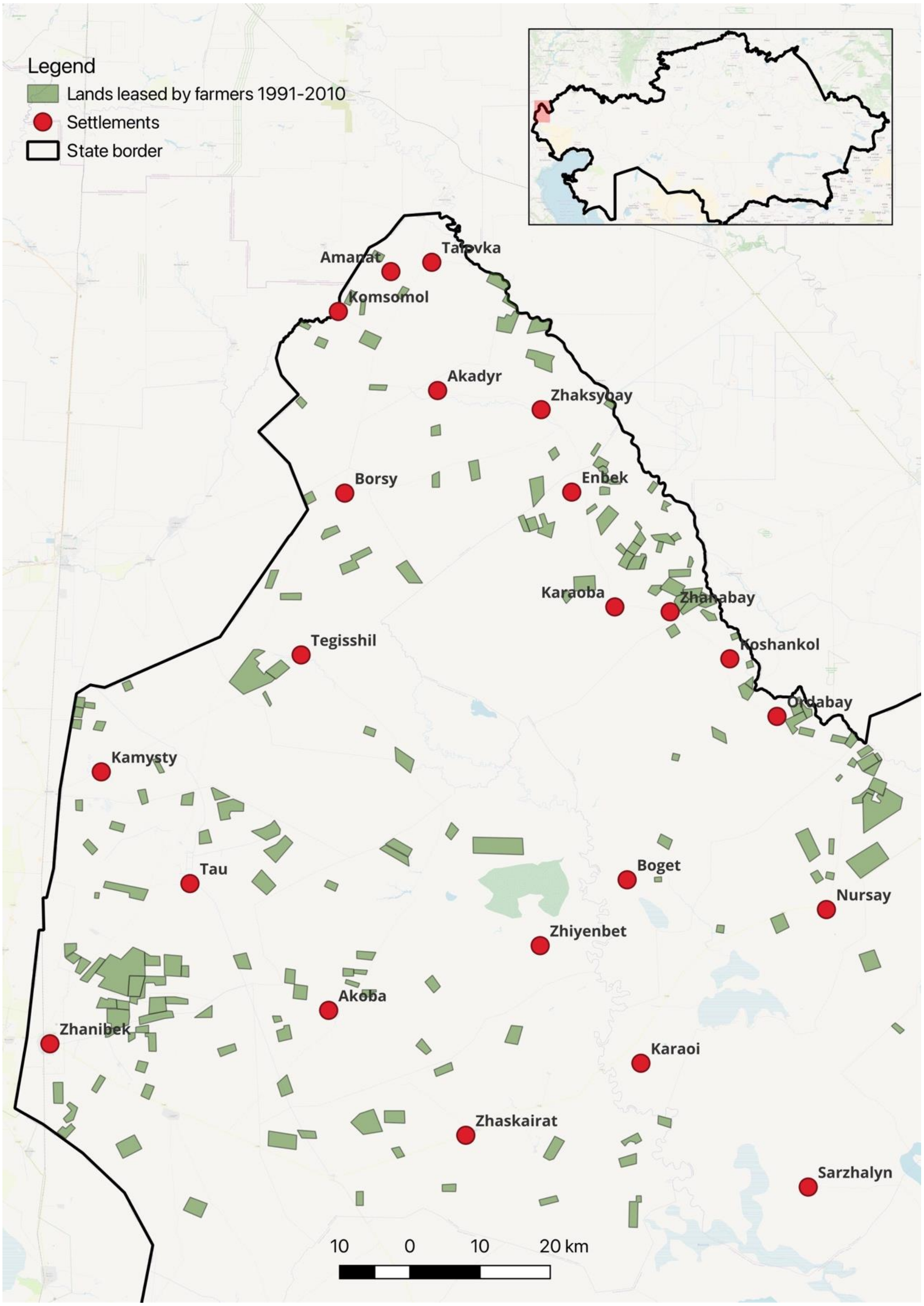

Figure 4. Lands leased by farmers from 1991 to 2010.
Map: Aibat Muzbay. Data Source: Land Cadastre.

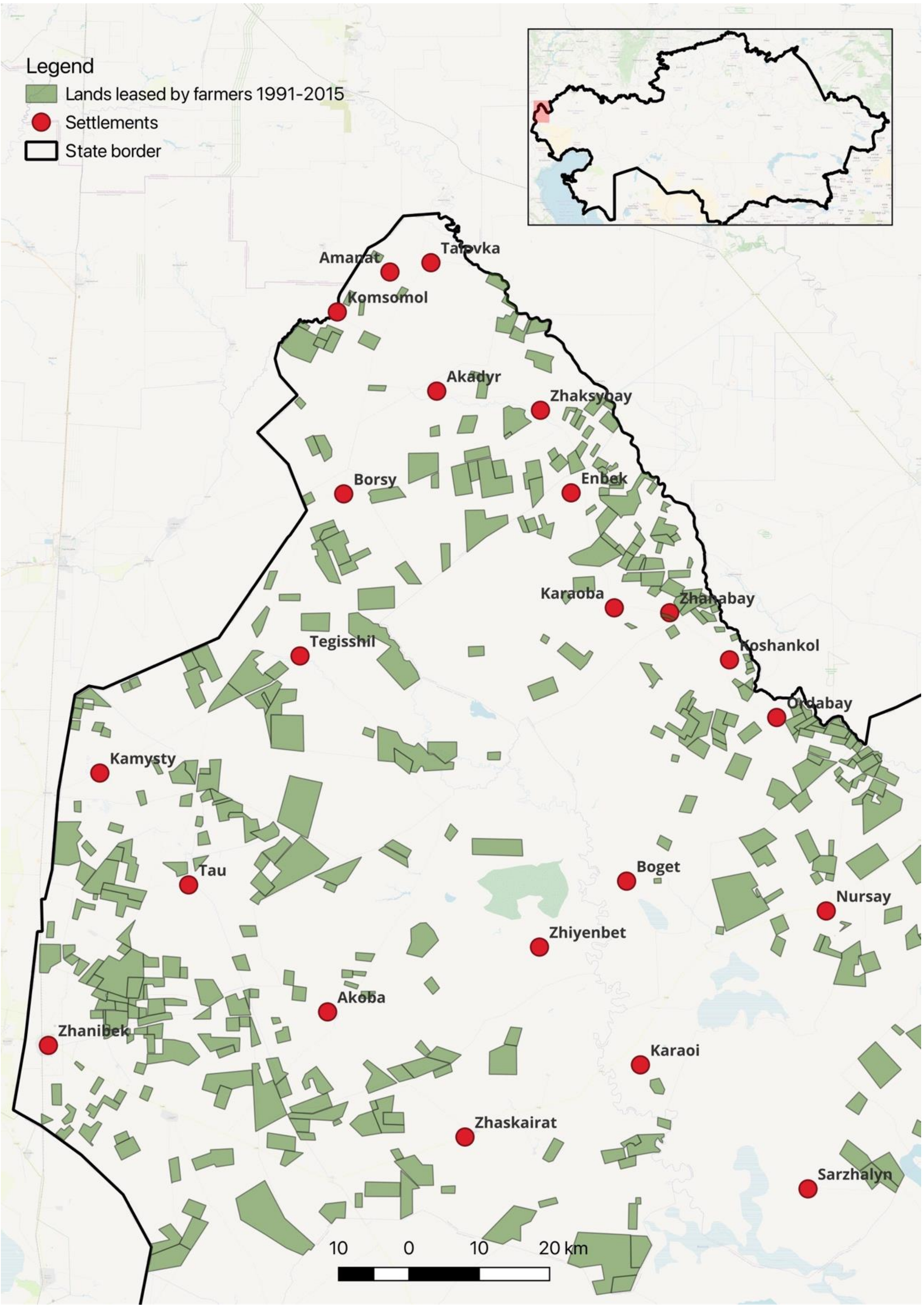

Figure 5. Lands leased by farmers from 1991 to 2015.
Map: Aibat Muzbay. Data Source: Land Cadastre.

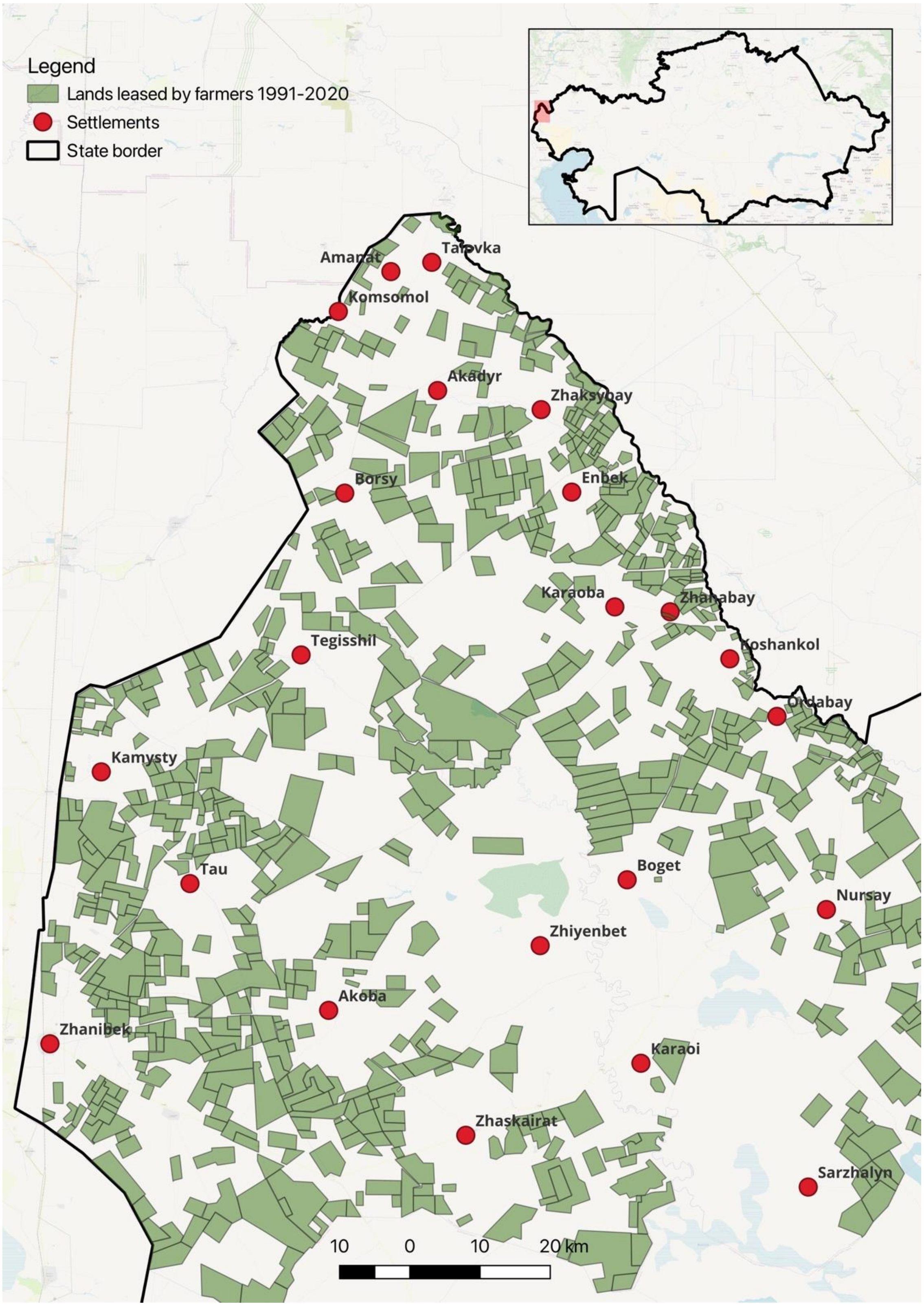

Figure 6. Lands leased by farmers from 1991 to 2020.
Map: Aibat Muzbay. Data Source: Land Cadastre.

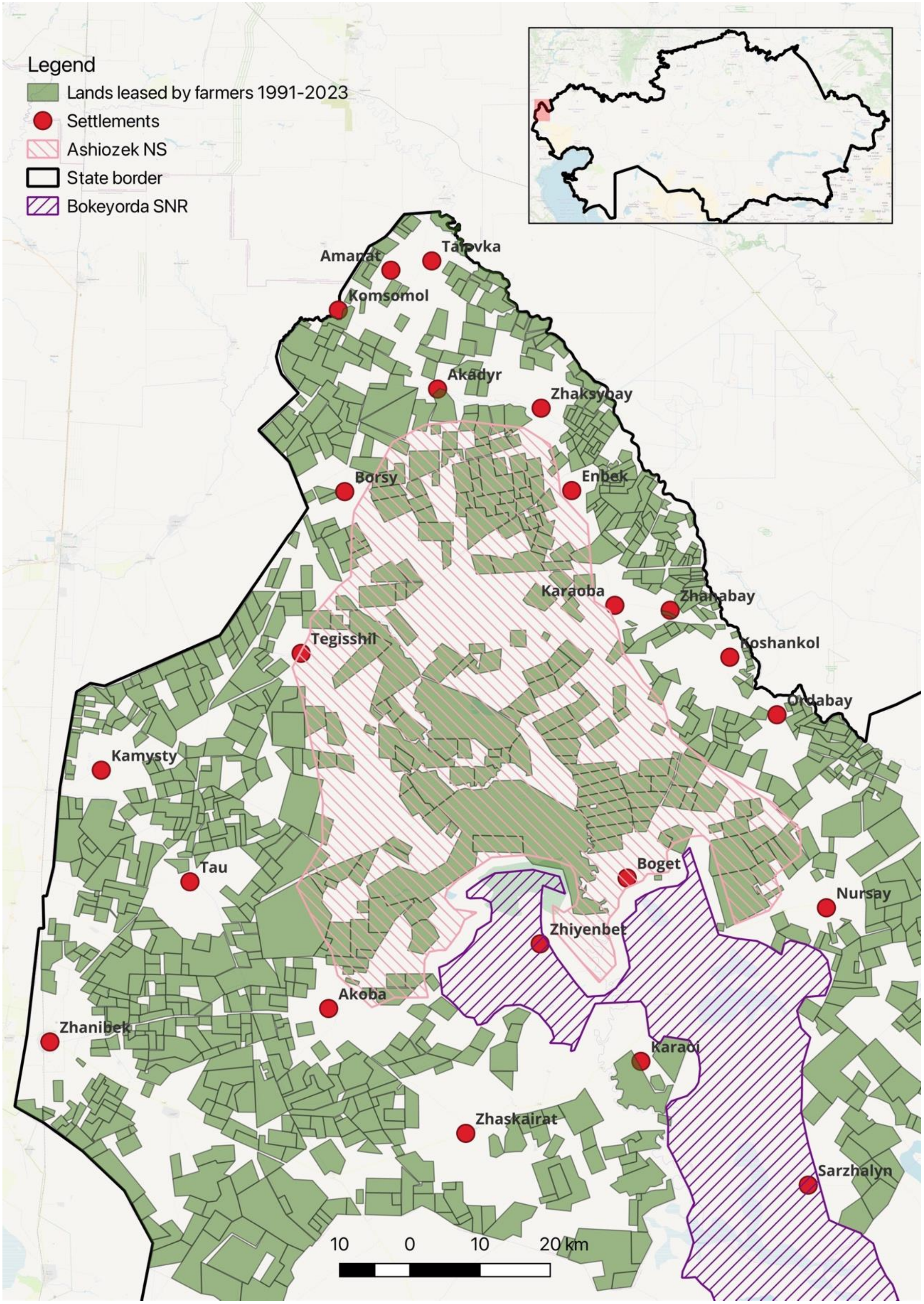

Figure 7. Lands leased by farmers from 1991 to 2023. Individual leasing lands around the villages is not under the practice due to the need of lands for common pastures. Pasture use in rent inside the protected area (SNR) is not allowed.
Map: Aibat Muzbay. Data Source: Land Cadastre.

The primary types of livestock in the region are cattle and small ruminants (sheep and goats), with the latter being more numerous. Equine breeding is not extensively developed due to the high mobility of horses, which can lead them across the border with the Russian Federation where they may be lost. Despite complaints regarding competition for grazing lands, a positive trend has been observed in the population of domestic livestock (Figure 8).

Following the Soviet Union collapse, there was a decline in livestock numbers. However, in contrast to arable lands, livestock numbers have recovered and even surpassed the figures at the onset of independence. This is partly due to the fact that most of the land used for grain production has been replaced with pastures and hay grounds for livestock breeding. Sheep and goats constitute the bulk of domestic livestock in the region.

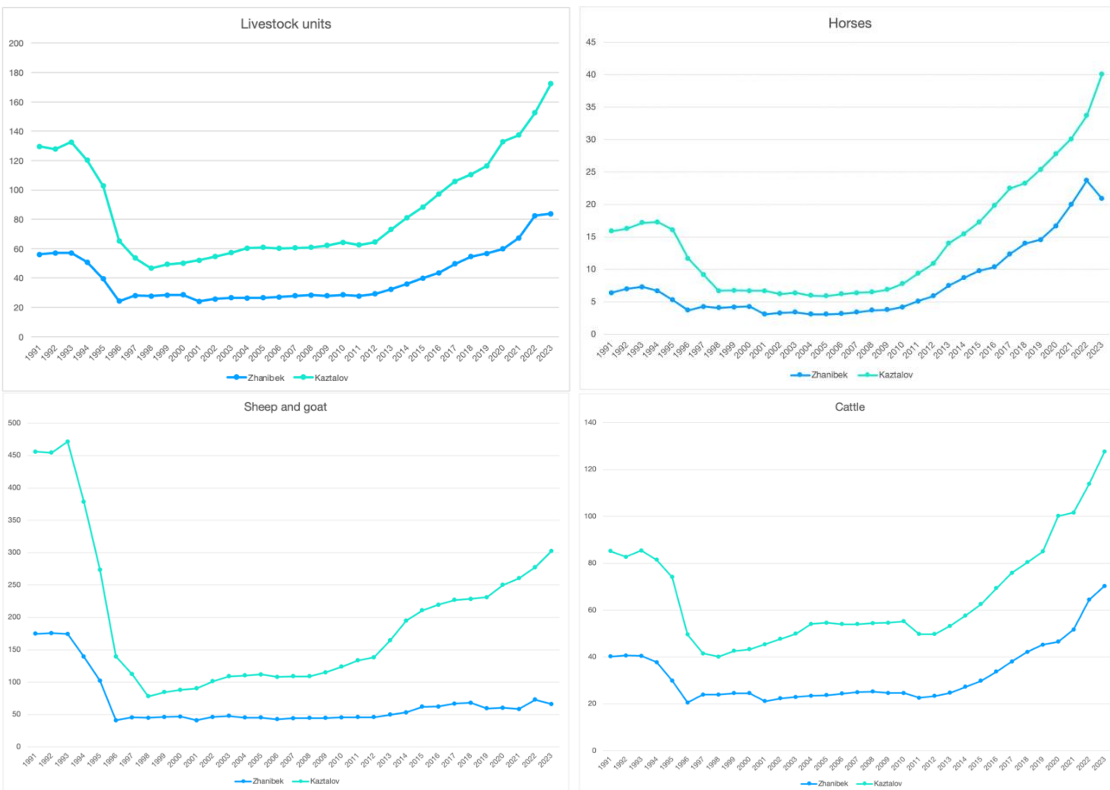

Figure 8. Changes of livestock number in the region since the independence. According to the norms set in the Republic of Kazakhstan, a standard livestock unit is equivalent to one horse, which equates to: horse – 1.0 unit; cattle – 0.8 unit; sheep and goats – 0.1 unit. Source: KazStat, 2024.

6. Results

6.1. Opinion of local farmers about the Human-wildlife conflict

As anticipated, the responses to the surveys with standardize questions were quite homogeneous; the local farmers acknowledged a conflict with the saigas, although without providing specific economic data. An interesting observation emerged from the survey findings: nearly all respondents indicated a significant reduction in the frequency of fires (Figure 9). The last natural steppe fires occurred more than three years ago, a time concurrent with the rise in saiga populations. Additionally, all respondents concurred that the saiga constitutes a valuable natural resource and expressed their willingness to participate in the sustainable use of saigas if official authorization be granted by the state.

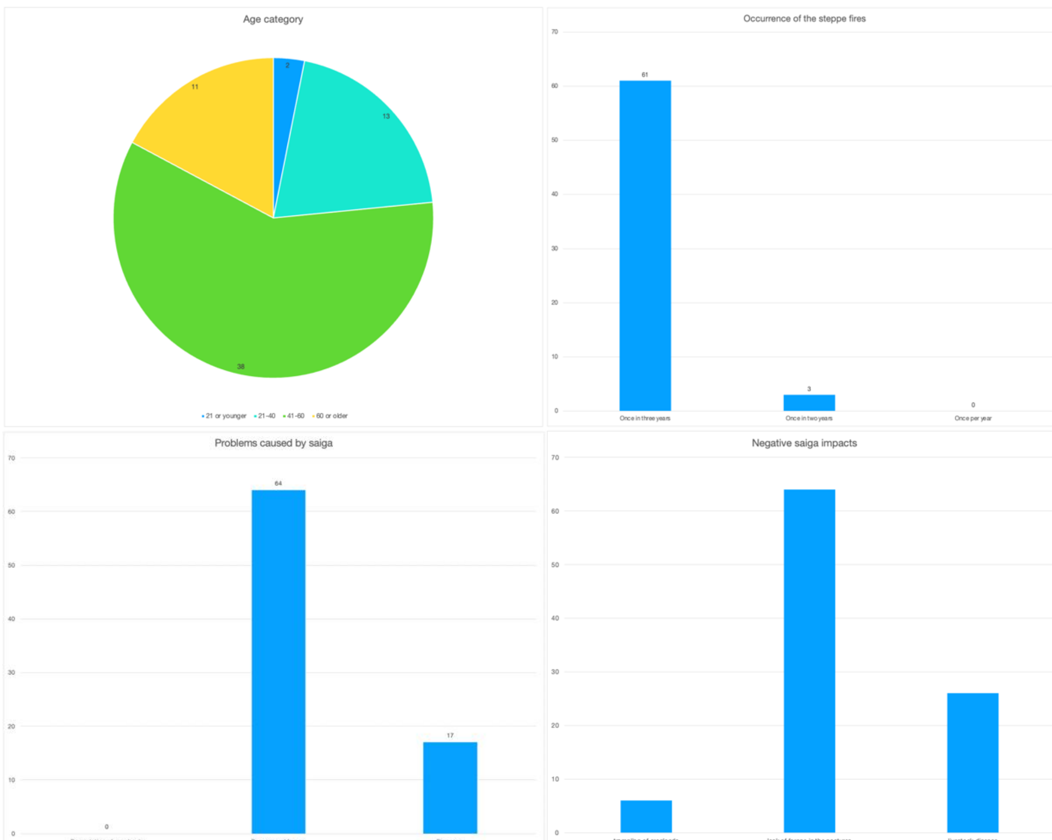

Figure 9. Results of the survey of local people. In general, most of the answers were quite similar. Local people were not satisfied with the presence of the saiga on their pastures.

The results of the extensive semi-structured interviews with local farmers did not differ significantly from the survey findings with the standardised set of questions. However, the interviews provided plenty of concrete answers to many questions. Each interview lasted over an hour, and while there was a standard guideline of questions, the majority of queries arose spontaneously during the interviews. In the following subsections, the semi-structured interview results are presented based on the opinions of local farmers and are not scientifically proven facts:

On the Emergence of the human-wildlife conflict

Nearly all the interviewed farmers reported that the conflict commenced between the years 2018 and 2019. However, the conflict became intolerable from the year 2020, after which farmers began to approach relevant authorities, including district administrative offices (rus: akimat) and the territorial inspection of the CFW for the West Kazakhstan region. Due to the inaction of the state bodies, farmers attempted to drive away the saigas from their pastures. These actions, however, led to conflicts with the inspectors from the Okhotzooprom, as this practice is not allowed.

On the Population of Saigas in the Region

The local people distrust the official numbers regarding the population size of the Ural saiga population. Almost all the interviewed farmers suggested that the number of Ural saiga population has reached about 2-2,5 million, excluding the offspring of May 2023. However, it needs to be noted that the visual estimates of the saiga population made by the field team differed substantially from those of the farmers. For instance, in areas where farmers reported hundreds of thousands of saigas, the experienced field team, equipped with professional monitoring gear, could not confirm such numbers (example: north of Akadyr village, local farmers and inspectors of Okhotzooprom, estimated about 500 thousand saigas, whereas the field team counted no more than 100 thousand). These findings surprized, as the local farmers are used to count their livestock, but obviously the large numbers and highly emotional discussion on the numbers influenced the judgment drastically. Under the current conditions, this huge discrepancy between perceived and actual saiga numbers becomes a problem as an alternative reality is created by the local farmers. There is an urgent need to educate local people counting the large saiga herds on their lands in order to relate to realistic estimates, rather than emotional statements.

Farmers opinions on negative Impact

The interviews revealed that saigas primarily affect pastures and hay grounds, as there are practically no grain crops in the region today. Four farmers reported that they had to reduce their cattle numbers by an average of 25% in 2022 and plan further reductions in 2023 due to the lack of:

1) Forage bases in pastures – during the active vegetation period when saigas come for calving, they consume all vegetation for over a month, and whatever is not eaten is trampled. Consequently, no fodder remains for the domestic cattle;
2) Hay for the winter period. Due to the presence of saigas during calving, vegetation across the entire steppe is under immense pressure. The influence of saigas is so significant that there is no vegetation left for haymaking, forcing some farmers to mow pasture lands (Figure 10).

Figure 10. Saiga herds grazing on the hay grounds. Such cases make local farmers blaming saiga antelope for low hay harvest. However, locals were more tolerant for the grazing of livestock on the hay grounds under any conditions. Photo: Aibat Muzbay.

Farmers have also assumed that diseases from saigas are transmitted to livestock, primarily to cows. According to the farmers, the most common ailment is blindness in cattle. Additionally, the presence of stillborn saiga calves or females that died during birth is perceived a risk in the region, especially as wolves – which are natural predators and “sanitizers” – have been decimated by hunters.

In October 2023, during the interviews, the principal complaints were from farmers in areas where calving occurred in May. Farmers from regions where calving only occurred in 2022 reported that the damage was not as severe in 2023 as it had been in the previous year. Farmers from the southern regions also expressed complaints about saigas but not as aggressively and emotionally as those from the northern regions.

Farmer views on possible solutions to the conflict:

Local farmers think that the only resolution to the conflict may be the reduction of the Ural saiga population. The farmers in the northern part of the region considered the optimal saiga population is to be 100-150 thousand, whereas farmers from the southern region are agreeable to coexist with 300-500 thousand saigas. These low numbers are directly connected with the observed disability of the farmers to count large saiga herds accurately, as explained above. At the same time, some (7 out of 18) farmers are open to the presence of saigas on their territories if they are fully compensated for the economic damage caused by the animals.

Farmers mitigation activities to mitigate negative impact:

Based on our findings during the field works in the Kaztalov and Zhanibek districts, farmers have adopted a variety of strategies to safeguard their pastures and hay grounds from saiga antelopes. One approach involved the installation of electric fences around the perimeters of their fields (Figure 11). Despite this measure, large herds of saigas were observed breaching these barriers. An alternative measure saw the placement of scarecrows at the boundaries of pastures (Figure 12). Initially, the scarecrows proved somewhat effective at deterring smaller herds of saiga, but larger aggregations appeared to ignore them over time. Lastly, farmers resorted to actively driving the saigas away from their fields, a tactic that yielded limited success and was not legally sanctioned. This method led to confrontations with Okhotzooprom, the authority responsible for wildlife management, due to its illegality.

Figure 11. Electric fence along the pasture (1) and hay ground (2) borders.
The design shown in the picture is not effective to keep saiga off the pastures.
Photo: Aibat Muzbay.

Figure 12. Scarecrows built by local farmers to prevent saiga using the pastures and and hay grounds of livestock. The measure was only effective for some time and smaller herds of saiga.
Photo: Aibat Muzbay.

6.2. Saiga accumulation in the area during calving

The calving of the Ural saiga population in 2023 took place in the first ten days of May. Past calving periods were analysed to determine approximate travel routes for fieldwork, and the itinerary was coordinated with the inspectors of the Okhotzooprom and the rangers of Bokeyorda State Nature Reserve.

In total 39 saiga female groups with the total number of around 107,500 adult animals were identified during the field work. Double counts of saiga herds were avoided, by counting animals only in the direction of movement and neglecting herds where any chance of repeated recording was possible. According to their location in the area these 39 saiga groups combined into five main calving grounds (Table 2).

Table 2. Information on calving grounds. The total number of females counted is 107,500. Calves were not counted, because most of them laid down in the steppe during the observation time and were thus not detectable during the counts.

Calving ground	Coordinates (latitude and longitude of the central point)	Number of saiga groups inside the calving ground	Number of saiga female
[1]	+50.300698, +47.633636	20	73,000
[2]	+49.971951, +47.765758	7	12,000
[3]	+49.827902, +47.660809	6	2,300
[4]	+49.461920, +47.978641	3	19,000
[5]	+49.406828, +48,259942	3	1,200

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The primary calving ground [1] is located outside the boundaries of protected areas. The other calving grounds [2] and [3] are within the “Ashiozek” NS, while the southernmost calving grounds [4] and [5] are located within the “Bokeyorda” SNR. Calving grounds [1], [2], and [3] are in areas that serve as grazing lands, potentially impacting more than 40 peasant farms due to the proximity of the saiga herds (Figure 13). In addition, calving grounds [1] and [2] are almost at the areas as in 2022 recorded by ACBK.

Moreover, additional approximately 80,000 saigas of mixed groups, including males and pregnant females, were observed to the south of the calving territories. These groups of saigas were constantly on the move. I assumed that females would separate from males and settle in calving areas to give birth to saigas, while males would continue to be nomadic, travelling from one feeding ground to another.

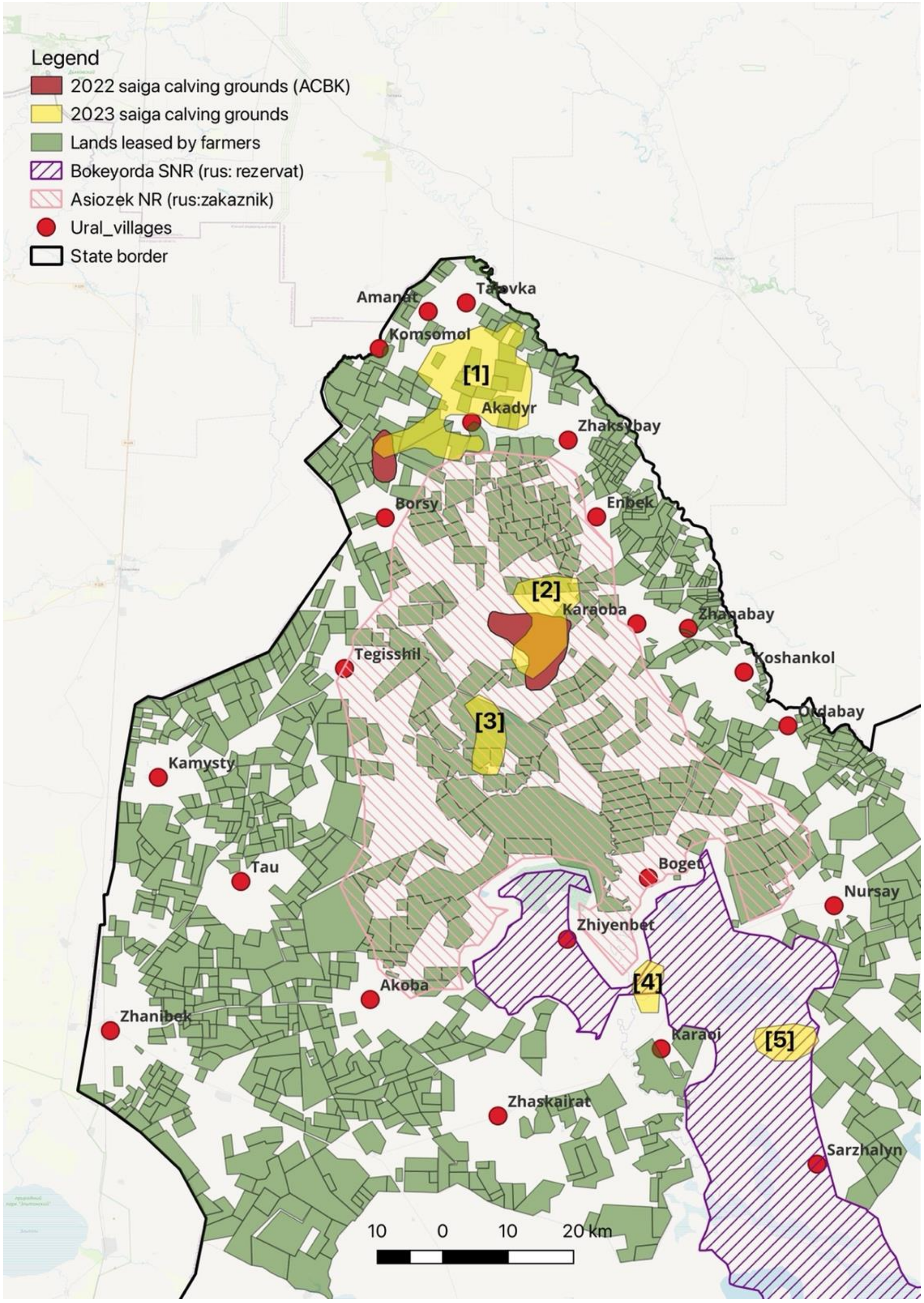

Figure 13. Location of calving grounds in spring 2023 in the Ural population of saiga. Map: Aibat Muzbay. Source of data: Author and Land Cadastre.

6.3. Vegetation composition

To comprehend the composition of the vegetation within the research territory, an analysis of 108 observational plots was conducted (Figure 14). The site descriptions were primarily focused on localities where saiga antelopes were encountered and where livestock concentrations were observed within the study area (based on personal observations and data from specialists of the ACBK). The nomenclature for the plant species is following The World Flora Online (WFO, 2024).

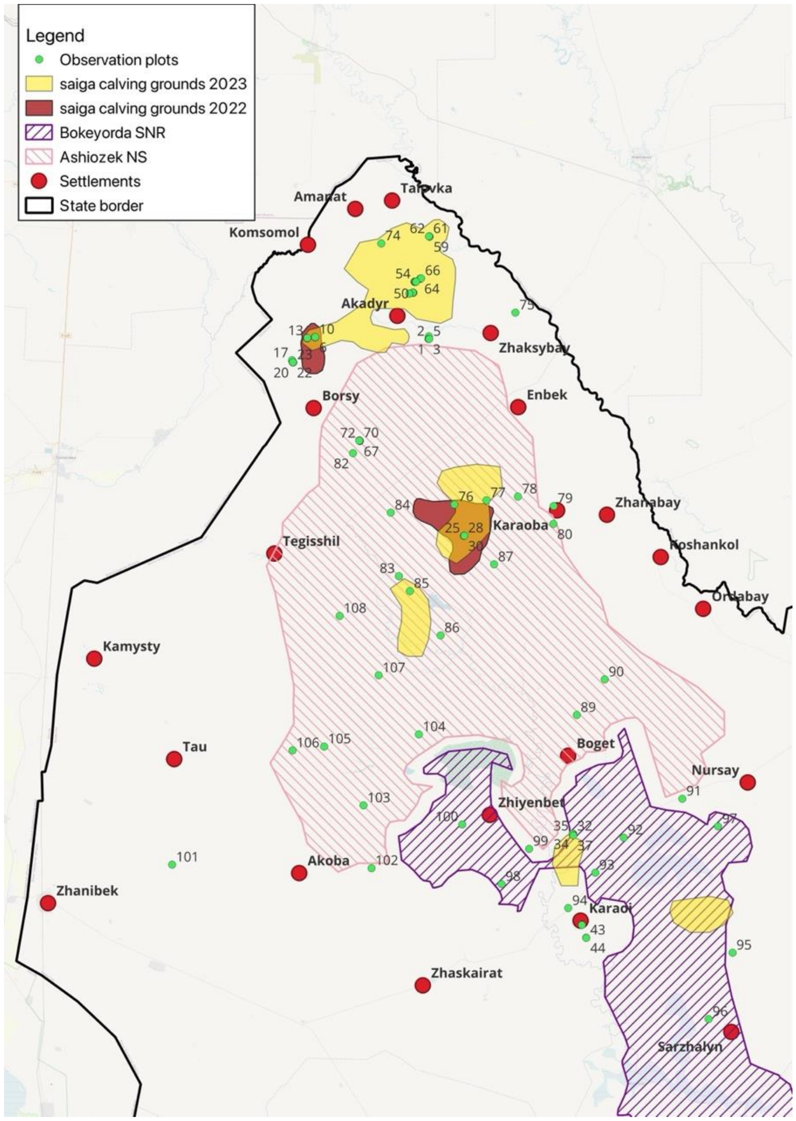

Figure 14. Map of the location of observation plots in the study area. Mainly the study was focusing on calving grounds and the saiga habitat. Additional focus was to the pastures close to villages and in remote areas. Map: Aibat Muzbay.

In the overarching analysis, a total of 115 plant species belonging to 28 families (Annex 2) were identified, with the most prevalent families being *Poaceae, Brassicaceae*, *Asteraceae,* and *Amaranthaceae*. Four dominant plant species were the most widespread species across the observation plots: *Poa bulbosa (89 % frequency)* , *Festuca valesiaca (81% frequency)*, *Tanacetum achilleifolium (74% frequency)*, and *Leymus ramosus (51 % frequency)* (Figure 15). The respective dominance of each of these species is related to the predominate form of land use in the region, namely pastoral grazing, and haymaking.

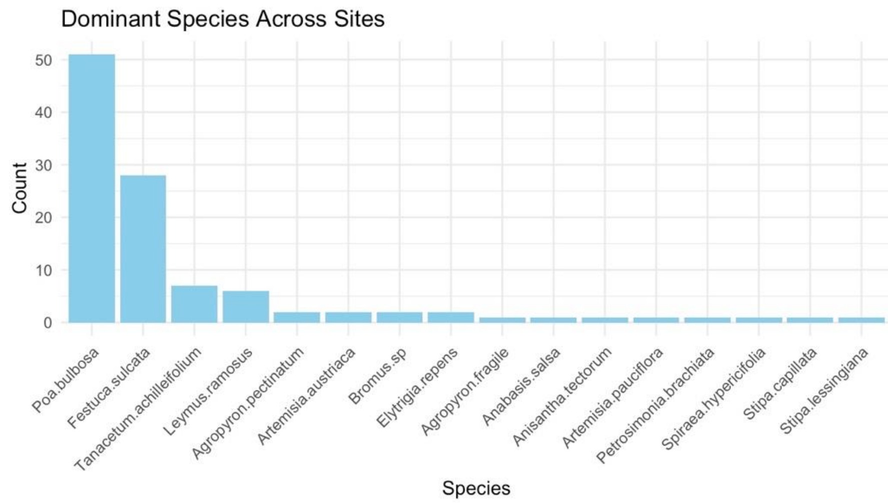

Figure 15. Number of sampling plots with highest species coverage. *Festuca valesiaca* is shown on the plot as *Festuca sulcata (*synonym for *F. valesiaca).*

NMDS shows as that all sampling plots are similar to each other according to their vegetation composition. It confirms that the area is represented by one ecosystem – the short grass-steppe. However, plot 85 stays out which is an observation of solonchak (salt pan) with domination of *Petrosomonia brachiate* and/or *Halocnemum strobilaceum* (32% cover) (Figure 16).

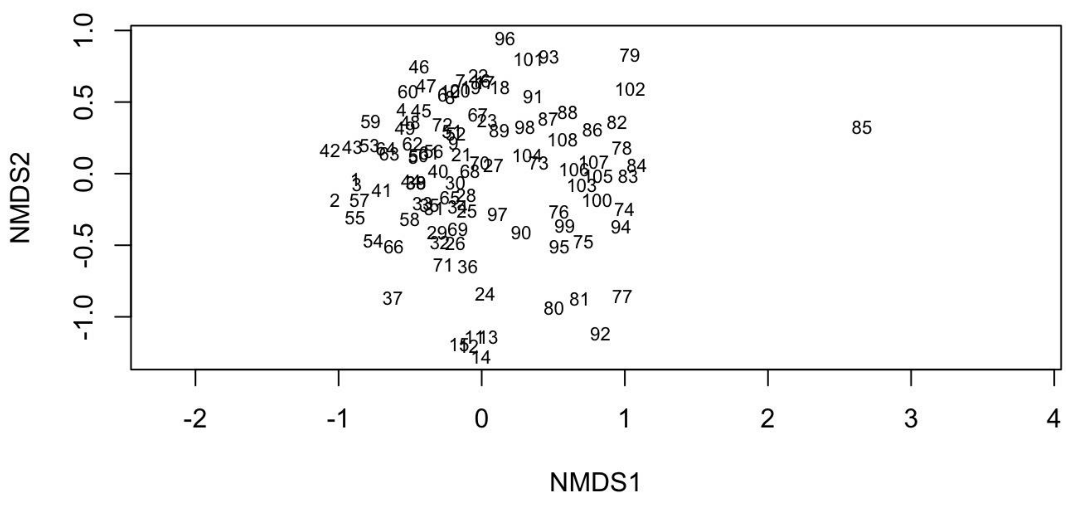

Figure 16. Scheme of a non-metric multidimensional scaling plot. Numbers in the plot represent observation sites (plots). Sites that are more similar (according to the vegetation composition inside the plots) to one another are ordinated closer together. The axes are arbitrary as is the orientation of the plot.

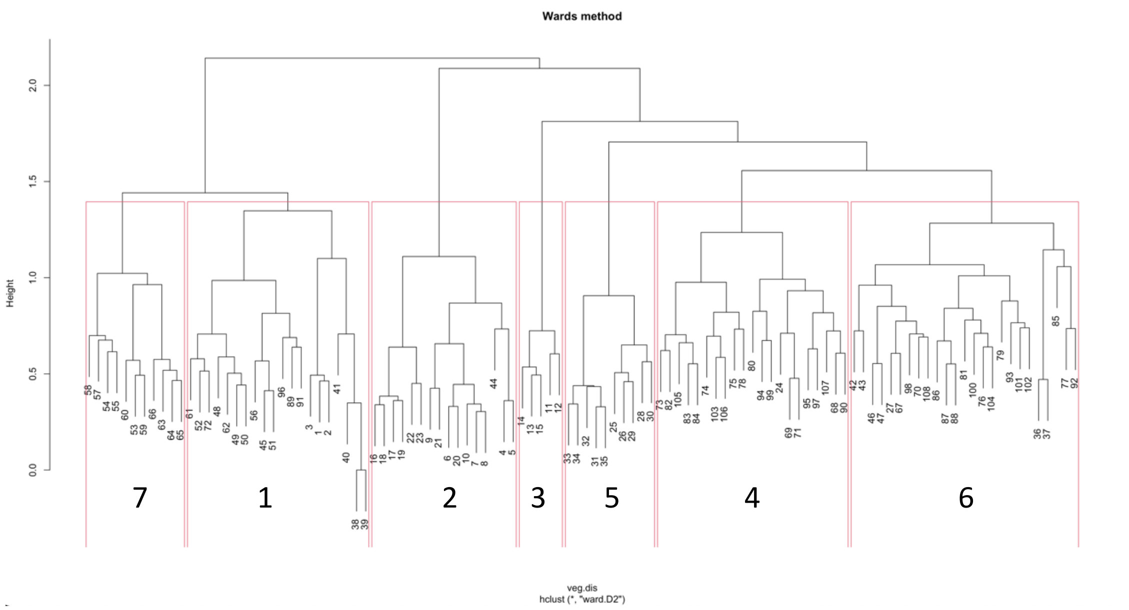

Figure 17. Hierarchical clustering dendrogram based on Ward.D2 method.

The application of hierarchical cluster analysis with the Ward.D2 method (Figure 17), along with cluster consistency analysis, enables the identification of vegetation groups, suggesting specific ecological niches or environmental conditions i.e. land-use.

Table 3. The values in the cells represent the degree of presence of a particular species in a specific cluster. These values can be interpreted as the probability of a species' membership to the cluster, where 1.00 signifies a 100% membership to the cluster, and an empty space or a dot indicates the absence of data or a zero presence in the given cluster.

Species / Custer	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Festuca valesiaca	1.00	1.00	1.0	0.90	0.5	0.52	0.91
Poa bulbosa	1.00	1.00	.	1.00	1.0	0.92	0.73
Tanacetum achilleifolium	0.80	1.00	0.4	0.86	0.7	0.64	0.45
Stipa capillata	0.10	0.12	1.0	0.24	0.4	0.04	.
Stipa lessingiana	0.10	0.25	.	0.62	0.3	0.12	0.36
Stipa sareptana	.	.	.	0.05	.	.	.
Arabidopsis thaliana	.	.	.	0.19	.	0.04	.
Arabidopsis toxophyla	.	.	.	0.19	.	0.08	.
Artemisia austriaca	0.10	0.12	1.0	1.00	0.9	0.52	0.09
Artemisia lerchiana	0.85	0.12	.	0.33	0.1	0.40	0.82
Artemisia nitrosa	.	.	.	0.19	.	0.08	.
Artemisia pauciflora	.	0.75	.	0.05	.	0.32	.
Artemisia pontica	0.05	.	.	.	.	.	0.09

Achillea millefolium	.	.	0.6	.	.	.	.
Achillea nobilis	0.20	0.12	1.0	0.33	.	0.16	0.27
Androsace filformis	0.05	.	.	0.14	.	0.20	.
Agropyron cristatum	0.20	0.44	0.6	0.05	0.9	0.04	.
Agropyron fragile	0.10	.	.	0.33	.	0.16	.
Alopecurus pratensis	.	.	.	0.10	.	0.04	.
Allium flavescens	.	.	.	0.05	.	.	.
Alyssum desertorum	0.15	.	.	0.19	.	0.12	.
Anabasis salsa	.	.	.	0.05	.	0.12	.
Anisantha tectorum	0.05	.	.	0.14	.	0.16	.
Amygdalus nana	.	.	.	0.05	.	.	.
Eremogone longifolia	.	.	.	0.05	0.1	0.04	.
Astragalus spp	0.10	.	0.2	0.19	.	.	.
Atriplex nitens	.	.	.	.	.	0.08	.
Bassia sedoides	.	0.06	.	0.05	0.2	0.24	.
Bromus squarrosus	0.25	.	.	0.10	.	0.08	0.91
Cachrys odontalgica	0.05	.	.	0.05	.	0.08	.
Carduus uncinatus	0.05	0.06	1.0	0.38	.	0.08	.
Camphorosma monspeliaca	.	.	.	0.05	.	.	.
Carex stenophylla	0.10	.	1.0	0.38	0.1	0.08	.
Capsella bursa pastoris	.	.	.	.	.	0.08	.
Ceratocarpus arenarius	0.20	.	.	0.05	.	0.36	.
Ceratocephala orthoceras	.	.	.	0.33	.	0.28	.
Convolvulus arvensis	0.05	.	.	0.05	.	.	0.09
Erophila verna	.	.	.	0.33	.	0.04	.
Erysimum hieracifolium	.	.	.	0.48	.	0.08	.
Falcaria vulgaris	0.15	.	0.2	0.19	.	0.04	.
Ferula caspica	.	.	.	0.05	.	0.04	.
Frankenia pulverulenta	.	.	.	.	.	0.04	.
Filago arvensis	.	.	0.2	0.10	0.3	0.08	.
Medicago falcata	0.10	.	.	0.19	.	.	0.18
Nepeta ucranica	.	.	0.6	0.10	.	.	.
Serratula dissecta	0.05	.	.	.	.	.	.
Silene spp.	0.20	.	1.0	0.05	0.1	.	0.55
Cirsium spp.	.	0.06	.	.	.	.	.

Climacoptera spp.	0.05	0.31	.	0.05	.	0.20	.
Draba nemorosa	.	.	.	0.05	.	.	.
Descurainia sophia	0.05	0.06	0.4	0.38	0.3	0.48	.
Dianthus spp.	.	.	0.4	0.10	0.2	.	.
Elytrigia repens	.	0.12	.	0.05	.	0.12	.
Euclidium syriacum	.	.	.	.	.	0.04	.
Euphorbia virgata	0.05	0.06	.	0.19	.	.	.
Eremopyrum orienthale	.	.	.	0.14	.	0.16	.
Eremopyrum triticeum	.	.	.	0.14	.	0.32	.
Eryngium planum	.	.	.	0.05	.	0.04	.
Gagea bulbifera	0.10	.	.	0.14	.	0.04	.
Galatella biflora	0.05	.	.	.	.	0.04	.
Galatella tatarica	0.15	0.06	0.2	0.05	0.1	.	.
Galatella villosa	.	0.06	.	0.14	.	.	.
Galium verum	.	.	.	0.10	.	.	.
Gypsophila paniculata	.	.	.	.	.	0.04	.
Hymenolobus procumbens	.	.	.	.	.	0.04	.
Inula salicina	.	.	.	.	.	0.04	.
Jurinea multiflora	.	.	.	0.24	.	.	.
Kochia prostrata	0.35	0.81	.	0.52	0.1	0.48	0.09
Koeleria cristata	0.30	0.06	.	0.52	.	0.20	0.55
Koeleria pyramidata	.	0.06	0.2	0.05	0.3	.	.
Lamium parczoskianum	.	.	.	0.19	.	0.32	.
Lappula patula	0.05	.	.	0.29	.	0.48	.
Lepidium perfoliatum	0.05	.	.	0.29	.	0.28	.
Lepidium ruderale	0.15	.	.	0.24	0.1	0.44	.
Leymus ramosus	0.45	0.06	.	0.38	1.0	0.76	0.82
Limonium gmelinii	.	.	.	0.48	.	0.12	.
Limonium sareptanum	0.40	0.19	0.4	0.10	0.5	0.12	0.27
Myosotis micrantha	.	.	.	0.19	.	0.08	.
Myosurus minimus	.	.	.	0.10	.	0.08	.
Onosma tinctoria	0.20	.	0.2	0.05	.	0.08	.
Ortinhogalum fisherianum	0.05	.	.	0.48	.	0.12	.
Pastinaca clausii	.	.	.	0.05	.	.	.

Petrosimonia brachiata	.	.	.	.	.	0.08	.
Petrosimonia triandra	.	.	.	.	.	0.04	.
Phlomis herba-venti subsp. pungens	0.05	.	0.4	0.24	.	.	.
Phlomoides tuberosa	.	0.06	1.0	0.48	0.5	0.08	.
Poa pratensis	.	.	0.6	.	.	.	.
Polygonum aviculare	0.05	.	.	.	.	0.08	.
Polygonum repens	.	.	0.2	.	.	.	.
Polygonum patulum	0.15	0.19	0.8	0.10	0.9	0.32	0.18
Postinaca clausii	.	.	.	.	.	0.04	.
Potentilla argentea	.	.	.	.	.	0.08	.
Potentilla bifurcata	.	0.06	.	0.19	. 0.08	.	
Potentilla humifusa	.	.	0.8	.	.	.	.
Pucinellia dilicholepis	.	.	.	.	.	0.04	.
Ranunculus spp.	.	.	0.2	.	.	.	.
Rorippa brachycarpa	.	.	.	.	.	0.04	.
Salsula spp.	.	.	.	.	.	0.08	.
Salvia dumetorum	.	.	0.2	.	.	.	.
Senecio glaucus subsp. coronopifolius	.	.	.	.	.	0.08	.
Serratula erucifolia	0.05	.	.	0.10	.	0.04	.
Scabiosa spp.	.	.	.	.	.	0.04	.
Silene dichotoma	.	.	.	.	.	0.04	.
Sisymbrium polymorphum	.	.	0.2	0.05	.	.	.
Spiraea hypericifolia	.	.	1.0	0.24	.	0.04	.
Suadea acuminata	.	.	.	.	.	0.04	.
Taraxacum spp.	.	.	0.6	0.05	.	0.04	0.09
Thalictrum minus	.	.	0.4	.	.	.	.
Trinia hispida	.	.	.	0.14	.	.	.
Tulipa patens	0.05	.	.	0.10	.	.	.
Tulipa schrenkii	0.20	0.06	.	0.10	.	.	.
Valerianella spp.	.	.	0.2	.	.	.	0.09
Verbascum phoeniceum	0.05	.	1.0	0.14	.	0.04	0.18
Veronica verna	.	.	.	0.57	.	0.20	.
Xanthium strumarium	.	.	.	0.05	.	.	.

Poa bulbosa shows complete membership (1.00) in many clusters, indicating its high adaptability and versatility across different ecological conditions. Its presence in most clusters suggests that *Poa bulbosa* can thrive in diverse environments, making it an important component of many ecosystems.

Festuca valesiaca also exhibits a high degree of membership to most clusters, reflecting its widespread distribution and ability to adapt to various conditions. Despite reduced membership in clusters 5 and 6, this species remains a significant participant in many ecological niches.

Leymus ramosus stands out for its high presence in clusters 1, 4, and 7, and perfect membership (1.0) in cluster 6, underscoring its importance in certain ecosystems and its adaptation to specific ecological niches. This species may play a key role in the structure and dynamics of the corresponding ecological communities.

Artemisia austriaca and *Tanacetum achilleifolium* both show significant presence in clusters 1, 2, and 4, indicating their adaptability and potential key roles within certain plant communities. While *Artemisia austriaca* demonstrates constant presence (1.00) in these clusters, emphasizing its specific ecological preferences or crucial role in maintaining ecosystem structure and function. *Tanacetum achilleifolium* displays variable presence, suggesting its flexibility to thrive under diverse ecological conditions.

Stipa capillata represented in cluster 3 as a representative of the in the Soviet Literature described further north distributed long gras steppe is occurring always together with *Festuca valesiaca* and is spatially not wide spread due to the relatively dry climate conditions.

6.4. Biomass collection

Despite the fact that our biomass production assessment plots were installed in areas remote from the villages, all of them were destroyed by livestock. Even the fact that local herders were informed about them, cows managed to destroy all posts and fences (Figure 18). This showed that cattle can graze at larger distances from settlements than I had anticipated. The poles erected are attractive to cows as they scratch on such structures to get rid of parasites, dead skin and mud. The mistake has been addressed and new pyramidal shaped plots were installed in October 2023 (Figure 19). Data from these sites will not be available until October 2025 and will serve as a source of data for future studies.

Figure 18. Plots destroyed by cows. The second photo shows the ear tags of cows lost while scratching against a fence. Photo: Aibat Muzbay.

Figure 19. Corrected new fenced plots that will be unattractive for cows to scratch. In addition, a stronger metal was chosen to build these pyramids.

7. Discussion

7.1. Vegetation composition in the area.

The vegetation in the region is characterized by communities that are utilized in the pasture lands and hay grounds either on natural short grass steppe vegetation or abandoned arable fields dating from the USSR era, which are currently in the process of transitioning back into the natural steppe ecosystems. An analysis of Soviet land use maps in the region indicated that at least 50% of the land had been ploughed during the virgin land cultivation campaign during the Soviet Union times. Present-day farming activities, specifically the continuous maintenance of hay grounds in these areas, are possibly slowing down the natural succession of these lands back to natural steppe.

The vegetation in the region is characterized by the short grass steppe with *Festuca valesiaca* – *Stipa lessingiana* with Stipa lessingiana and some meadows growing in depressions dominated by Agropyron repens (Atlas Kazakhstan SSR, 1982). In this study the the short grass steppe is differentiated to Dominant Vegetation Formations (DVF) because of current and past land use in the region. Two types of short grass steppe were identified, based on land use with the specific DVF i.e. the natural and:

Natural short grass steppe

Based on the acquired data, it has been ascertained that the primary type of vegetation in the territory is the short grass steppe with grasses not higher than 50 cm and relatively few herbal plant species. The natural short grass steppe is typified by the dominance of vegetation formations comprising species such as *Festuca valesiaca, Stipa lessingiana, Stipa capilata, Poa bulbosa*, and *Elytrigia repens* (Figure 15). Only this natural type of the shortgrass steppe is described in the Soviet literature as mentioned above repens (Atlas Kazakhstan SSR, 1982). This biome is predominantly utilized as pasture by local farmers. Observations indicate that 70% of all plots with the presence of *Festuca valesiaca* and/or *Poa bulbosa* DVF were grazed by ungulates, predominantly by cattle and saiga. The efficaciousness of these plants in pastureland settings has been noted by numerous scholars. According to Larin's research ("Forage plants of the meadow and pasture lands of the USSR," 1937), all DVF species possess considerable value in pastures. The DVF found in natural and in succession after abandoned fields and/or overgrazing short gras steppes are characterized like follows:

- *DVF with Poa bulbosa predominant. The species* is an ephemeroid plant with high forage qualities, which combines a high yield in severely arid regions with an unassuming nature towards soil types. Utilizing minimal moisture reserves during autumn, winter, and spring, it commences vegetation early and by the beginning of April, provides sufficient biomass for foraging animals. This DVF is widespread on the plains and mico-depressions of the observation area.
- *DVF with Festuca valesiaca predominant. The species* is a perennial small tussock grass, categorized as a valuable pasture plant. With moderate grazing intensity, it can persist

on natural pastures for many decades. It grows in spring earlier than other grasses, but only with the onset of a rainy period; flowering occurs in May–June, after which it quickly becomes coarse and dry. In autumn it becomes green gain and remains green going into winter. It can be grazed two to three times during the vegetation period. Before flowering, its grass is readily consumed by sheep, goats, horses, and small cattle. Hay harvested before flowering is favoured by all types of livestock. This DVF is often associated with the species *Stipa lessingiana* and *S. capillata* and the above described DVF with *Poa bulbosa*. It Is the most widespread DVF throughout the observation area covering large parts of the plains distant from settlements.

- *DVF with Elytrigia repens* predominant. It is a widespread perennial grass which can be a forage plant modest value but also a challenging weed to eradicate. It is well-grazed by all livestock types, especially at the beginning of the vegetative period. After mowing and grazing, it regrows well and is an excellent milk-enhancing plant for cows and a good fattening feed for beef cattle. In the investigated area it grows in sallow depressions and along periodically dry streams. The DVF is presently found in depressions (also along temporary streams) where water is gathering in spring.

The short grass steppe in succession after abandoned fields and/or overgrazing

The short grass steppe in succession after abandoned fields and/or overgrazing is characterized by the presence of *Leymus ramosus, Tanacetum achileiflium, Artemisia species, Bromus species* and *Agropyron repens* DVF (Figure 20). These are lands where vegetation has changed due to anthropogenic influence. Predominantly, this is the former use as arable lands for wheat production and areas near settlements where grazing is very intense. Consequently, DVF species that emerge indicate a certain character of land use. Specifically:

- The DVF with dominance of uniform *Leymus ramosus* signifies an advanced succession stage on abandoned fields. Within the first decade after abandonment of crop fields, annual herbs form clusters, and the fallows appear quite patchy (Dieterich, 2000). The prevalent state with *Leymus ramosus* DVF may represent a sub-climax for an extended period of time, as most are used for hay production, which appears to stabilize the DVF. *Leymus r*amosus propagates vegetatively through rhizomes and seems more competitive than short grass steppe taxa under this land use conditions.
- The DVF with *Tanacetum achileifolium* predominance indicates overgrazing by livestock. Both saiga and livestock eat the species, but seemingly not as a preferred source of food. Nevertheless, our observations reveal that in absence of other herbs saiga is selectively picking out the species neglecting dominant *Poacea* species.
- The DVF with *Artemisia predominance*, particularly *Artemisia austriaca*, indicates a distinct degradation of pasturelands due to intensive overgrazing. Vegetation types such as *Artemisia austriaca* are less palatable to livestock during the vegetative period due to their bitterness (Baidusen et al., 2013).

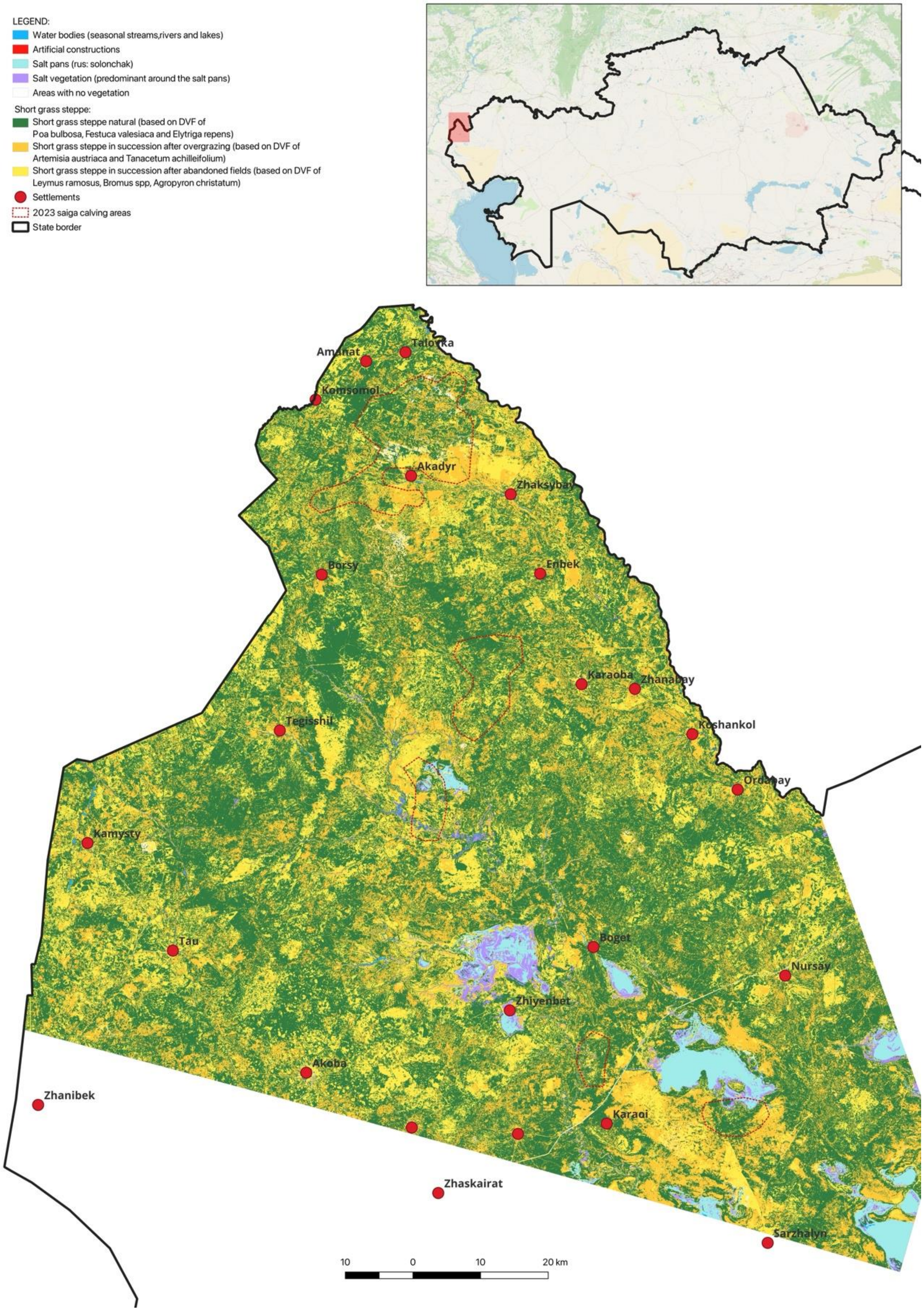

Figure 20. Map of natural short grass steppe and short grass steppe in succession after abandoned fields and/or overgrazing. Obviously, areas around the villages are overgrazed whereas the more distant areas from settlements are covered with the natural short grass

steppe. The Landsat image covers only the central and northern part of the study area, however all calving grounds were fully covered with the image and analysed.

7.2. Saiga impact

Here presented research reveals that from the perspective of livestock keeping farmers saiga has a certain negative impact on the pasture lands and hay fields within the study area. However, this impact is temporally and spatially limited, and the nature of said impact does not exceed that of climatic effects. In 2022, during the initial vegetation assessments in the region, I noted the active growth of *Poa bulbosa* was caused by significant precipitation in both 2021 and 2022. A reduction in precipitation correlated with a decrease in vegetative activity. In 2023, it was quite challenging to identify *Poa bulbosa* at observation plots due to the absence of moisture, thus resulting in much less productive pastures.

In addition, saiga is a selective feeder with a strong preference for herbal plants, rather than grass (*Poaceae*) (Abadurov et al., 2005), including species which are not much used by livestock and may even become weeds such as *Tanacetum achilleifolium*, *Ornithogalum fischerianum*, *Tulipa spp.* (Fadeev et al., 1982.). Also, such annual Brassicacae as *Euclidium syriacum*, *Lepidium ruderale* and *L. perfoliatum* are well eaten by saiga (Dieterich et al., 2012) while being mostly avoided by livestock. Only in spring during the calving time, saiga is also eating a lot of *Poacea* (Dieterich et al., 2012). Throughout the year Livestock forages on the grasses of the short grass steppe, which predominate in the investigated area. Thus, there is also a certain degree of segregation of saiga and livestock regarding fodder plants, thus leading to a more effective and less competitive use of the vegetation.

Certainly, impact of saigas from the end of April to the beginning of June in calving territories is not neglible. The considerable aggregation of saigas in one area, along with an increased density of saigas per hectare, undoubtedly exerts a distinct influence. An example of pasture trampling is well illustrated in Figure 21, where saigas alongside with domestic livestock forge trails through the pastures. Nevertheless, it is difficult to understand, what the density of such trails would be without saiga, as both livestock and saiga are using them. Furthermore, I could not establish if the trails affect the overall biomass productivity or if the water (surface and infiltration) collected on the trails benefits adjacent vegetation, an improved growth of which may thus partly or fully compensate for productivity losses on the trails.

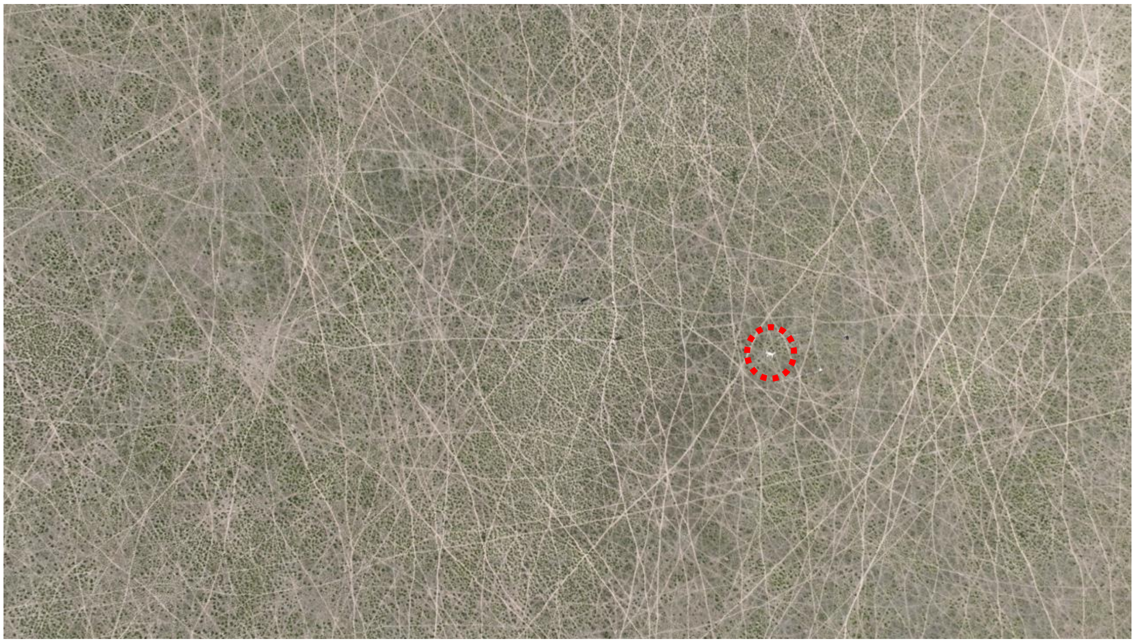

Figure 21. Trails of ungulates in the [2] saiga calving ground. Red circle – dead saiga calf. Elevation 75 m above the ground. Photo: Aibat Muzbay.

For the last three years the precipitation amount has fallen from 416.7 mm (2021) to 371.1 mm (2023). Biomass available in the steppes is a function of the amount of precipitation. 47 mm less precipitation (12%) under the arid conditions of the short grass steppe has significantly negative impact on the productivity of vegetation on the pastures and hay grounds. Thus, the overarching effect on the availability of fodder for livestock is the level of precipitation and not the number of saiga. Certainly, farmers perceive this fact differently and use the saiga as a scape goat for all problems coming in their way (illness, scarcity of fodder and hay, dried up watering places etc.).

In parallel with the growth of saiga population, there has also been an increase in livestock numbers in the region, apart from sheep and goats. In addition to this, the area of available land is constantly shrinking due to the leasing of vast tracts of land by private farmers. Consequently, the farmers want to use all available land only for their own benefit and do not want to share their resources with anyone, especially saigas, which the farmers do not have the benefit of. As a result, in their eyes, saigas become guilty of all anthropogenic, natural and climatic pressures on the forage resources in their pastures.

7.3. Conflict mitigation by the Kazakh Government 2023

Since October 2023, the Government of the Republic of Kazakhstan, through the Committee for Forestry and Wildlife (CFW), has initiated a saiga population management program amid escalating conflicts between saigas and local residents in the region. The initial number of saigas planned to be culled for the purpose population control was set at 300,000. However, from October 2023 to January 2024, a harvest of 43,000 (14%) saiga individuals was reported (CWF report during the COP14 CMS in Samarkand, Uzbekistan). The local farming community has expressed several reservations regarding this program:

1) The culling of 300,000 saigas was planned for both the Ural and Betpak-Dala populations and supposed to show an effort to regulate the population size to more tolerable levels. However, considering the officially estimated and the even higher locally perceived population size as well as the birth rates in 2023 and 2024, the culling of this number of saigas would unlikely have yielded a substantial result in diminishing the conflict.

2) Significant funds are allocated for saiga management, yet these resources are not transferred to farmers as compensation for the damage incurred.

3) Residents do not benefit directly from saiga management; they cannot obtain meat since due to applied regulations for food safety the carcasses must first be sent to the regional centre (500 km away) for sanitary and epidemiological control and are primarily sold in urban markets and meat processing plants. The only benefit local people were able to gain is their involvement in culling actions. However, people who “suffer” from the saiga were also left because they were overloaded with their own work in the farms.

8. Recommendations

Saiga is the only large ungulate species of the vast drylands in Kazakhstan, which is still present in functional numbers i.e. able to graze the steppe and desert ecosystems in significant intensity. This is important, as dryland plant species and large ungulates have been together on an evolutionary path for millennia. Without their presence the vegetation cover will change, while wild fires become more frequent and soil erosion is more likely. All other large ungulate species of the Kazakh drylands are either locally extinct (wild horse *Equus ferus* and Bactrian camel *Camelus ferus*) or rare (Goitered gazella *Gazella subgutterosa* and kulan *Equus hemionus kulan*, both endangered EN under IUCN Red List) thus present in numbers only locally significant for the dryland ecosystems. Thus, the objective should be that saiga is present throughout the steppe and desert ecosystem in Kazakhstan and not only in several restricted areas with local sub-populations. In order to achieve this, the current policy to simply reduce the saiga numbers is counterproductive and the government's solution must be to ensure that local people are prepared to accept saigas in their neighborhoods. The main focus of the government should be on local acceptance of saigas, namely by the farmers themselves. This is now considered to be the only proper solution to this conflict.

The **vision** for the future of the saiga should be the following:

- Suitable Saiga habitat are **all steppes and semi-deserts** in Kazakhstan and parts of Russia, Uzbekistan and Turkmenistan!
- The division into sub-population (Ural, Betpakdala, Ustyurt and Kalmykia) are a result of low numbers of saiga in the 1920ies.
- A conservative estimate is that there is room for more than **10 million saiga** in its historical habitat today!
- The **sustainable use** strategy leads to a situation, that local people welcome the species returning to their region, as they are benefiting directly and/or indirectly from their presence.

To achieve this vision, a program for the sustainable use of saigas should be introduced in Kazakhstan. Sustainable use is not just about guaranteeing minimum population growth with concurrent use, it is a whole program that includes four main elements:

1. Firstly, it is Benefit Sharing as an dimension of sustainable use. These benefits include:
   1.1. Intangible benefits. This is the sense of spiritual fulfilment and enjoyment from observing and coexisting with wildlife.
   1.2. Ecosystem services. Local farmers have already noticed that the number of steppe fires has been greatly reduced with the dramatic increase in the numbers of saigas. There used to be other ungulates in the Ural steppe, which were removed by humans, with the consequence that the entire produced biomass burned every year. Now this function of fire safety of the steppe depends solely on saigas (and livestock). Also, the abundance of saigas in the steppe means the safety of livestock from predators like the wolf.

1.3. Access to meat. Local people could partially replace their livestock with saigas. That is, it could be economically and physically advantageous for them to consume saiga for food. Saigas do not need to be herded and protected from wolves or horsethieves. There is no need to prepare hay for saigas in winter; they can easily overwinter in the southern regions and return.
1.4. Financial income for land users. Farmers could receive rewards for having saigas on their pastures. And these rewards could be paid from the profits that are possible from exporting saiga horns. This measure needs especially to be considered for the calving grounds of the saiga, as the animals stay on one place for several weeks during that time.
1.5. Revenues from the use of saigas for the development of local people's welfare. Saiga is a very valuable resource. There is a huge potential for its sustainable use. These funds could go back to the villages for improvement of communal infrastructure, services and overall wellbeing.

2. Secondly, it is the sense of ownership as a dimension of sustainable use. Benefit sharing alone is not sufficient. Local people need to realize that saiga conservation is the responsibility of each and every one of them. To do this, they must be empowered to prevent illegal and illegitimate use, and to manage and utilize saigas. Also, local people should be empowered to participate in decision-making on management, conservation and benefit sharing.

3. Third, appropriate institutions are a dimension of sustainable use. It is necessary to develop different institutional arrangements for different forms of sustainable use, ownership, and benefit sharing:

3.1. Touristic use without take of saigas – local business in cooperation with land users, hunting area holders = income for local people
3.2. Hunting tourism – hunting area holders = income for hunting area holders and their staff
3.3. Domestic sport hunting – hunting area holders provide opportunities to domestic hunters (sale of meat and horns not permitted) = income for hunting area holders and their staff
3.4. Commercial hunting for production of meat and horns (population control as side effect) – central national entity (e.g. Okhotzooprom) together with hunting ground owners (handling, storage, processing and sale of horns through monopoly organization) = generation of revenues for payments to land users and hunting area holders
3.5. Collection of horns from natural mortality – local land users, hunting area managers in collaboration with monopoly organization = financial reward for collectors but majority of revenues for community development and welfare
3.6. Associations of users of saiga in local range areas = participation in decision making about management and benefit sharing

3.7. National level fund = management of funds from commercial saiga use and spending for land user rewards and local development

4. And fourth, suitable techniques are a dimension of sustainable use. Sustainable use of saigas should be in such a way that the approach used can ensure:

4.1. Securing animal welfare
4.2. Avoidance of adverse impact on animal behavior, population and ecosystem
4.3. Best products and optimum revenues
4.4. Prevention of illegal take and illegal trade.

The population control program, implemented from October 2023 to February 2024, was a good experience for Kazakhstan, as the last legal hunt before that was 20 years ago. Decision makers and local specialists will now be able to adequately assess their capacities and limitations. The next program should focus on the sustainable use of saigas, taking into account its above explained four important dimensions. Also, to ensure legal international trade in saiga derivatives as the major source of cash revenues from saiga, a justified removal of the annotation on international commercial trade at the next CoP CITES needs to be achieved.

9. Literature

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Annex 1. Vegetation observation form

Head data vegetation and biomass sampling / _______________ 20___ / Ural

Basic data			
Plot-ID			
Date			
Team members			
Plot size (m x m)			
Plot location			
Longitude			
Latitude			
Accuracy (in m)			
Relief position			
Inclination			
Exposition			
Cover herb layer (%)			
Maximum height herbs (cm)		Mean height (cm)	
Moss layer (%)			
Litter layer (%)			

Plot-ID:

Species name	**Cover class**	**Comment**
	Londo	

Annex 2. Species list

№	Spientific name	Family
1	*Achillea millefolium L.*	*Asteraceae*
2	*Achillea nobilis L.*	*Asteraceae*
3	*Agropyron cristatum (L.) Gaertn.*	*Poaceae*
4	*Agropyron fragile (Roth) P.Candargy*	*Poaceae*
5	*Allium flavescens Poepp. ex Kunth*	*Amaryllidaceae*
6	*Alopecurus pratensis L.*	*Poaceae*
7	*Alyssum desertorum Stapf*	*Poaceae*
8	*Amygdalus nana L.*	*Rosaceae*
9	*Anabasis salsa (Ledeb.) Benth. ex Volkens*	*Amaranthaceae*
10	*Amarenus filformis (L.) Fourr.*	*Fabaceae*
11	*Anisantha tectorum (L.) Nevski*	*Poaceae*
12	*Arabidopsis thaliana (L.) Heynh.*	*Brassicaceae*
13	*Arabidopsis toxophylla (M.Bieb.) N.Busch*	*Brassicaceae*
14	*Eremogone longifolia (M.Bieb.) Fenzl*	*Caryophyllaceae*
15	*Artemisia austriaca Jacq.*	*Asteraceae*
16	*Artemisia lerchiana Weber*	*Asteraceae*
17	*Artemisia nitrosa Weber ex Stechm.*	*Asteraceae*
18	*Artemisia pauciflora Weber ex Stechmann*	*Asteraceae*
19	*Artemisia pontica L.*	*Asteraceae*
20	*Astragalus L. spp*	*Fabaceae*
21	*Atriplex nitens (*synonym of *Atriplex sagittata Borkh.)*	*Amaranthaceae*
22	*Bassia sedoides (Pall.) Asch.*	*Amaranthaceae*
23	*Bromus squarrosus L.*	*Poaceae*
24	*Cachrys odontalgica (Prangos odontalgica (Pall.) Herrnst. & Heyn)*	*Apiaceae*
25	*Camphorosma monspeliaca L.*	*Amaranthaceae*
26	*Capsella bursa-pastoris Medik.*	*Brassicaceae*
27	*Carduus uncinatus M.Bieb.*	*Asteraceae*
28	*Carex stenophylla Wahlenb.*	*Cyperaceae*
29	*Ceratocarpus arenarius L.*	*Amaranthaceae*
30	*Ceratocephala orthoceras (Ranunculus testiculatus Crantz)*	*Ranunculaceae*
31	*Cirsium arvense (L.) Scop.*	*Asteraceae*
32	*Climacoptera Botsch. spp.*	*Amaranthaceae*
33	*Convolvulus arvensis L.*	*Convolvulaceae*
34	*Descurainia sophia (L.) Webb ex Prantl*	*Brassicaceae*

35	*Dianthus L. spp.*	*Caryophyllaceae*
36	*Draba nemorosa L.*	*Brassicaceae*
37	*Elymus repens (L.) Gould*	*Poaceae*
38	*Eremopyrum orientale (L.) Jaub. & Spach*	*Poaceae*
39	*Eremopyrum triticeum (Gaertn.) Nevski*	*Poaceae*
40	*Erophila verna (L.) DC. (*synonym of *Draba verna L.*	*Brassicaceae*
41	*Eryngium planum L.*	*Apiaceae*
42	*Erysimum hieracifolium Pall. (*synonym of *Erysimum cuspidatum DC.)*	*Brassicaceae*
43	*Euclidium syriacum (L.) W.T.Aiton*	*Brassicaceae*
44	*Euphorbia virgata Waldst. et Kit.*	*Euphorbiaceae*
45	*Falcaria vulgaris Bernh.*	*Apiaceae*
46	*Ferula caspica M.Bieb.*	*Apiaceae*
47	*Festuca valesiaca Schleich. ex Gaudin*	*Poaceae*
48	*Filago arvensis L.*	*Asteraceae*
49	*Frankenia pulverulenta L.*	*Frankeniaceae*
50	*Gagea bulbifera Salisb.*	*Liliaceae*
51	*Galatella biflora Nees*	*Asteraceae*
52	*Galatella tatarica (Less.) Novopokr.*	*Asteraceae*
53	*Galatella villosa Rchb.f.*	*Asteraceae*
54	*Galium verum L.*	*Rubiaceae.*
55	*Gypsophila paniculata L.*	*Caryophyllaceae*
56	*Hymenolobus procumbens (L.) Nutt. (*synonym of *Hornungia procumbens Hayek)*	*Brassicaceae*
57	*Inula salicina L.*	*Asteraceae*
58	*Jurinea multiflora B.Fedtsch.*	*Asteraceae*
59	*Kochia prostrata (L.) Schrad. (*synonym of *Bassia prostrata (L.) Beck)*	*Amaranthaceae*
60	*Koeleria cristata (L.) Bertol.*	*Poaceae*
61	*Koeleria pyramidata (Lam.) P.Beauv.*	*Poaceae*
62	*Lamium paczoskianum Vorosch. (*synonym of *Lamium amplexicaule var. orientale (Pacz.) Mennema)*	*Lamiaceae*
63	*Lappula patula Asch.*	*Boraginaceae*
64	*Lepidium perfoliatum L.*	*Brassicaceae*
65	*Lepidium ruderale L.*	*Brassicaceae*
66	*Leymus ramosus (K.Richt.) Tzvelev*	*Poaceae*
67	*Limonium gmelinii Kuntze*	*Plumbaginaceae*
68	*Limonium sareptanum (A.K.Becker) Gams*	*Plumbaginaceae*

69	*Medicago falcata L.*	*Fabaceae*
70	*Myosotis micrantha Pall. ex Lehm.*	*Boraginaceae*
71	*Myosurus minimus L. (*synonym of *Ranunculus minimus E.H.L.Krause)*	*Ranunculaceae*
72	*Nepeta ucranica L.*	*Lamiaceae*
73	*Onosma tinctoria Bieb.*	*Boraginaceae*
74	*Ornithogalum fischerianum Krasch.*	*Asparagaceae*
75	*Pastinaca clausii Calest.*	*Apiaceae*
76	*Petrosimonia brachiata (Pall.) Bunge*	*Amaranthaceae*
77	*Petrosimonia triandra (Schrank) Rech.*	*Amaranthaceae*
78	*Phlomis herba-venti subsp. pungens (Willd.) Maire ex DeFilipps*	*Lamiaceae*
79	*Phlomoides tuberosa Moench*	*Lamiaceae*
80	*Poa bulbosa L.*	*Poaceae*
81	*Poa pratensis L.*	*Poaceae*
82	*Polygonum aviculare L.*	*Polygonaceae*
83	*Polygonum patulum M.Bieb.*	*Polygonaceae*
84	*Polygonum repens Meisn.*	*Polygonaceae*
85	*Pastinaca clausii Calest.*	*Apiaceae*
86	*Potentilla argentea L.*	*Rosaceae*
87	*Potentilla bifurcata Poir. (*synonym of *Sibbaldianthe bifurca (L.) Kurtto & T.Erikss)*	*Rosaceae*
88	*Potentilla humifusa D.F.K.Schltdl.*	*Rosaceae*
89	*Puccinellia dolicholepis (V.I.Krecz.) Pavlov*	*Poaceae*
90	*Ranunculus L. spp.*	*Ranunculaceae*
91	*Rorippa brachycarpa Hayek*	*Brassicaceae*
92	*Salsola collina Pall.*	*Amaranthaceae*
93	*Salvia dumetorum Andrz.*	*Lamiaceae*
94	*Scabiosa L. spp.*	*Caprifoliaceae*
95	*Senecio glaucus subsp. coronopifolius (Maire) C.Alexander*	*Asteraceae*
96	*Serratula dissecta Ledeb.*	*Asteraceae*
97	*Serratula erucifolia Druce (*synonym of *Klasea erucifolia (L.) Greuter & Wagenitz)*	*Asteraceae*
98	*Silene dichotoma Ehrh.*	*Caryophyllaceae*
99	*Silene L. spp.*	*Caryophyllaceae*
100	*Sisymbrium polymorphum (Murray) Roth*	*Brassicaceae*
101	*Spiraea hypericifolia L.*	*Rosaceae*
102	*Stipa capillata L.*	*Poaceae*
103	*Stipa lessingiana Trin. & Rupr.*	*Poaceae*
104	*Stipa sareptana A.K.Becker*	*Poaceae*

105	*Suaeda acuminata (C.A.Mey.) Moq.*	*Amaranthaceae*
106	*Tanacetum achilleifolium Sch.Bip.*	*Asteraceae*
107	*Taraxacum erythrospermum Andrz. ex Besser*	*Asteraceae*
108	*Thalictrum minus L.*	*Ranunculaceae*
109	*Trinia hispida Hoffm.*	*Apiaceae).*
110	*Tulipa patens Agardh. ex Schult.f.*	*Liliaceae*
111	*Tulipa schrenkii Regel* (synonym of *Tulipa suaveolens Roth)*	*Liliaceae*
112	*Valerianella Mill. spp.*	*Caprifoliaceae*
113	*Verbascum phoeniceum L.*	*Scrophulariaceae*
114	*Veronica verna L.*	*Plantaginaceae*
115	*Xanthium strumarium Lour.*	*Asteraceae*