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INFLUENCE OF NATURAL AND ANTHROPOGENIC FACTORS ON THE DIGRESSION OF MOUNTAIN PASTURES OF THE ASSY PLATEAU

The study considers the features of nature management of one of the large mountain pastures of Ile Alatau in the Asy River valley (Northern Tien Shan). Located on a mountain plateau at an altitude of 2200-2800 m, the pasture is characterized by landscape and biological diversity, highly productive plant communities. The state of plant associations of the Asy valley was studied in the second half of the 1990s, when natural pastures were practically not used due to socio-economic collisions, which ensured pronounced demutational and regenerative processes of grass phytocenoses. These restoration processes took place against the background of unfavorable climatic changes: less precipitation and higher air temperature in the warm period. Subsequent field work dates back to the period 2012-2020, when the ecosystems of the Assy River valley experienced a powerful anthropogenic impact in the form of overgrazing, press of tourists and poachers. At the same time, the vast majority of livestock breeders do not consider the obvious degradation of pastures and do everything possible to increase the number of livestock, violating the principles of sustainable use of pastures. In these conditions it is completely unrealistic to organize works on improvement, phytoremediation of fodder vegetation. Undoubtedly, it is necessary to carefully organize the use of highly productive alpine pastures and strict control over the number of grazing livestock. Much awareness raising and organization of a harmonious balance between economic and ecological components is necessary. Recommendations are given on the use of different systems for monitoring, restoration and sustainable use of pasture ecosystems in the region.

Key words: ecosystem services, mountain pastures, Ile Alatau, overgrazing, degradation and restoration of plant resources, monitoring and phytoremediation, sustainable pasture management.

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Табиғи және антропогендік факторлардың Асы үстіртіндегі таулы жайылымдарға дигрессиялық әсері

Зерттеуде Асы өзені (Солтүстік Тянь-Шань) алқабында орналасқан ірі жайылымдарының бірі – Іле Алатауды пайдалану ерекшеліктері қарастырылады. Таулы үстіртте 2200-2800 м биіктікте орналасқан жайылым өзіне тән ландшафтымен және биологиялық әртүрлілігімен, жоғары өнімді өсімдіктер қауымдастығымен ерекшеленеді. 1990 жылдардың екінші жартысында Асы алқабындағы өсімдіктер қауымдастығының жағдайы зерттелді. Табиғи жайылымдар әлеуметтік-экономикалық қақтығыстарға байланысты іс жүзінде қолданылмады, бұл өз кезегінде шөпті фитоценоздардың айқын демутациялық-қалпына келтіру процестерін қамтамасыз етті. Бұл қалпына келтіру процестері қолайсыз климаттық өзгерістер жағдайында болды: жауын-шашын азайып, жылы мезгілдерде ауа температурасы көтерілді. Келесі далалық жұмыстар 2012-2022 жж., мерзіміне тиесілі. Бұл кезде Асы өзені алқабының экожүйесі малдардың шектен тыс жайылымы, туристер мен браконьерлердің қысымы түрінде күшті антропогендік әсерге ие болды. Өз кезегінде, малшылардың көпшілігі жайылымдық жерлердің айқын деградациясын ескермей, мал басын өсіру үшін жайылымдардың тұрақты пайдалану қағидасын бұзды. Бұндай жағдайда өсімдіктерді жақсарту және фиторемедиациялау жұмыстарын ұйымдастыру мүмкін

емес. Осы орайда жоғары өнімді альпілік жайылымдарды мұқият ойластырып, қолдану және жайылатын мал сандарын қатаң бақылау қажет екені сөзсіз. Экономиялық және экологиялық компоненттер арасындағы тепе-теңдікті ұйымдастырып, түсіндіру жұмыстарын жүргізу қажет. Өңірдің жайылымдық экожүйелерін бақылау, қалпына келтіру және тұрақты пайдаланудың әртүрлі жүйелерін пайдалану бойынша ұсыныстар беріледі.

Түйін сөздер: экожүйелік қызметтер, таулы жайылымдар, Іле Алатауы, малдың шамадан тыс жайылуы, өсімдік ресурстарының деградациясы және қалпына келтірілуі, мониторинг және фиторемедиация, жайылымдарды тұрақты пайдалану.

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Влияние природных и антропогенных факторов на дигрессию горных пастбищ плато Ассы

В исследовании рассматриваются особенности природопользования одного из крупных горных пастбищ Иле Алатау в долине реки Асы (Северный Тянь-Шань). Расположенное на горном плато на высоте 2200–2800 м пастбище отличается ландшафтным и биологическим разнообразием, высокопродуктивными растительными сообществами. Изучалось состояние растительных ассоциаций долины Асы во второй половине 1990-х гг., когда естественные пастбища, ввиду социально-экономических коллизий практически не использовались, что обеспечило ярко выраженные демутационно-восстановительные процессы травяных фитоценозов. Эти восстановительные процессы происходили на фоне неблагоприятных климатических изменений: стало меньше осадков и выросла температура воздуха в теплый период. Последующие полевые работы относятся к периоду 2012–2020 гг., когда экосистемы долины р. Ассы испытывали мощное антропогенное воздействие в форме перевыпаса скота, пресса туристов и браконьеров. При этом, подавляющая часть животноводов не считается с очевидной деградацией пастбищных угодий и делает все возможное для роста поголовья, нарушая принципы устойчивого использования пастбищ. В этих условиях совершенно нереальна организация работ по улучшению, фиторемедиации кормовой растительности. Несомненно, что необходима продуманная организация использования высокопродуктивных альпийских пастбищ и строгий контроль за численностью выпасаемого скота. Необходима большая разъяснительная работа и организация гармоничного равновесия между экономическим и экологическим составляющими. Даются рекомендации по использованию различных систем мониторинга, восстановления и устойчивого использования пастбищных экосистем региона.

Ключевые слова: экосистемные услуги, горные пастбища, Иле Алатау, перевыпас, деградация и восстановление растительных ресурсов, мониторинг и фиторемедиация, устойчивое использование пастбищ.

Introduction

Natural pastures are the basis of pastoralism, a way of life, and an important component of the cultural heritage of many peoples. On the one hand, grasslands provide numerous ecological services such as climate regulation, soil and water conservation, sand fixation, soil improvement, and biodiversity support [1]. On the other hand, grasslands also can clean the air, water, and soil of pollutants through various physical, chemical, and biological processes that maintain ecosystem quality and human health [2].

However, years of anthropogenic overload combined with the effects of climate warming have led to a decline in the productivity of pasture ecosystems and their resilience to natural hazards, particularly drought [3]. It has been reported that about 50% of the world's pastures are degraded [4-6], and temperate latitude pastures lost more than 70% of their natural cover by 1950. [7]. In Kazakhstan, the area of natural pastures is 180.4 million ha, of which more than 5.9 million ha have been improved and 105.2 million ha are watered. Accordingly, more than 111.1 million ha of pastures are suitable for grazing [8]. At the same time, in Kazakhstan, more than 80% of the total number of farm animals is concentrated in private farmsteads, whose owners, due to economic factors, graze their livestock mainly within a radius of 5-7 km from

their residence place. As a result of the so-called near-settlement pasture digression, about 20 million hectares of pastures are degraded, while some remote pastures are almost not used [9].

Grazing has been an important economic activity in mountain meadows for thousands of years. At the same time, a significant part of alpine meadows suffers from overgrazing due to unwise management [10]. Many studies have shown that overgrazing is what has led to severe degradation of mountain pastures [11], reduction of biodiversity, loss of natural habitat [12], acceleration of soil erosion [13], and seriously threatens the balance of soil-herb ecosystems and pasture productivity [14]. Several global quantitative reviews [15,16] have shown that the impact of grazing on vegetation is related to its productivity. The latter, in turn, is controlled by abiotic factors such as climate (precipitation, temperature) and topographic conditions. Several works have shown that both in humid regions with high productivity during the growing season and in pastures of arid zones with relatively low productivity, it is the amount of precipitation that has the greatest influence on plant productivity [17]. At the same time, other researchers have described the priority effect of grazing on pasture vegetation both in forest steppes in northern Mongolia [18] and the desert-steppe zone in northern China [19].

Considerable pasture massifs of Central Asia are located in the mountains. A common feature of all mountain systems is the vertical change of soil and vegetation cover. At the same time, each of the mountain systems has its features conditioned by the height of ridges, their position, exposure of slopes, geological structure, and latitudinal zonality. Local topographic conditions in the mountains, which may also interact with the consequences of livestock grazing, should also be considered [20]. Moreover, many studies have shown that the primary production of individual plants and communities can respond neutrally or positively to herbivore grazing under certain circumstances [21,22]. It follows from these studies that the impact of herbivores on plant productivity is complex and, in particular, depends to a large extent on pasture load.

The purpose of our study was to investigate the influence of contrastingly different levels of pasture load and meteorological conditions on the vegetation cover, its floristic composition, projective cover, and condition of the main species of forage plants of natural pastures of the Assy River valley in the subalpine and alpine zones of the Ile Alatau.

Materials and methods

Study of the region

The natural pastures of the Asy River valley, located in the subalpine and alpine zones of Ile Alatau at the upper boundary of the coniferous forest belt, with the transition to the subalpine belt, were studied. Administratively, the territory belongs to the Yenbekshikazakh district of the Almaty region. The main coordinates are 43° 15’ N, 78° 03’ E on the Assy plateau, altitude of 2200-2800 m (Figure 1). The area is more than 40,000 ha. The Assy pasture stretches from west to east for about 40 km with an average width of about 10 km. Numerous small rivers and streams flow through the pasture from the adjacent gorges into the Assy River (flowing eastward). The southern slopes surrounding the plateau are open, on the northern slopes there are areas of spruce and juniper forests, bedrock outcrops are not uncommon on the slopes, and rocky outcrops occur on the ridges (Figure 2). These pastures provide important ecological services, including biodiversity conservation, carbon storage, and water regulation, as well as ecosystem services such as distant pastoralism, cultural heritage, tourism, and recreation at local and regional scales.

Official meteorological data on temperature and precipitation in the studied area obtained by the workers of the Assy meteorological station located at an altitude of 2260 m above sea level in the western part of the Assy valley were used. According to the altitudinal location, the Assy River valley is characterized by a relatively cold and dry climate. The mean annual air temperature for the 1990-1999 decade was +0.53°C and increased to +1.15°C in the last decade of 2013-2022. The average monthly temperature of July for the 1990-1999 decade was +12.18°C and for the 2013-2022 period was +13.26°C. The average monthly temperature of January for 1990-1999 is. -13.1°C, and for the period 2013-2022. -12,1°C. Active temperatures for vegetation growing above +5°C in the Assy valley start in May, +6.09°C in 1990-1999 and +7.36°C in 2013-2022, and end in September: +6.94°C in 1990-1999 and +8.09°C in 2013-2022. That is, over the last 33 years, a gradual noticeable warming of the climate can be traced on the territory of the Assy plateau.

Figure 1 – Study region map

Figure 2 – Rocky outcrops, juniper forests, mountain meadows, and spruce forests on the Assy plateau

The amount of average annual precipitation according to the data of the Assy weather station has significantly decreased over the last 33 years (approximately from 340 mm to 258 mm), with summer precipitation prevailing to a large extent. It should be noted that in comparison with other mountainous areas of Ile Alatau of similar altitudinal belt, the Assy valley is characterized by relatively low precipitation. Pastures in the Assy valley have a very short growing season, limited by low

temperatures and variable precipitation. Growth of pasture vegetation begins in mid-May and mostly ends in August. The duration of the frost-free period is about 200 days. The snow cover is stable.

Methods of geobotanical surveys

Geobotanical surveys carried out by the authors in 1998 and in 2012-2015 were conducted by the route method by the Instruction on conducting large-scale (1:1000 – 1:100000) geobotanical surveys of natural forage lands of the Republic of Kazakhstan, 1996, developed in the system of land management of the Republic of Kazakhstan [23]. In the course of fieldwork, a map of the region was georeferenced to the soil and vegetation cover on the ground using pocket computers and GPS navigators, and the boundaries of the studied types of biocenoses were delineated based on fieldwork on the ground. The phytoproductivity of plant communities was determined using the mowing method with subsequent drying of the collected phytomass. Soil profiles and excavations were made as part of the soil cover study. Vegetation communities were described, GPS-coordination of description points was carried out, photographs were taken, and herbarium was collected to clarify the floristic composition of vegetation of the study area. During the vegetation study, the following was determined: the floristic composition of plant communities; their structure and spatial distribution; composition of life forms; confinement to habitat conditions; degree of anthropogenic impact on vegetation; and projective coverage of soil by plants. During the study of vegetation (on 100 m^2 plots) the species composition of communities, projective coverage of soil by plants, height of herbage, its development, and visual productivity were determined. A total of 50 sample plots of 100 m^2 were geobotanically described. Yields of plant communities were determined on cutting plots bounded by 1x1 m square frames. In plant communities with uniform projective cover, 1 m^2 harvesting plots were laid in fourfold repetition, and in sparse herbage in eight to tenfold repetition. Determination of projective cover provides objective criteria for species ratio in the community. The ratio of species characterizes the dominance (prevalence) of plants in the community and communities (phytocenoses) are named according to the dominance.

Results and Discussion

According to remote sensing data, on the territory of the Assy valley forest areas occupy about 5%, shrubs – about 10%, rocky areas, and river floodplains – about 5% in total, and grassy open slopes used as pastures – 80%. The considered altitudinal belt is the most favorable for the growth of spruce forests on steep shaded slopes and mountain meadows on more gentle slopes and plateaus. In the warm period of the year in the Ile Alatau mountains for every 100 m of ascent the air temperature decreases by 0.6-0.7°C. On the contrary, in the winter period in the lower part of the mountains (up to the height of 1700 m), the air temperature increases by 0.36°C for every 100 m of ascent, which is caused by the flow of heavier cold air downwards. At the same time, the general trend of temperature decrease with altitude does not change. Not only precipitation but also evapotranspiration, which is related to air temperature, is considered for the general characterization of climate [24]. This general picture of climate dependence on altitude belts in the Ile Alatau Mountains varies with slope exposure. The west-facing slopes are close to the southern slopes in terms of heat sum, while the eastern slopes are close to the northern slopes. This has a significant impact on vegetation: steep shaded slopes of northern exposures are covered with forest, gentle and warmer slopes – with meadow vegetation, and slopes of southern exposures – with steppe vegetation.

Anthropogenic factors have greatly changed the appearance of the mountain ecosystems of Ile Alatau, near which there are densely populated cities and towns, including the city of Almaty. Since the 1990s, due to a sharp decline in industrial and agrarian production, deep changes in natural and anthropogenic ecosystems have occurred in Kazakhstan. Due to unauthorized logging and more frequent fires, the area of forests and shrubs has decreased. At the same time, due to a significant, several-fold drop in the number of livestock and the difficulty for most private subsidiary farms to use remote pastures, the summer pastures (zhailau) of the Assy valley were practically not used in the 1990s for 6-8 years. At the same time, due to sharply reduced grazing on a significant area of distant pastures in the 1990s, restorative succession of the post-pasture demutation type took place (Figure 3).

Since 2000, animal husbandry in Kazakhstan has been developing extensively, i.e. the increase in the volume of production is due to a quantitative increase in the number of livestock, both in large farms and in small farms, where livestock farming is conducted on an individual family basis. At the same time, due to the predominant use of fodder by animals as the most economically advantageous, the main load fell

on natural pastures. Considering the rich grass and abundance of water sources on mountain pastures, they began to be used more and more intensively for seasonal distant cattle breeding. At the same time, the species structure of grazing animals was changing. In Soviet times the most developed branch of animal husbandry in the Republic of Kazakhstan was sheep breeding and dairy cattle breeding. At present, due to a sharp decline in fodder production and a reduction in the volume of insurance fodder procurement, herd horse breeding, and meat cattle breeding have received the greatest development in private farms. Thus, if in 2000 the number of horses amounted to 976 thousand, in 2023 it reached 4,200 thousand heads [25]. Currently, sheep and horses, in the ratio of approximately 1:1, and cattle are grazed in the Assy valley. According to our calculations, the total number of cattle during the study period is about 300,000 heads, which significantly exceeds the forage capacity of pastures. The grazing period begins in mid-May and lasts until October, averaging 120-150 days. By the end of the season, in early fall, a typical pasture digression picture develops (Figure 4).

Figure 3 – Post-grazing demudation in the area of the observatory in the Assy River valley, June 2000

Figure 4 – Digression of the same habitat as a result of overgrazing in fall 2020.

At the same time, due to the explosive increase of private vehicles, the valley of the Assy River is experiencing a huge recreational load, primarily due to the invasion of automobile and motorcycle tourists, hunters, and fishermen in the warm season. As a result, there is a decrease in productivity and species diversity of plants (especially at the expense of rare and endangered species), an increase in the proportion of plant species in phytocenoses that are poorly eaten by animals, impoverishment of fauna (primarily commercial species), as well as animals sensitive to the disturbance factor. Overgrazing, especially on steep mountain slopes, causes soil erosion and turf disruption. There is practically no mountain landscape in the Assy valley that has not been affected, at least indirectly, by human economic or recreational activities.

According to the "Classification of natural fodder lands of the Republic of Kazakhstan", the territory of the Assy plateau belongs mainly to the mid-mountain steppe, partly high-mountain subalpine and fragmentally (on the peaks) alpine belt. The relief is represented by an intermountain wavy-rolling plain sloping down to the Assy River floodplain. The vegetation is subject to the laws of vertical zonality and reflects natural and climatic conditions of the mountain landscape related to relief forms, slope exposure, soil diversity, and climatic factors. The main life forms are perennial and annual grasses, dwarf semi-shrubs, and shrubs. Ephemerals and ephemeroids are seldom found. In terms of relation to water regime, mesoxerophytes, mesophytes, and xerophytes are predominant. Hydrophytes and hygrophytes make up a very small percentage of the flora. The vegetation cover of the study area is typical for steppes and is diverse both in terms of floristics and geobotany. It is mainly composed of xerophilous (*Stipa pennata* L. and *Stipa capillata* L., *Festuca valesiaca* Schleich. ex Gaudin (tipchak) and *Helictochloa* Romero Zarco genus species) and mesophilous (*Poa* L., *Elytrigia* Desv., *Bromus* L., *Hordeum* L., *Dactylis* L. genera species) grasses with significant presence and even predominance in some places of various species of xeromesophilous forbs.

Since the contrast of the soil and vegetation cover of the northern and southern slopes is manifested in the middle mountains, both xerophytes and mesophytes are distinguished in the composition of ecological types of the flora. Vegetation at the same altitude on the southern slopes (warm and dry) is more xerophilic and on the northern slopes (cold and humid) more mesophilic. In addition, different edaphic variants of communities are distinguished: pelitophytes – on loamy soils, litophytes – on stony and gravely soils. Psammophytes and halophytes are practically absent. Mid-mountain steppe communities also vary in the richness of species composition of their constituent plants. In some habitats, there are mono-species communities, but more often there are multi-species communities. In polydominant meadow communities, which occupy the first place by richness of species composition, long-rooted mesophilic grasses predominate: *Hordeum vulgare* L., *Festuca pratensis* Huds., *Bromus inermis* Leyss., *Alopecurus soongaricus* (Schrenk) Petrov, *Phleum phleoides* (L.) H. Karst., *Phleum paniculatum* Huds., *Elytrigia repens* (L.) Desv. ex Nevski, *Poa pratensis* L. They are accompanied in great abundance by mesophilic forbs: *Achillea millefolium* L., *Medicago falcata* L., *Sanguisorba officinalis* L., *Lathyrus pratensis* L., *Pentanema britannicum* (L.) D.Gut.Larr. et al., *Trifolium repens* L., species of *Alchemilla* L., *Astragalus* L., *Potentilla* L., *Geranium* L., *Myosotis* L. genera, and others. The total projective coverage of soil by plants is high (70-80%, and in some places up to 100%).

It should be noted that the steppe vegetation is characterized by year-to-year fluctuations. In dry years, xerophilous plant species develop better, in wet years – less drought-resistant species. The change of plant communities also occurs under the influence of anthropogenic factors: pasture succession leads to the formation of disruptions and complete degradation of vegetation cover in watering places, cattle wintering places, pens, and settlements. Due to this, valuable fodder plants disappear, and their place is taken by poorly eatable or uneatable forbs and weeds. *Stipa pennata*, *Stipa kirghisorum* P. A. Smirn., and *Stipa richteriana* Kar. & Kir. are the most unstable to grazing and other types of anthropogenic impact, so they easily fall out of the herbage, being replaced by more stable needlegrass (*S. capillata*) and then by tipchak (*F. valesiaca)*. With the predominance of needlegrass, *Stipa* L. genus (feathergrass) – tipchak, and needlegrass-tipchak-*Artemisia* L. genus community typical for the western part of the Assy plateau. Tipchak-grasses, tipchak-forbs, tipchak, tipchak-grasses-*Artemisia* communities with average yields of 2.5-3.6 c/ha are also widespread. They occur throughout the territory, but the largest massifs of tipchak communities are found in the central part.

Non-forested slopes are characterized by the predominance of soft-stemmed grasses (*Poa*, *Dactylis*, *Bromus*, *Alopecurus* L., *Festuca* L., *Phleum* L. genera) and colorful, species-rich meadow grasses

(*Geranium*, *Alchemilla*, *Polygonum* L., *Astragalus*, *Polemonium* L., *Ligularia* Cass., *Aconitum* L. genera), forming grass (*Gramineae* L. genus) – forb, forb – grass and forb types of pastures. In the lower part of the belt on the slopes of southern exposure, the species composition of pastures significantly includes steppe species of grasses (*Poa stepposa* Besser, *F. valesiaca*, *Helictochloa* and *Stipa* genera) and forbs (*Phlomoides* Moench, *Achillea* L., *Origanum* L., *Astragalus*, *Dracocephalum* L. genera). Yields of mid-mountain meadow and meadow-steppe pastures vary from 5 to 15 c/ha of dry matter.

The vegetation cover of high-mountain areas is represented by colorful medium- and low-grass subalpine and alpine meadows. Among high-mountain pastures, the most widespread are kobresia (*Kobresia* Willd.), sedge (*Carex* L.), forb – grass, and fescue (*Festuca*) – forb – grass communities with yield fluctuations from 2 to 9 c/ha of dry mass, but more often it is 2-4 c/ha.

In the valley, fragments of alpine meadows with islands of kobresia associations and low (5–12 cm) forbs (*Thymus* L., *Astragalus*, *Leontopodium* R.Br. ex Cass. genus) are common in the eastern part. In general, the most characteristic for Assy plateau are simple one- or two-component communities: tipchak, bunchgrass – grass – forb, *Stipa capillata*-tipchak, feathergrass – tipchak, tipchak – feathergrass and grass – forb.

Their unstable modifications are weed-grass, weed-forb with *Poaceae* Barnhart, weed, *Cousinia* Cass., *Descurainia* Webb & Berth., *Urtica* L., *Artemisia austriaca* Jacq., and others. At the same time, the fodder yield of the plants eaten is low (0.5–2.0 c/ha of dry weight). Almost all feathergrass pastures contain tipchak (*F. valesiaca*) – a small-bunchgrass with a wide ecological amplitude. It becomes the dominant plant cover in conditions where feathergrass plants cannot maintain their dominance due to a significant increase in rockiness (for example, in the middle part of the valley) or under the influence of grazing. Tipchak – feathergrass and tipchak types of pastures are widespread; tipchak-*Artemisia* (*Artemisia sublessingiana* Krasch. ex Poljakov and *Artemisia frigida* Willd.) are rare. The productivity of tipchak pastures is lower than that of feathergrass type and averages 2.5–4.5 c/ha of dry weight.

The species richness of the communities is 7–20 species, the projective cover of soil by plants is 70–100%, the average height of the herbage is 15–50 cm, the yield of eaten plants ranges from 3-7(10) c/ha of dry mass. At the time of surveys (1st decade of July), 20-30% grass loss by grazing was observed practically everywhere, and 40-50% near livestock camps. Cattle graze on slopes, trampling trails completely devoid of vegetation (Figure 5).

Figure 5 – Pasture erosion

Mechanical impact (trampling, biting, etc.) occurring under the influence of grazing, especially by cattle and small cattle, and recreational load are worse withstood by representatives of herbaceous perennials – grasses and forbs of subalpine and alpine zones. Since the mountain pastures of the Assy valley have been used since ancient times for summer pasturing of cattle with a heavy

load, their herbage has been heavily grazed and trampled, which led to its degradation. Degradation is expressed in the reduction of dominant species' share (feathergrass and other grasses), which lose the role of herbage edifiers and become subdominant, then occur singularly and, finally, drop out of the herbage altogether. There is a change of dominants, for example, feathergrass to tipchak, and, in turn, tipchak to poorly eaten species of forbs. Thorny uneaten weeds such as *Cousinia*, *Urtica*, and *Onopordum* L. genera, non-edible *Artemisia austriaca* and annual poisonous weed *Descurainia sophia* (L.) Webb ex Prantl grow on particularly intensively and unsystematically used plots. Changes in species composition and changes in dominants lead to a decrease in yield. Pastures degrade in 5-8 years under the influence of intensive grazing. Relatively weakly disturbed herbaceous vegetation under favorable conditions recovers in 5-6 years, while severely disturbed vegetation does not recover for decades.

During the years of extensive economic development in Kazakhstan, soil and vegetation components of mountain pasture ecosystems, experiencing significant stresses, were subjected to degradation, but the number of state and private livestock was relatively evenly dispersed over vast pasture and hayfield territories. Livestock grazed the above ground phytomass to a state of unclosed vegetation cover and various stages of degradation. In 1992-1994, after the disbanding of collective farms, cattle were unevenly distributed among a few large and numerous small private farms and due to the impoverishment of the majority of the population, collapse of the infrastructure of semi-industrial livestock and fodder production, their number decreased several times.

The sharp reduction of pasture load in the Assy valley in 1993-1994 caused the processes of vegetation restoration. The processes of restoration proceed in reverse order and are expressed in the fact that the plant communities are again dominated or present in the vegetation communities by feathergrass, tipchak and soft-stemmed grasses, which previously completely or partially disappeared from the herbage. Restoration of vegetation in the valley is also evidenced by the fact that there are quite a lot of juvenile specimens of feathergrass, tipchak and other grasses in the herbage. The herbage has high projective coverage – 70-100%, average height varies from 15 to 50 cm. According to our observations, by about 2000 the valley herbage had recovered after many decades of intensive grazing, had a very good condition, high growth, almost 100% projective cover and consisted of well-eatable grasses.

After 2000, the number of grazing livestock began to grow rapidly, and signs of pasture degradation increased. In disrupted areas near yurts, wintering areas, and livestock camps, small areas of *Descurainia sophia* (L.) Webb ex Prantl, *Cousinia polycephala* Rupr., *Urtica cannabina* L. and *Onopordum acanthium* L. gall are observed (Figure 6).

Figure 6 – Cotton thistle *Onopordum acanthium* L.

Discussion

Studies of the current state of ecosystems in the alpine and subalpine zones of the Ile Alatau, conducted on the high-mountain summer pasture of the Assy plateau after 2013, revealed the negative consequences of overgrazing, intensive recreational load and climate changes. Practically, the change of species in the series of herbage degradation on the studied territory of the Assy plateau is as follows: feathergrass *Stipa* (*Poaceae* family) → bunchgrass *Poaceae* (feathergrass *Stipa* – tipchak *F. valesiaca*) → tipchak – feathergrass and forbs → tipchak with feathergrass and forbs → tipchak with forbs → tipchak – forbs → forbs – tipchak → forbs – tipchak *F. valesiaca*, with weeds → weeds – forbs – tipchak, → weeds – forbs → weeds → disruption by cattle. Changes in floristic composition and a change in dominant plant species valuable for food lead to a decrease in the yield and forage capacity of alpine pastures.

The sharp drop in livestock numbers in the region, as well as in Kazakhstan as a whole, in the 90s was accompanied by demutational processes of vegetation restoration. According to our observations, by about 2000, the herbage of the Assy valley had recovered after many decades of intensive grazing, was in good condition, had high growth, almost 100% projective cover, and consisted mainly of well-eaten grasses. After 2000, the number of grazed livestock gradually increased, and its species structure changed, accompanied by an increase in the number of horses and cattle, and the load on pastures increased accordingly. The vegetation is again subjected to intensive overgrazing, large poorly eaten or un-eaten forbs are growing – Asiatic dock (*Rumex confertus* Willd.), bristly (*Cirsium arvense* var. *integrifolium* Wimm. & Grab.) and boar thistle (*Cirsium arvense* (L.) Scop.), buzulnik (*Ligularia* Cass.), European wand loosestrife (*Lythrum virgatum* L.), purple loosestrife (*Lythrum salicaria* L.), marsh spurge (*Euphorbia palustris* L.), leafy spurge (*Euphorbia virgata* Waldst. & Kit.), etc.

The main factors of anthropogenic impact and processes of degradation of phytocenoses of the Assy plateau are overgrazing and road digression, as well as, to a lesser extent, fires and recreational loads. In addition, the large crowding of livestock on the plateau and the insufficient level of veterinary care and vaccination creates an unfavorable epizootic situation not only for domestic animals but also for wild animals.

Conclusion

Regardless of the number of livestock and climatic changes, the issue of rational use of natural pastures is always acute in Kazakhstan. This requires continuous and effective monitoring of pastures condition, recording of their floristic composition and fodder capacity in relation to climatic changes, development of a set of measures to preserve and improve the quality of pastures. It is known that the foundation of rational use and protection of natural fodder lands is compliance of the number and type of livestock with the fodder capacity of the pasture, use of pastures by seasons, haying and pasture rotation, and paddock grazing system. Surface improvements are necessary on already degraded areas, which include reduction of pasture load and regulation of grazing, application of fertilizers to meadows, elimination of bunchgrass hummocks, sowing of perennial grasses and grass mixtures in the turf of natural herbage, improvement, and regulation of water regime (snow retention, use of groundwater), control of weeds and poisonous plants and shallow soil loosening.

In the early 1990s, as a result of large-scale socio-economic transformations, accompanied by the destruction of agricultural infrastructure, there was a sharp drop in the number of livestock throughout the country. In the following years, the number of livestock began to gradually recover, with a significant change in its composition. During the Soviet period, fine-fleece sheep breeding dominated livestock production in Southeast Kazakhstan and much attention was paid to fodder production. In recent years, the number of horses of indigenous breeds and their offspring (as the most adapted to year-round herds on fodder) as well as the number of camels, especially dairy, has been growing rapidly.

In this context, at present the pressure on public pasture lands (state fund lands) is increasing unevenly and in all seasons. The lands located close to settlements are especially affected. There is also a pronounced increase in pasture digression and rapid depletion of pastures. If this trend persists, irreversible disturbance of the natural environment balance, destruction of soil and vegetation cover on vast areas of natural pastures and strengthening of carbonization processes may occur. Taking into account the above-mentioned, as well as the fact that rural residents make up 43% of the population of Kazakhstan and livestock plays a significant role

in the food supply of the country, it is necessary to provide state support to the livestock industry, allocate funds for reclamation and improvement of the quality of natural pastures, as well as rational and science-based use of water resources.

Conflict of Interest

All authors have read and are familiar with the content of the article and have no conflict of interest.

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