BIODIVERSITAS
Volume 24, Number 7, July 2023
Pages: 3835-3843

ISSN: 1412-033X
E-ISSN: 2085-4722
DOI: 10.13057/biodiv/d240722

Assessment of the current state of rangelands in Karakalpak Ustyurt, Uzbekistan

NODIRA K. RAKHIMOVA♥, TASHKHANIM RAKHIMOVA, KHABIBULLO F. SHOMURODOV, BEKHZOD A. ADILOV, VASILA K. SHARIPOVA, UMIDA SH. SAITJANOVA, BEKHRUZ SH. KHABIBULLAEV, JASUR S. SADINOV, FARRUKH I. POLVONOV, AZAMAT T. SULTAMURATOV

Institute of Botany, Academy of Sciences, Republic of Uzbekistan. 100125 Tashkent, Uzbekistan. Tel./fax.: +99871-262-79-38, ♥email: rakhimovanodi@mail.ru

Manuscript received: 2 May 2023. Revision accepted: 13 July 2023.

Abstract. *Rakhimova NK, Rakhimova T, Shomurodov KhF, Adilov BA, Sharipova VK, Saitjanova USh, Khabibullaev BSh, Sadinov JS, Polvonov FI, Sultamuratov AT. 2023. Assessment of the current state of rangelands in Karakalpak Ustyurt, Uzbekistan. Biodiversitas 24: 3835-3843.* Assessing the current state of rangelands common in the territory of Karakalpak Ustyurt, Uzbekistan is of great importance in connection with intense land degradation and climate change. The article is devoted to study the main attributes and indicators for qualitative and quantitative assessment of rangelands including the current state of vegetation, soil cover and use of fodder resources. The studied types of rangelands are common on gray-brown desert soils, takyrs, and salt marshes, characterized by high gypsum content. Rangeland vegetation of Ustyurt, composed mainly of *Artemisia terrae-albae* Krasch., *Anabasis salsa* (Ledeb.) Benth. ex Volkens, *Xylosalsola arbuscula* (Pall.) Tzvelev, *Salsola arbusculiformis* Drobow, *Caroxylon orientale* (S.G. Gmel.) Tzvelev, ephemera, and other plant species, is the main fodder source for Karakul sheep and camels. The nutritional value of rangeland varieties is quite high in spring, it is characterized by an increased content of digestible protein in this period and decreases towards autumn, while the above-ground yield of species reaches its maximum growth. Autumn and winter-spring precipitation play the main role in the fodder productivity of rangelands. The productivity of rangelands depends on the favorable climatic conditions of the year, if more precipitation falls, the year will be more favorable for the growth and development of plants.

Keywords: Animal husbandry, Aral Sea, biodiversity, climate change, degradation, ecosystem, productivity, vegetation cover

INTRODUCTION

Recently, the problem of preserving the biological diversity of the Earth has attracted increasing attention from the world scientific community (Pollock et al. 2020; Norris et al. 2020). Modern civilization considers the conservation of biodiversity as the main basis that ensures the sustainable development of not only nature but also society (Pascual et al. 2022). Therefore, a conceptual approach to solving the problem of biodiversity should be based on the priority consideration of the ecosystem function of biodiversity. Numerous studies were conducted on the conservation of biodiversity in different ecosystems in Uzbekistan (Adilov et al. 2021a; Rakhimova et al. 2021a, 2021b; Shomurodov et al. 2021; Akhmedov et al. 2021; Akramov et al. 2021; Saribaeva et al. 2022; Temirov and Rakhimova 2022; Sharipova et al. 2022; Akhmedov et al. 2022; Halimova and Rakhimova 2022; Rakhimova and Rakhimova 2022a, 2022b, 2022c; Rakhimova et al. 2022; Saitjanova and Shomurodov 2022; Shomurodov et al. 2022; Vaisova et al. 2022; Abduraimov et al. 2023a, 2023b; Rakhimova et al. 2023a, 2023b; Khamraeva et al. 2023).

In many countries of the world, rangeland degradation leads to the destruction of ecosystems, the depletion of biological diversity, and endangers vulnerable species (Bedunah et al. 2012). Unfortunately, the degradation of rangeland ecosystems is gaining momentum year after year in Uzbekistan as well (Rakhimova et al. 2018; Rajabov et al. 2020). In the steppe pastures of Uzbekistan, the amount of green mass, especially plants with high nutritional value, is declining. The yield of natural pastures is not high. In successful rainfall years, you can get only 3-4 centners per hectare. As Khalilov (2021) notes, today 23 million sheep (*Ovis aries*) and goats (*Capra hircus*) are raised in the pasture and steppe regions of Uzbekistan. At the same time, the pasture area in the country covers 21 million hectares (Khalilov 2021). The decrease in pasture productivity is primarily due to the intensification of the desertification process.

In recent years, issues related to the state of pastures, their use, loss of biodiversity due to intensive grazing have been discussed on the pages of various scientific, popular science literature, as well as Internet sites, since, in fact, pasture degradation is not only in the countries of Central Asia but also in all continents is developing rapidly. In Uzbekistan 50-70% of the total rangeland areas are affected by different level of degradation (Rakhimova et al. 2018). According to Bobokulov (2014), average yield of rangelands has decreased by 21% in recent years. With unregulated grazing, vegetation is destroyed, which leads to pasture degradation and a decrease in productivity, especially in the Republic of Karakalpakstan, in Bukhara and Navoi regions - 42-43%. The starting point for the

study was the pastures of the Republic of Karakalpakstan, which differ in the area (one of the largest in the republic) and the diversity of pasture syntaxa on the one hand, and are vulnerable to the current anthropogenic pressure (in the form of the development of the oil and gas sector) and environmental conditions associated with the Aral Sea crisis - with another.

Ustyurt is an elevated plateau with absolute heights of 160-300 m above sea level. Almost from all sides, the plateau is bounded by cliffs. The territory of the plateau includes the borders of Uzbekistan, Turkmenistan, and Kazakhstan, and the total area of Ustyurt is 21,2 million hectares, of which 7,2 million hectares fall on the Karakalpak part, promising for the development of animal husbandry, especially for Karakul sheep and camels (Rakhimova et al. 2020).

Climatic conditions in Karakalpakstan have a positive effect on the development of desert vegetation with various medicinal, tannic, essential oil, and especially fodder plants. In this regard, natural pastures prevail in Karakalpakstan, accounting for about 90% of the total area, which is the main source of forage, the basis for the development of animal husbandry, especially karakul sheep breeding. In the 60-70s of the last century, plant communities formed in the dry part of the sea are currently used at different levels in the areas of animal husbandry, fishing, and ecological tourism. However, new-generation studies on the composition, patterns of distribution, rational use, and protection of existing biological diversity have not been carried out.

Based on the foregoing, it becomes clear that the need for a comprehensive study of pasture ecosystems in Ustyurt under the conditions of progressive desertification has become an urgent and top priority today.

MATERIALS AND METHODS

Study area

The study area is located in the Republic of Karakalpakstan, Kungrad district, the total area of the territory is 7,300,000 ha. The geographical name of the territory is the Karakalpak part of the Ustyurt Plateau (Figure 1). At the same time, the land occupied by pastures is 5,255,857 ha; lands occupied by protected natural areas - are 2,044,143 ha. The lands of the Complex (landscape) reserve "Saigachiy" occupy 597,000 hectares, and the lands of the National Natural Park "South Ustyurt" - 1,447,143 hectares of territory.

The climate of Ustyurt is strong continental, characterized by hot dry summers and rather severe winters, accompanied by strong winds, low precipitation, high evaporability and a sharp change in temperature throughout the seasons and during the day. The absolute maximum temperature is +45.5°C (July), the minimum is -37.0°C (January) (Rakhimova et al. 2020). According to B. Adilov et al. (2021b), between 1970 and 2020 in Ustyurt, an increase in annual air temperature by 2°C was noted, and the amount of average annual precipitation increased by almost 40 mm.

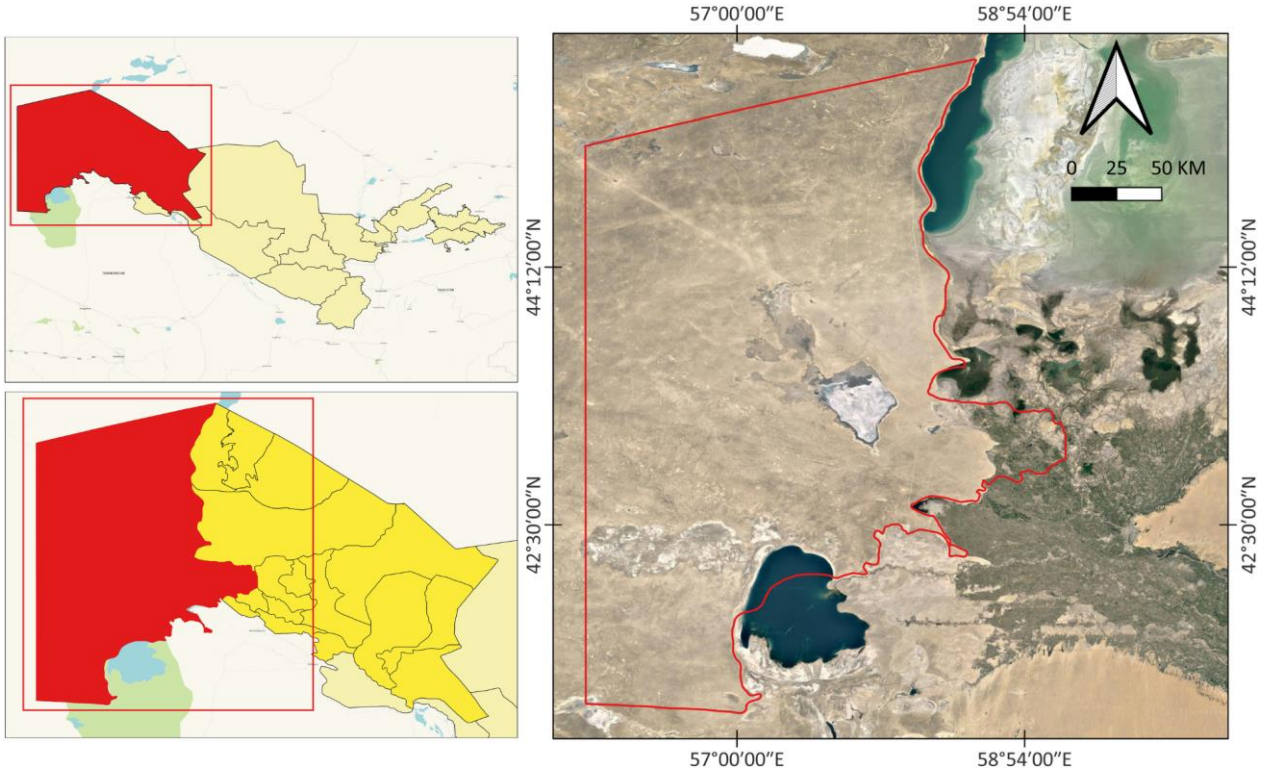

Figure 1. Map of the study area in Karakalpak Ustyurt, Uzbekistan

However, the pastures of this region are characterized by a sparse vegetation cover, consisting of shrubs and semi-shrubs with a low yield (0.5-2.0 c/ha) with sharp fluctuation over the years and seasons. Pasture vegetation of Ustyurt, composed mainly of *Artemisia terrae-albae* Krasch., *Anabasis salsa* (Ledeb.) Benth. ex Volkens, *Xylosalsola arbuscula* (Pall.) Tzvelev, *Salsola arbusculiformis* Drobow, *Caroxylon orientale* (S.G. Gmel.) Tzvelev, ephemera, and other plant species, is the main fodder source for Karakul sheep (*Ovis aries*) and camels (*Camelus dromedarius*, *C. bactrianus*) (Rakhimova and Rakhimova 2022b).

In order to use the desert grasslands efficiently, a complete well irrigation system throughout the grasslands is required. The most important challenge for development in livestock farming within a certain area is the absence of water reservoirs suitable for livestock watering. Unfortunately, a significant amount of rehabilitation and cleaning of these wells is required. Data on the condition of these water sources are unavailable. It is required to increase the number of water wells in order to develop livestock farming systems.

During the expeditions organized during 2020-2023 within the framework of the State Program, the staff of the Institute of Botany of the Laboratory of Geobotany estimated the current state of rangelands of the Karakalpak Ustyurt (Uzbekistan). The objects of the study are pasture varieties of Karakalpak Ustyurt, or rather 38 pasture varieties (ID number: 1.1, 1.2, 1.3a, 1.3b, 2.1a, 2.1b, 2.1c, 2.1d, 2.1e, 2.1f, 2.1g, 2.2, 2.3, 3.1a, 3.1b, 3.2a, 3.2b, 3.2c, 3.3, 3.4, 3.5, 3.6a, 3.6b, 3.7, 3.8, 3.9, 3.10, 3.11, 4.1a, 4.1b, 4.2a, 4.2b, 4.3, 4.4, 4.5, 7.1a, 7.1d, 7.2) belonging to *A. salsa*, *Haloxylon ammodendron* and *Halocnemum strobilaceum* types of pastures (Figure 2).

In the study of pasture vegetation, the generally accepted methods of route field geobotanical and floristic studies were used, which are widely used in mapping vegetation, studying and monitoring pastures. The species richness and the average height of homogenous shrubs, as measured in centimeters, were recorded. Names of grassland types and associations, geobotany data, forage yields, and livestock grazing allotments are reported according to the Methodical guidelines for geobotany surveys of natural forage resource conditions on lands in Uzbekistan (Granitov 1980).

The areas of the allotment sites were generated according to the methods for grassland vegetation classification (Granitov 1980) to create a grassland classification based on the map of vegetation across the territories. The projective cover is determined visually (Ramensky 1971). The name of pasture types and varieties, the determination of productivity, the establishment of pasture allotments are given in accordance with the guidelines (Granitov 1980). Latin names of plant species are given by https://powo.science.kew.org/. Nutritional value and bonitet were determined according to Nikolaev et al. (1977). Photographs of plant species and plant communities in nature were carried out using a digital camera (*Nicon* D7500, *Nikon* D80). "Key to vascular plants of Karakalpakstan" was used for identification of plant species (Bondarenko 1964).

To assess the degree of pasture degradation, the authors for the first time developed a scale for determining pasture degradation, which can be used in assessing the state of pastures in the plains of Central Asia. At the same time, there are 4 degrees of degradation, which are assessed by grades: very high (75-100 grade), high (50-75 grade), medium (25-50 grade), and low/absent (0-25 grade).

RESULTS AND DISCUSSION

The following types of pastures were studied during field studies, below is a brief description of each type of pasture. According to the modern classification of pastures of Karakalpak Ustyurt, *Anabasis salsa-Salsola arbusculiformis* complex includes 4 pasture varieties (*Salsola arbusculiformis-Artemisia terrae-albae*-shrubs; *Salsola arbusculiformis-Artemisia terrae-albae*: (i) with *Convolvulus fruticosus, Rheum tataricum, Stipa richteriana*; (ii) with *Anabasis brachiata; Salsola arbusculiformis-Anabasis salsa* with shrubs-*Salsola arbusculiformis*), which covers half of the northern and eastern parts of the territory (1,291,413 ha) and is distributed on gravelly, loamy, takyr-saline, gypsum soils of Karakalpak Ustyurt. More than 10 wells are registered in this territory (Karakudyk, Koskuduk, Turlybay, Sengir, Onbay, Egyz, Kashkyn, Karatykabay, Turaly, Tulegen, Koskudyk, etc.). But, unfortunately, they are in need of cleaning and significant restoration work.

A **B** **C**

Figure 2. Pasture types of Karakalpak Ustyurt, Uzbekistan. A. *Anabasis salsa.* B. *Haloxylon ammodendron.* C. *Halocnemum strobilaceum*

The vegetation cover includes trees (*Haloxylon ammodendron* (C.A. Mey.) Bunge), shrubs (*Nitraria schoberi* L., *Lycium ruthenicum* Murray., *Atraphaxis spinosa* L., *Convolvulus fruticosus* Pall., *S. arbusculiformis*), semi-shrubs *(Salsola gemmascens* Pall., *C. orientale, A. salsa*, *Nanophyton erinaceum* (Pall.) Bunge*)*, dwarf shrubs (*Artemisia terrae-albae, A. kemrudica* Krasch., *Atriplex cana* C.A. Mey., *Anabasis brachiata* Fisch. & C.A. Mey. ex Kar. & Kir.), herb perennials (*Rheum tataricum* L., *Stipa richteriana* Kar. & Kir., *Biebersteinia multifida* DC., *Poa bulbosa* L., *Fritillaria karelinii* (Fisch. ex D.Don) Baker, *Asparagus breslerianus* Schult. & Schult., *Stipa caucasica* Schmalh., *Limonium suffruticosum* (L.) Kuntze), annuals (*Petrosimonia sibirica* (Pall.) Bunge, *Eremopyrum bonaepartis* (Spreng.) Nevski, *Diptychocarpus strictus* (Fisch. ex M. Bieb.) Trautv., *Ceratocarpus arenarius* L.). However, the role of annuals in the *Anabasis salsa-Salsola arbusculiformis* type is insignificant. This is due to the short duration of their vegetation and their exclusive dependence on meteorological conditions; in dry years in spring, many ephemera do not appear at all, while in wet years their number increases by 2-3 times. In general, the number of species is dominated by representatives of the life form of perennial grasses. But, despite this, the main cenose-formers in the vegetation cover are shrubs and semi-shrubs.

Due to unfavorable weather conditions, low precipitation, dryness, and late spring (2021), a significant decrease in the species composition of the vegetation cover was observed. The northern part of the Karakalpak Ustyurt is represented by a very homogeneous landscape over a vast area. The composition of the vegetation remains monotonous due to *S. arbusculiformis, A. salsa* and *A. terrae-albae*) complexes. Due to a lack of moisture in the dominant species (*S. arbusculiformis, A. terrae-albae*) weak annual regrowth (up to 1 cm) was noted and they were in a depressed state. The specificity of the floristic composition is emphasized by the relatively low percentage of annuals, which is typical for Ustyurt communities.

The nutritional value of pasture varieties *Anabasis salsa-Salsola arbusculiformis* type is quite high in spring (up to 130 conditionally feed units (c.f.u.)), it is characterized by an increased content of digestible protein in this period and decreases towards autumn, while the above-ground yield of species reaches its maximum growth. According to estimates of the yield of the eatable part (c/ha), seasonal yield (according to c.f.u., c/ha), fodder stock, and pasture load, *Anabasis salsa-Salsola arbusculiformis* type is recommended to be used as autumn-winter pastures. The yield of the eaten mass ranges from 1.0 to 2.5 c/ha, the maximum yield occurs in autumn. The value of the gross feedstock in spring reaches its maximum due to the fact that in this season *S. arbusculiformis, A. salsa*, and *Atraphaxis spinosa* are characterized by an increase of 40-50% of the gross feedstock, while the gross stock is 0.6-5.1 c/ha.

Anabasis salsa-Salsola arbusculiformis complex is rated as "very poor pastures" (average 8.2 grades) and saves an average of 0.8 centners of fodder units per hectare. The average seasonal load for camels is from 0.01 to 0.2 and for small cattle from 0.08 and 0.2 units per hectare. The degree of degradation is assessed as low.

Anabasis salsa complex, which includes 9 pasture varieties, occupies a large area compared to other complexes of Karakalpak Ustyurt (2,664,774 ha) and accounts for 36.4% of the total territory. At the same time, 46% of the pasture variety that makes up the Karakalpak Ustyurt is found in the Central, 36% in the South, and 18% in the North. The type is distributed on takyr, loamy salt marsh, salt, and in some places highly gypsum soils. More than 60 wells are registered in these territories, and at present most of them are in need of reconstruction. Most of these wells are located in the Central part of the Karakalpak Ustyurt.

The *A. salsa* pasture varieties are floristically the poorest of all known plant communities. The general background of pasture varieties is always created by *A. salsa*. In the studied areas, *A. salsa* reaches the highest density, the rest of the plants are scattered and solitary, and there are very few ephemeris and ephemerides and they have dried up. Among these *A. salsa*, in some places single bushes of *H. ammodendron, Atraphaxis spinosa, Caroxylon orientale* are observed. In some areas, single specimens of *Rheum tataricum* are scattered. Also, in the *A. salsa* type, relict, Red Data Book species are registered - *Xylosalsola chiwensis* and *Malacocarpus crithmifolius*, as well as single individuals of *Crambe edentula*. Plants grow on the bottom of cliffs, where the collapse of cliffs is periodically observed, which are covered by bushes of these species (*Xylosalsola chiwensis, Malacocarpus crithmifolius* and *Crambe edentula*). With the development of animal husbandry, it is necessary to take into account measures to protect their habitats.

Anabasis salsa complex is characterized by a rather high content of digestible protein in the spring, during the period when sheep eat the most. The nutritional value of pasture varieties reaches up to 145 c.f.u. and this figure gradually decreases towards the winter period. At the same time, *A. salsa, Salsola gemmascens* and *H. ammodendron* are the main valuable food, due to which the nutritional value is higher in spring. In general, the yield of the *A. salsa* type eaten mass ranges from 0.5 to 2.0 c/ha and is recommended for use in autumn-winter pastures. A high indicator of the gross stock of fodder falls in the summer period and its value reaches from 1.1 to 5.0 c/ha. In the summer season, *A. salsa* and *H. ammodendron* are characterized by the formation of up to 86% of the gross feedstock. A fodder unit per hectare averages 0.9 centners and, according to the grading class, belongs to “very poor pastures” (average 8.8 grades). The degree of degradation is assessed as low, while dirt roads are preserved, which are assessed as "conditionally unused".

Anabasis salsa-Artemisia terrae-albae complex occupies the second place in terms of occupied territory (2, 432,821 ha) and the main areas are located in the central part of Karakalpak Ustyurt. More than 40 wells and reservoirs are registered in this territory, and at present most of them are in need of reconstruction.

According to geobotanical zoning, the type embraces the territory of the Karabaur region, where gently undulating

hills with a significant amount of exposed limestone are typical, which creates a kind of hydrological conditions for the development of pasture vegetation. According to the topographic maps of the Republic of Uzbekistan (SASPlaneta (http://www.sasgis.org/sasplaneta), more than 40 wells and reservoirs are registered in this territory, and at present most of them need reconstruction. The type is rich in forage species - as part of pasture varieties shrub and semi-shrub life forms predominate, which ensures the distribution of yields in the autumn-winter period. In this regard, pasture varieties of this type, according to seasonal use, belong to the autumn-winter group. In the formation of pasture varieties and improving their fodder quality, in addition to the dominants of this type, especially, the role of shrubs (*Atraphaxis spinosa, Convolvulus fruticosus, Limonium suffruticosum, S. arbusculiformis, Caragana grandiflora, Reaumuria fruticosa, Calligonum junceum*) is significant. The negative side, which worsened the quality of pasture varieties, is the regular presence of "low-quality" shrub species such as *Nanophyton erinaceum, Anabasis brachiata, Anabasis eriopoda, Peganum harmala, Leuzea repens, Karelinia caspia* act as weed species, however, they do not show signs of pasture weeding. In addition, the main populations of Red Data Book species (*Xylosalsola chiwensis, Euphorbia sclerocyathium*) are localized on the territory, which means that measures to protect their habitats should be taken into account when developing transhumance and planning linear infrastructures.

The yield of the eaten fodder mass fluctuates between 0.5-3.0, and the gross stock is 1.0-5.0 c/ha. Representatives of this type on each hectare retain an average of 1.1 centners of fodder unit and the development of an average of 11 grades belongs to the grading class "very poor pastures". The average seasonal load for camels and small ruminants is 0.04 and 0.3 units per hectare, respectively. The degree of degradation is estimated as medium, the origin of which is associated with the activities of gas production complexes and linear infrastructures.

Haloxylon ammodendron complex is relatively rich and diverse in terms of floristic composition (309,458 ha). This type of pasture is represented by 7 pasture varieties. *H. ammodendron* is a pasture type distributed evenly across Ustyurt (northern, central, and southern parts). Significant areas of *H. ammodendron* are found in the vicinity of the Agyin and Churuk salt marshes, the sands of Kartpaikum, and around the Sarykamysh and Assakeaudan depressions. This type of pasture is common on gray-brown gypsum salt marshes, crusty-puffy salt marshes, hilly gypsum sands, and takyr salt marshes soils. *H. ammodendron* pasture types are chukalaki, which are considered original eolian phenomena in depressions in the south of Ustyurt. There are almost no permanent watercourses (rivers, streams) on Ustyurt. Groundwaters are found not deep from the day's surface. In the surveyed area there is Sarykamysh Lake and several dry or backfilled wells: Zhamanasu-Mankekudyk, Nasambek, Aktailak, Akchukur, Aydymbay, Butakhan, Karakidir, Koskuduk, Kartpay, Kuanyshkazgan, Markabay, Tasastaukuduk, Urumbaykazgan, Shaharkazgan. The watering of new pasture areas will allow the use of additional fodder resources and will contribute to an increase in the total number of livestock.

Due to its high edifying properties, *H. ammodendron* pastures form the main layer in the desert. Due to unfavorable weather conditions, this year the growth of shoots of *H. ammodendron* is up to 3 cm, and dried saxaul forests are found in places. Often rodents undermine saxaul and damage the tap root. The value of saxaul grows on chukalaki.

The eaten part of the fodder mass of this type of pasture ranges from 2.1 to 8.2 c/ha. In spring and summer, *H. ammodendron* is eaten weakly (10%), in autumn and winter it increases sharply (30-45%). Fresh one-year-old shoots are readily eaten by sheep and camels, fruit-bearing twigs and fruits of saxaul are fattening food. Gross fodder stock in summer reaches up to 19 q/ha due to the complete formation (45-80%) of the above-ground parts of *H. ammodendron, Tamarix hispida, Caroxylon orientale* and *A. terrae-albae*. The nutritional value of this type of pasture ranges from 37 to 148 cu depending on the season. The content of digestible protein decreases from spring to winter. Representatives of this type on each hectare save an average of 3.0 centners of fodder unit and the development of an average of 30 points belongs to the grading class "poor pastures". The degree of degradation is assessed as low. The pasture load increases with the increase in the volume of forage reserves by the seasons of the year. Calculations on the yield of the eatable part, nutritional value of forage, and forage reserve showed that the saxaul type of pastures is recommended to be used as autumn-winter-spring, in some cases as year-round pastures.

Halocnemum strobilaceum complex is one of the characteristic features of the Ustyurt Plateau. This pasture type is dominated by *H. strobilaceum*, one of the most common desert species. *H. strobilaceum* has an extensive range and is representative of the saline, and salt-marsh flora of ancient Middle-earth. The main areas of this type of pasture are located in the central and northern parts of Karakalpak Ustyurt. This type is found quite often on wet and puffy salt marshes, on loamy and sandy salt-marsh soils around shores, salt lakes, in hilly depressions, chukalaks, as well as on gypsum puffy salt marshes and pseudosands. Varieties of this type of pastures are characterized by the extreme poverty of the species composition and sparseness of the vegetation cover, which in some cases reaches a monodominant community. Such poverty of the species composition of *H. strobilaceum* forests is explained by the presence of a high concentration of soil solution, to which a limited number of species are adapted.

Halocnemum strobilaceum pasture type includes 3 pasture varieties with an area of 77,426 ha: *H. strobilaceum* on wet salt marshes in combination with salines, *H. strobilaceum* on chukalaks with *H. ammodendron, Kalidium caspicum* and *H. strobilaceum, Kalidium caspicum*. The main representatives of the studied type are shrubs, dwarf shrubs and semi-shrubs. In the surveyed area of *H. strobilaceum*, there is Sarakamysh Lake with a low water level, a buried well Churuk, 8-9 km away there is the only functioning well Davetkuduk, and the salt wells Karakudyk

and Agyin are also nearby. On average, the yield of the eaten mass of this type ranges from 1-4.3 centners/ha, and the gross stock is from 6.3-17 centners/ha. In autumn and winter, a large eaten mass is formed. Representatives of this type on each hectare retain an average of 1.5 fodder units and develop an average of 14.9 grades and, according to the grading scale, it belongs to "very poor pastures". The degree of degradation can be assessed as low since the construction of roads and the operation of gas compressor complexes are underdeveloped. Considering the indicators of the yield of the eaten mass, nutritional value, and the norm of livestock, we can recommend *H. strobilaceum* pasture type as autumn-winter pastures.

As you know, the seasonality of use is one important indicator that must be taken into account when assessing pastures. As Nikolaev et al. (1977), depending on the nature of the pasture herbage and the degree of plant-eating by animals in different periods of the year, the fodder value of the same types of pastures can vary greatly.

Ustyurt is a large pasture reserve for the development of Karakul sheep and camel breeding in the republic. The vegetation cover of desert pastures is diverse, plants of various life forms are scattered in it - from semi-shrubs and large shrubs to very small annual ephemerals. Therefore, the seasonal use of pastures is very important. Most of the species distributed in the region are mainly valuable for Karakul sheep and camels.

Inedible harmful and poisonous plant species, common in desert areas, are relatively few and do not have a significant impact on livestock feeding. However, in recent years, the irrational use of desert pastures has led to an increase in their number and area of distribution. These include, for example, *Peganum harmala*, *Sophora pachycarpa*, *Leuzea repens*, *Phlomis thapsoides*, *Iris songarica*, *Diarthron vesiculosum*, and others. With proper and high-quality livestock grazing, in addition to the species composition of pastures, it is also important to know how plants affect livestock as food eaten. In this case, it is necessary to take into account the eatability of plants by livestock in different seasons of the year. When analyzing the seasonal productivity of pasture varieties of Karakalpak Ustyurt according to seasonal use, we identified three groups: year-round, summer-autumn-winter, autumn-winter (Table 1). The seasonality of pasture use depends on the yield of the consumed part (c/ha), seasonal yield, fodder stock and grazing load.

Throughout the year, the year-round pastures used can be called pastures of the highest quality. They make up 30% of the total pasture differences in Karakalpak Ustyurt (Figure 3).

The following pasture varieties are allocated to year-round pastures on the map: 2.1b, 3.2a, 3.2c, 3.3, 3.4, 3.7, 3.10, 3.11, 4.1a, 4.1b, 4.2b, 4.3, 4.5. In their composition, readily eaten plant species are distributed evenly over the seasons of the year. For example, this group includes an *A. terrae-albae* pasture variety numbered 3.2a, 3.2b, 3.3, 3.4, which includes dominants and subdominants *(H. ammodendron, Atraphaxis spinosa, Convolvulus fruticosus, S. arbusculiformis, A. salsa, A. eriopoda, Caroxylon orientale, A. terrae-albae, Aeluropus littoralis, Stipa richteriana, Alhagi pceudalhagi, Climacoptera lanata, Caroxylon scleranthum, Eremopyrum bonaepartis, Tetracme quadricornis).*

For summer-autumn-winter pastures, the following pasture varieties were identified: 1.3a, 2.1a, 3.5, 3.6a, 3.6b, and they make up 12% of the total pasture varieties of Karakalpak Ustyurt. They include the following dominants and subdominants: *H. ammodendron, Atraphaxis spinosa, Convolvulus fruticosus, Caroxylon orientale, S. arbusculiformis, A. salsa, A. brachiata, A. terrae-albae, X. arbuscula, Calligonum junceum, C. microcarpum, Rheum tataricum, Stipa richteriana.* These grazing varieties are rich in forage species such as *S. arbusculiformis, Caroxylon orientale, A. terrae-albae* and *A. salsa*, which are eaten during the summer and autumn months and their dry twigs are eaten in winter.

The following pasture varieties were identified for autumn-winter pastures: 1.1, 1.2, 1.3b, 2.1c, 2.1d, 2.1e, 2.1f, 2.1g, 2.2, 2.3, 3.1a, 3.1b, 3.2b, 3.8, 3.9, 4.2 a, 4.4, 7.1a, 7.1d, 7.2 and they make up 58% of the total pasture varieties of Karakalpak Ustyurt. Dominants and subdominants of the above pasture varieties are *S. arbusculiformis, A. terrae-albae, A. kemrudica, H. ammodendron, Convolvulus fruticosus, Caroxylon orientale, C. gemmascens, S. arbusculiformis, A. salsa, Atraphaxis spinosa, Reaumuria fruticosa, Kalidium caspicum, Tamarix hispida, T. elongata, Calligonum junceum, C. aralense, Ammodendron conollyi, Halocnemum strobilaceum, Halostachys caspica, Nitraria schoberi, Lycium ruthenicum.* Thus, Ustyurt is a large pasture reserve for the development of karakul and camel breeding in the republic, while most of the species common in the region are mainly valuable for Karakul sheep and camels. According to our results, in a year, grazing 1 livestock of a camel requires 18 hectares, and 2.8 hectares for sheep (Figure 4).

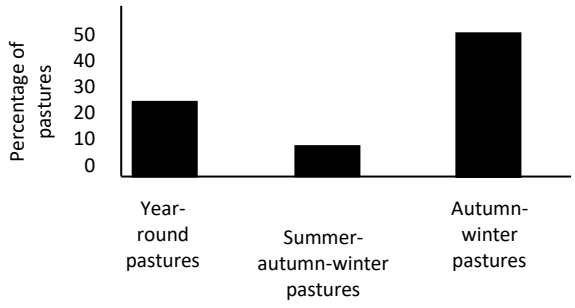

Figure 3. Seasonal distribution of pastures in Karakalpak Ustyurt, Uzbekistan

Table 1. Forage mass yield (c/ha) and seasonality of the use of the studied pasture varieties

ID pasture variety	Pasture varieties	Area (ha)	Forage mass yield (c/ha)	Seasonality of use
1.1	*Salsola arbusculiformis, Artemisia terrae-albae, Atraphaxis spinosa, Reaumuria fruticosa, Convolvulus fruticosus* with *Haloxylon ammodendron* on gravelly soils	460,023	0.8-2.1	Autumn-winter
1.2	*Anabasis salsa* with *S. arbusculiformis, Atraphaxis spinosa, Convolvulus fruticosus* with the participation *H. ammodendron, Rheum tataricum* on gravelly soil with spots of takyrs	316,254	1.5-3.5	Autumn-winter
1.3a	*S. arbusculiformis, A. terrae-albae* with the participation *Convolvulus fruticosus, Rheum tataricum, Stipa richteriana* on takyr saline soils	206,560	0.4-1.2	Summer-autumn-winter
1.3b	*S. arbusculiformis, A. terrae-albae* with the participation *Anabasis brachiata* on flat elevations	308,577	0.5-1.5	Autumn-winter
2.1a	*A. salsa* with the participation *Artemisia terra-albae, S. arbusculiformis* on takyr soils	477,583	0.4-1.2	Summer-autumn-winter
2.1b	*A. salsa* with the participation *Caroxylon orientale, S. arbusculiformis, H. ammodendron*, with *Nanophyton erinaceum, Pyankovia brachiata,* with takyr spots	1,224,805	1.1-2.7	Year-round
2.1c	*A. salsa* with the participation *Caroxylon orientale, H. ammodendron, A. terrae-albae, Anabasis brachiata, A. eriopoda* on strongly saline, highly gypsum soils, with takyr spots	382,410	1.0-2.5	Autumn-winter
2.1d	*A. salsa* with the participation *A. terrae-albae, Artemisia kemrudica, Caroxylon orientale* on highly gypsum soils	262,473	0.6-1.7	Autumn-winter
2.1e	*A. salsa* with the participation *H. ammodendron* with takyr spots	199,061	1.3-2.8	Autumn-winter
2.1f	*A. salsa* with the participation *Caroxylon orientale, A. terrae-albae* on outcrops of gypsum-bearing bedrocks of gentle and steep slopes (southern deserts)	4,747	0.2-0.7	Autumn-winter
2.1g	*A. salsa* with *Convolvulus fruticosus, Nitraria schoberi, Malacocarpus crithmifolius* and with single individuals *Crambe edentula* on gypsum-bearing bedrocks of the southern cliff	1,247	0.2-0.9	Autumn-winter
2.2	*A. salsa, Caroxylon gemmascens* with the participation *Caroxylon orientale, Xylosalsola arbuscula, Artemisia kemrudica* with spots of takyrs	97,883	0.6-2.3	Autumn-winter
2.3	*Artemisia kemrudica* with the participation *X. arbuscula, Anabasis brachiata* on the bozingen, *Caroxylon gemmascens* on strongly gypsum soils, *H. ammodendron* on the downs	6,433	1.2-2.9	Autumn-winter
3.1a	*A. salsa, A. terrae-albae* with the participation *Caroxylon orientale* on salt-marshes, saline soils and *Anabasis brachiata, Nanophyton erincseum, Atraphaxis spinosa* on rubble flat elevations	97,903	0.7-1.7	Autumn-winter
3.1b	*A. salsa, A. terrae-albae* with the participation *H. ammodendron* on salt-marsh soils	83,201	1.1-3.5	Autumn-winter
3.2a	*A. terrae-albae* with *A. salsa* and *Caroxylon orientale* on salt-marshes, saline soils	18,490	1.0-2.1	Year-round
3.2b	*A. terrae-albae* with *H. ammodendron* on rubble flat elevations	406,930	1.2-2.9	Autumn-winter
3.2c	*A. terrae-albae* with the participation *Atraphaxis spinosa, S. arbusculiformis, Reaumuria fruticosa* on sandy-loamy flat elevations	409,711	1.1-3.0	Year-round
3.3	*H. ammodendron, Artemisia terra-albae* with the participation *Caroxylon orientale* on salt-marsh, saline soils	74,285	1.1-2.6	Year-round
3.4	*A. salsa, Caroxylon orientale, A. terrae-albae* with *Atraphaxis spinosa, Convolvulus fruticosus, S. arbusculiformis* and *Limonium suffruticosum* on bedrock outcrops of gentle slopes dissected by dry ravines and, in places, pure thickets of *A. terrae-albae* on alluvial fans, with spots of takyrs	502,273	0.7-2.4	Year-round
3.5	*Caroxylon orientale, Anabasis brachiata, A. salsa* with the participation *Atraphaxis spinosa, H. ammodendron, Anabasis eriopoda* along flat depressions with takyr soils	255,578	0.2-0.9	Summer-autumn-winter
3.6a	*A. terrae-albae, Caroxylon orientale* with *Calligonum junceum* and single specimens of *H. ammodendron* on loamy-sandy gravelly flat elevations, with spots of takyrs	178, 27	0.9-2.6	Summer-autumn-winter
3.6b	*A. terrae-albae, Caroxylon orientale* with *H. ammodendron* and *X. arbuscula, Calligonum microcarpum* with the participation *Stipa hohenackeriana* on thin gypsum sands	26,536	1.8-3.8	Summer-autumn-winter
3.7	*A. terrae-albae, A. salsa* on flat elevations	80,305	0.6-1.4	Year-round
3.8	*A. salsa* on takyr soils and with the participation *S. arbusculiformis, Caroxylon orientale, H. ammodendron* on flat elevations, with spots of takyrs	83,304	0.6-1.7	Autumn-winter
3.9	*A. salsa, Caroxylon orientale* in places with the participation *Nanophyton erinaceum* on gravelly elevations and *A. terrae-albae* on loamy soils	125,633	0.4-1.9	Autumn-winter

3.10	*H. ammodendron, A. salsa* with the participation *Caroxylon orientale, S. arbusculiformis* on loamy and saline soils	70,137	1.7-3.6	Year-round
3.11	*A. terrae-albae, Nanophyton erinaceum, A. salsa* on gravelly flat elevations	100,839	0.3-0.8	Year-round
4.1a	*H. ammodendron, Kalidium caspicum, K. foliatum* on gypsum salt marshes with the participation *Reaumuria fruticosa, R. songarica* and in combination with *Halocnemum cruciatum*, in depressions on plump salt marshes	36,32536 325	2.1-4.1	Year-round
4.1b	*H. ammodendron, Kalidium caspicum, K. foliatum* on gypsum salt marshes, in combination with *Halocnemum cruciatum, Tamarix hispida* on chukalaks	25,433	2.9-5.5	Year-round
4.2a	*H. ammodendron, Caroxylon orientale* on gypsum pseudosands with the participation *Reaumuria fruticosa, Zygophyllum pinnatum* in combination with *Kalidium caspicum* in depressions on gypsum salt marshes	93,166	3.5-7.3	Autumn-winter
4.2b	*H. ammodendron, Caroxylon orientale* with the participation *Calligonum junceum, Reaumuria fruticosa, X. arbuscula* on gypsum pseudosands with *Tamarix hispida, T. elongata* in depressions	31,990	2.1-4.3	Year-round
4.3	*H. ammodendron, Caroxylon orientale, A. terrae-albae* on gypsum pseudosands	67,941	3.9-7.9	Year-round
4.4	*H. ammodendron, A. terrae-albae, Caroxylon orientale* on the slopes and depressions of hilly gypsum sands and with the participation *Haloxylon persicum* on the tops of sand mounds	28,082	4.2-8.2	Autumn-winter
4.5	*H. ammodendron, A. terrae-albae, A. salsa* on takyr saline soils, with the participation *Kalidium caspicum* and *Halostachys caspica* on gypsum salt marshes and *Halocnemum cruciatum* on chukalaks	26,521	2.1-3.9	Year-round
7.1a	*Halocnemum strobilaceum* on wet salt marshes devoid of vegetation	31,495	0.9-3.6	Autumn-winter
7.1d	*Halocnemum strobilaceum* with the participation *Kalidium caspicum* and *H. ammodendron* on gypsum pseudosands	8,922	1.9-4.3	Autumn-winter
7.2	*H. strobilaceum, Kalidium caspicum* on wet and plump salt marshes, with *H. ammodendron* on gypsum plump salt marshes, and with *Reaumuria songarica, Kalidium caspicum* on alluvial fans of temporary streams	36,075	1.9-4.2	Autumn-winter

Figure 4. Grazing camels and sheep in Karakalpak Ustyurt, Uzbekistan

The surveys performed over the recent years on the desert pasture productivity in Uzbekistan showed a visible decrease in grassland biomass. First, this is associated with global warming and catastrophic drying of the Aral Sea, which played an important role in climate regulation in the region. A significant decrease in the species composition of plant communities because of the unfavorable environmental conditions, such as low precipitation and dryness in the late spring. The dynamics of the productivity of the aboveground mass of the studied pasture varieties depends entirely on the development of edificators. In general, the yield of the eaten mass of *Anabasis salsa-Salsola arbusculiformis* complex of the complex ranges from 0.8 to 2.3 c/ha, the maximum yield occurs in autumn. In the *Anabasis salsa* complex, the yield of the eaten mass ranges from 0.5 to 2.0 c/ha. The season of the greatest formation of the eaten mass corresponds to autumn. The yield of the eaten mass of *Anabasis salsa-A. terrae-albae* of the complex ranges from 0.7 to 1.7 c/ha. The season of the greatest formation of the eaten mass corresponds to autumn. The yield of the eaten mass of the *H. ammodendron* complex ranges from 3.5 to 7.3 c/ha. The yield of the eaten mass of the *H. strobilaceum* complex ranges from 0.9-4.3 c/ha. In the autumn and winter periods, a large eaten mass is formed.

ACKNOWLEDGEMENTS

The work was carried out under the State Program (PFI-5), i.e., "Assessment of the current state of vegetation cover and pasture resources of the Republic of Karakalpakstan" and project "Formation of a modern list of flora based on an in-depth study of the vegetation of the dried bottom of the Aral Sea, the creation of a digital database and a collection of their gene pool" (AL-6322041306).

REFERENCES

Adilov BA, Shomurodov KhF, Polvonov FI, Eshmuratov RA, Tamambetova Sh. 2021a. Changes in the biomass of vegetation in the Aral Sea Region. Intl J Multidisciplin Res Analys 4: 676-683. DOI: 10.47191/ijmra/v4-i5-29.

Adilov B, Shomurodov H, Fan L, Li K, Ma X, Li Ya. 2021b. Transformation of vegetative cover on the Ustyurt Plateau of Central Asia as a consequence of the Aral Sea shrinkage. J Arid Land 13: 71-87. DOI: 10.1007/s40333-020-0077-7.

Abduraimov OS, Mamatkulova IE, Maxmudov AV. 2023a. Structure of local populations and phytocoenotic confinement of *Elwendia persica* in Turkestan Ridge, Uzbekistan. Biodiversitas 24 (3): 1621-1628. DOI: 10.13057/biodiv/d240334.

Abduraimov OS, Maxmudov AV, Kovalenko I, Allamurotov AL, Mavlanov BJ, Saribaeva ShU, Mamatkasimov OT. 2023b. Floristic diversity and economic importance of wild relatives of cultivated plants in Uzbekistan (Central Asia). Biodiversitas 24 (3): 1668-1675. DOI: 10.13057/biodiv/d240340.

Akhmedov A, Nomozova Z, Umurzakova Z, Turdiboev O, Atayeva Sh, Jumayev N. 2022. Assessment of the current condition of populations of the red list species *Salvia submutica* Botsch. & Vved. (Lamiaceae Lindl.) in Nuratau mountain ridge, Uzbekistan. Ekológia (Bratislava). 41 (4): 322-328. DOI: 10.2478/eko-2022-0033.

Akhmedov A, Rog I, Bachar A, Shomurodov H, Nasirov M, Klein T. 2021. Higher risk for six endemic and endangered *Lagochilus* species in Central Asia under drying climate. Perspective Plant Ecol Evol Syst 48: 125586. DOI: 10.1016/j.ppees.2020.125586.

Akramov DKh, Mamadalieva NZ, Porzel A, Hussain H, Dube M, Akhmedov A, Altyar AE, Ashour ML, Wessjohann LA. 2021. Sugar containing compounds and biological activities of *Lagochilus setulosus.* Molecules 26: 1755. DOI: 10.3390/molecules26061755.

Bedunah DJ, Angerer JP. 2012. Rangeland degradation, poverty, and conflict: how can rangeland scientists contribute to effective responses and solutions?. Rangeland Ecol Manag 65 (6): 606-612. DOI: 10.2307/23355250.

Bobokulov N. 2014. Desert rangeland livestock husbandry in Uzbekistan and rational use of fodder resources. ICARDA, GIZ, Tashkent.

Bondarenko ON. 1964. Key to higher plants of Karakalpakstan. Tashkent: Science of the Uzbek SSR. [Russian]

Granitov AI. 1980. Methodological Guidelines for Geobotanical Survey of Natural Fodder Lands in Uzbekistan. Tashkent, Uzgiprozem. [Russian]

Halimova Sh, Rakhimova T. 2022. Biomorphological features of some medicinal plants under the conditions of Bukhara (Uzbekistan). J Pharm Negative Results 13: 2325-2333. DOI: 10.47750/pnr.2022.13.S09.277.

Khalilov N. 2021. https://kun.uz/ru/news/2021/07/15/jivotnovodstvo-uzbekistana-naxoditsya-pod-ugrozoy-za-otsutstviyem-astbishch-lyudi-vynujdeny-prodavat-skot 40

Khamraeva DT, Bussmann RW, Abduraimov OS, Rakhimova NK. 2023. Adaptive mechanisms of conservation populations of rare and endemic species of *Kamelinia tianschanica* F.O. Khass & I.I. Malzev in Uzbekistan. Pak J Bot 55 (3): 1065-1074. DOI: 10.30848/PJB2023-3(18).

Nikolaev VN, Amangeldiev AA, Smetankina VA. 1977. Desert Pastures, Their Fodder Evaluation and Appraisal. Nauka, Moscow. [Russian]

Norris K, Terry A, Hansford J, Turvey S. 2020. Biodiversity conservation and the earth system: Mind the gap. Trends Ecol Evol 35 (10): 919-926. DOI: 10.1016/j.tree.2020.06.010.

Pascual U, Mcelwee D, Diamond S, Ngo H, Bai X, Cheung W, Lim M, Steiner N, Agard J, Donatti C, Duarte C, Leemans R, Managi Sh, Pires A, Reyes-Garcia V, Trisos Ch, Scholes R, Portner H. 2022. Governing the transfotmative change across the biodiversity-climate-society nexus. BioScience 72 (7): 684-704. DOI: 10.1093/biosci/biac031.

Pollock L, O'Connor L, Mokany K, Rosauer D, Talluto M, Thuiller W. 2020. Protecting biodiversity (in all its complexity) new models and methods. Trends Ecol Evol 35 (12): 1119-1128. DOI: 10.1016/j.tree.2020.08.015.

POWO [Plants of the World Online]. 2023. URL: https://powo.science.kew.org/.

Rajabov TF, Ramsey RD, Mardonov BK, Rakhimova T, Valiev ShA. 2020. Sensitivity of Landsat 7 and 8-derived vegetation indices on semi-arid rangelands of southwestern Uzbekistan. Geocarto Intl 37 (3): 1-16. DOI: 10.1080/10106049.2020.1723715.

Rakhimova T, Shomurodov KhF, Vohidov YuS, Adilov BA, Rakhimova NK, Mayinov ShK. 2018. Current state of desert rangelands of Uzbekistan and its sustainable use. Navruz, Tashkent. [Uzbek]

Rakhimova T, Rakhimova NK, Shomurodov KhF, Abduraimov OS. 2020. Ontogenetic structure of rare species on the Ustyurt Plateau in Uzbekistan. Arid Ecosyst 26/3 (84): 238-243. DOI: 10.1134/S2079096120030075.

Rakhimova NK, Rakhimova T, Adilov BA, Tamambetova ShB, Polvonov FI. 2021a. Current condition of *Crambe edentula* Fisch. & C.A. Mey. ex Korsh. on the Ustyurt Plateau in Uzbekistan. Arid Ecosyst 11 (4): 377-382. DOI: 10.1134/S2079096121040090.

Rakhimova T, Rakhimova N, Sharipova V, Beshko N, Hayitov R. 2021b. Current state of coenopopulations of some rare endemic species in Navoi region, Uzbekistan. Ekológia (Bratislava) 40 (4): 357-363. DOI: 10.2478/eko-2021-0037.

Rakhimova NK, Rakhimova T. 2022a. The current state of endemic species, *Iris magnifica* (Vved.) F.O. Khass. (Iridaceae) in Kashkadarya region of Uzbekistan. Annals Phytomed 11 (2): 612-618. DOI: 10.54085/ap.2022.11.2.75.

Rakhimova NK, Rakhimova T. 2022b. The status of *Salsola arbusculiformis* and *Anabasis salsa* shrub grasslands on the Ustyurt plateau in Karakalpakstan (Uzbekistan). Arid Ecosyst 12 (3): 286-295. DOI: 10.1134/S2079096122030106.

Rakhimova T, Rakhimova N. 2022c. Ontogenesis and ontogenetic structure of cenotic populations of *Eremurus anisopterus* (Asphodelaceae) in the Kyzylkum desert (Uzbekistan). Botanica Pacifica 11 (2): 39-44. DOI: 10.17581/bp.2022.11218.

Rakhimova NK, Rakhimova T, Sadinov JS. 2022. Current state of *Anabasis salsa* pasture varieties in Karakalpak Ustyurt (Uzbekistan) due to Aral Sea drying. Plant Sci Today 9 (sp3): 25-30. DOI: 10.14719/pst.1804.

Rakhimova NK, Shomurodov KhF, Sharipova VK, Saitjanova USh, Sadinov JS. 2023a. Using biodiversity indices to assess the current state of tugai vegetation of the Amu darya river, Uzbekistan. Biodiversitas 24 (1): 467-472. DOI: 10.13057/biodiv/d240153.

Rakhimova NK, Rakhimova T, Shomurodov KhF, Sharipova VK. 2023b. The status of coenopopulations of *Xylosalsola chiwensis* (Popov) Akhani & Roalson and *Scorzonera bungei* Krasch. & Lipsch. on the Ustyurt plateau (Uzbekistan). Arid Ecosyst 13 (2): 189-195. DOI: 10.1134/S2079096123020117.

Ramensky LG. Selected works. 1971. Problems and Methods of Studying the Vegetation Cover. Science, Leningrad. [Russian]

Saitjanova USh, Shomurodov KhF. 2022. Dynamics of *Medicageta sativae* formation on the Ustyurt plateau under climate change and drying of the Aral Sea. Plant Sci Today 9 (sp3): 71-78. DOI: 10.14719/pst.1862.

Saribaeva Sh, Abduraimov O, Allamuratov A. 2022. Assessment of the population status of *Alium oschaninii* O. Fedtsch. in the mountains of Uzbekistan. Ekologia (Bratislava) 41 (2): 147-154. DOI: 10.2478/eko-2022-0015.

SASPlaneta (http://www.sasgis.org/sasplaneta)

Sharipova VK, Rakhimova T, Rakhimova NK. 2022. Ecological state of some pasture differences of *Haloxylon ammodendron* of Karakalpak Ustyurt (Uzbekistan). E3S Web Conf 361: 04028. DOI: 10.1051/e3sconf/202236104028.

Shomurodov Kh, Rakhimova T, Adilov B, Beshko N, Karimov F, Polvonov F. 2021. Current state of vegetation of the Aral Sea. Environmental transformation and sustainable development in Asian region. IOP Conf Ser Earth Environ Sci 629: 012085. DOI: 10.1088/1755-1315/629/1/012085.

Shomurodov Kh, Rakhimova T, Adilov B, Beshko N. 2022. Current status of vegetation of the dried bottom of the Aral Sea. Biodiversity, conservation and sustainability in Asia. Vol. II: Prospects and Challenges in South and Middle Asia: Monography. Springer Nature Switzerland AG. DOI: 10.1007/978-3-030-73943-0.

Temirov E, Rakhimova N. 2022. The bioecological features of some species of the Cupressaceae introduced in the conditions of Tashkent city, Uzbekistan. Biodiversitas 23 (10): 5532-5538. DOI: 10.13057/biodiv/d231065.

Vaisova G, Rakhimova T, Matkarimova A. 2022. The current state of the coenopopulation of *Capparis spinosa* L. (Capparaceae) in the semi-desert of Uzbekistan. Annals Phytomed 11 (2): 619-624. DOI: 10.54085/ap.2022.11.2.76.