Food and Agriculture Organization of the United Nations

UNIVERSITÄT GREIFSWALD
Wissen lockt. Seit 1456

Proceedings from the International Cold Winter Desert Conference

Central Asian Desert Initiative

2-3 December 2021, Tashkent, Uzbekistan

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Food and Agriculture Organization of the United Nations,
Tashkent, 2022

Required citation:

FAO. 2022. *Proceedings from the International Cold Winter Desert Conference – Central Asian Desert Initiative. 2-3 December, Tashkent, Uzbekistan.* Tashkent. https://doi.org/10.4060/cc1339en

ISBN 978-92-5-136958-6

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Chapter 1. Opening Plenary Session

Welcome address by Dr. Viorel Gutu

FAO Sub-Regional Coordinator for Central Asia
FAO Representative in Uzbekistan

It is an honor and pleasure to see you all today at this event. It is difficult to overestimate the importance of cold winter deserts for biodiversity of the Central Asian region. These deserts are homeland for many red listed species of flora and fauna. Nowadays these important ecosystems are endangered by various factors such as climate change and excessive use of natural resources leading to land degradation.

To address these issues, the Central Asian Desert Initiative (CADI) project put efforts on removing the anthropogenic pressure on land and natural resources as well as conservation of biodiversity in Kazakhstan, Turkmenistan, and Uzbekistan. Under the FAO component, the team managed to implement activities on development of the GIS based remote sensing tools for inventory of the desert ecosystems, capacity building of the rural smallholders on basic agricultural practices, nursery establishment and development of beekeeping using farmer field school modality developed by FAO. As a response to emergency caused by the COVID-19 outbreak, the project continued its training program on development of local handicrafts and distribution of the required equipment to the most vulnerable in 2 project sites located in Bukhara and Navoiy regions of Uzbekistan.

Throughout implementation, the CADI project focused and contributed to SDGs 2, 5, and 15 to ensure food security, gender equality and sustainable land use for conservation of the desert ecosystems.

Special appreciation should be expressed to the University of Greifswald for coordination and to the project partners in three Central Asian countries for efficient cooperation. It is difficult to overestimate the significant contribution and regular support provided by the main national partner of the CADI project in Uzbekistan - State Forestry Committee.

It is important to emphasize that establishment of the Regional CADI Secretariat will serve as an entry point for sustaining the initiatives implemented by the CADI project. I hope that the policy dialogue that will launch the Conference today, will delineate and shape major directions for the long term and efficient operation of the CADI Secretariat in Central Asia.

Presentations of the research papers at this event will help to draw attention of the international community and wide range of stakeholders to the importance of these biomes for biodiversity conservation and sustainable land management.

Let me wish all participants of the International Conference a productive and successful event within these two days! Thank you!

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Welcome address by Dr. Josef Tumbrinck

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety of Germany
Deputy Director General N I – Nature Conservation

Dear colleagues from the State Committee on Forestry as well as from the Ministry of Agriculture of the Republic of Uzbekistan,

Distinguished colleagues from the State Committee of the Republic of Uzbekistan on Ecology and Environmental Protection,

Dear implementing partners of the International Climate Initiative (IKI) project "Central Asian Desert Initiative – conservation and sustainable use of cold winter deserts in Central Asia": colleagues from the University of Greifswald, the Michael Succow Foundation, FAO's Subregional Office for Central Asia as well as project partners in Uzbekistan, Turkmenistan, and Kazakhstan,

Dear organizers of this international conference,

Ladies and gentlemen,

Good morning, everyone in Tashkent – and elsewhere if you are joining virtually, just like me from Germany!

A warm welcome to the International Conference on Cold Winter Deserts, promoted by the Central Asian Desert Initiative – or in short: CADI.

Thank you for giving me the opportunity to make a brief address on behalf of Germany's Federal Ministry for the Environment, Nature Conservation and Nuclear Safety. I am very happy to be able to participate today. This is definitely one of the advantages of virtual events that are part of what some already call the "new normal".

I would like to begin by acknowledging the current situation we are still facing. The COVID-19 pandemic has had and still has tremendous and horrible impacts on the people's lives all around the world. The current pandemic shows us just how much we depend on nature and intact ecosystems as our life insurance. In particular, it has shown us how strongly interlinked biodiversity, climate change, and human well-being are. Conservation and the sustainable use of biodiversity are fundamental to reduce the risk of future zoonotic diseases.

Environmental protection, biodiversity conservation, and climate change mitigation and adaptation are shared goals of the governments of our respective countries. Currently, we are all looking towards the ongoing CBD COP 15 negotiations and in particular we are looking forward to the Post-2020 Global Biodiversity Framework being approved – hopefully – in early May next year. What will be of utmost importance, once the Framework is approved, is speedy implementation!

I am convinced that our cooperation for instance in the context of the CADI-project can provide important insights into what works and what does not, in order to make implementing the Post-2020 Global Biodiversity Framework a success.

This conference is about cold winter deserts – one of the key ecosystems of Central Asia. The countries of Uzbekistan, Turkmenistan and Kazakhstan harbour large parts of this ecosystem and, therefore, are crucial for the preservation of this surprising and beautiful biome. Cold winter deserts harbour highly specialized endemic species, high biodiversity, and important migration corridors for more than 300 bird species. They are one of few places in the world where ungulates like Kulan, Goitered Gazelle, Saiga Antelope and Urial migrate annually.

Deserts provide a variety of ecosystem services of great economic, social, and cultural value on the local and global scale. For instance, the natural vegetation of Saxaul communities has the potential of being a globally important carbon sink.

However, Central Asian desert ecosystems are considered a "critical or endangered" ecoregion. Cold winter deserts are still underrepresented in the regional and global network of protected areas. Also, they remain the only biome worldwide for which the United Nations Educational, Scientific and Cultural Organization (UNESCO) has not yet inscribed a World Natural Heritage site. But you know way better than me about the manifold challenges that we have to overcome to preserve this biome for future generations.

Against this background, the CADI flagship project, supported by my Ministry's International Climate Initiative, is being implemented since 2016. It aims to preserve the biodiversity and ecosystem services of the cold winter deserts in Central Asia. The CADI project follows a strong regional approach. One of the examples is the transnational nomination in 2022 of the "Cold Winter Deserts of Turan" as World Natural Heritage site. Here, three countries join forces to put seven desert sites under a common protection: a strong sign which – hopefully – closes a gap in the UNESCO list.

In 2019, here in Tashkent, representatives from Uzbekistan, Turkmenistan and Kazakhstan agreed to establish a new regional Desert Secretariat. This shows both the need and the strong commitment of Central Asian states to protect biodiversity and to raise awareness about the global importance of cold winter deserts. The Interim Secretariat is currently developing a Programme of Work to protect the cold winter deserts in Central Asia.

By 2022, the Interim Secretariat is to be turned into a permanent structure which will hopefully continue the Central Asian Desert Initiative. For this, I wish to express my strongest support. Also, I would like to express our gratitude towards the Committee of Forestry for the support of the Secretariat! I wish you all the best for successful realization of this initiative.

Furthermore, I would like to draw your attention to a new IKI-project which will be implemented by the Organisation for Economic Co-operation and Development (OECD) starting in summer 2022. The project will further strengthen our collective effort to set Central Asia on the path towards a sustainable transformation by fostering a multi-sector approach to tackle energy water and land use management issues.

The CADI project has shown the importance of working together across national borders; the new project will support Central Asian States in identifying starting points for concrete cross-border cooperation projects tackling the nexus. Those transboundary projects will be identified throughout the project phase and together with the EBRD a financing mechanism will be developed.

The first High Level Political Dialogue, hosted by Mr. Umurzakov Sardor Uktamovich, Deputy Prime-Minister for Investment and Foreign Economic Affairs and Minister of Investment and Foreign Trade, successfully took place in October 2021. The next one will take place in summer 2022 in Nur-Sultan. We very much look forward to further strengthen our longstanding cooperation through this project!

I would like to end by expressing my gratitude to all partners of the CADI project. Thank you all for your engagement and incredible efforts over the past five years in implementing this important project, even in such difficult times as during the current pandemic. This conference is an excellent opportunity to present and discuss many of the CADI project results achieved since 2016.

I wish you a very successful exchange over the coming two days.

Thank you very much!

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Welcome address by Nizomiddin Bakirov

Chairman
State Committee on Forestry of the Republic of Uzbekistan

Good morning, distinguished Guests and Conference Participants!

First of all, I am very glad to see you at this conference.

Over the past five years, the great attention paid by the President to the field of forestry, the fight against ecology, climate change and desertification in our country, as well as the expansion of forests have led to significant changes.

Over the past five years, the great attention paid by the President to the forestry sector has led to significant improvements in the fight against ecology, climate change and desertification in our country, as well as the expansion of forests.

In particular, I think you all know about the measures taken to combat desertification and reduce the negative effects of its consequences.

For example, in the framework of the national "Green Space" project in Uzbekistan, a 40-day tree-planting campaign has been launched, with all our citizens actively involved in the process. We plan to plant 200 million seedlings this year alone.

It is no coincidence that today's conference is called the International Conference on Cold Winter Deserts - it is time to study the international experience in the fight against desertification and work together with international organizations, experts in the field and neighbouring countries.

The temperate deserts are special natural areas with unique ecosystems and species that stretch from the northern Islamic Republic of Iran through Central Asia to Mongolia. According to the International Union for Conservation of Nature (IUCN), despite their ecological importance, temperate deserts are one of the least recognized biomes in the world. Ninety-five percent of the temperate deserts are located in Central Asia, which is why the region bears a great responsibility for the conservation of this biome. Against this background, the Central Asian Desert Initiative (CADI) focuses on biodiversity conservation, the conservation and sustainable use of temperate deserts in Central Asia. The CADI project is implemented by the University of Greifswald (Germany), the Michael Succow Foundation (Greifswald, Germany) and the Food and Agriculture Organization of the United Nations (FAO) Central Asia Subregional Office (Ankara, Türkiye).

This project is part of the International Climate Initiative (IKI). The Federal Ministry of Environment, Nature Protection and Nuclear Safety (BMU) supports this initiative on the basis of a resolution adopted by the German Bundestag.

The main goals and objectives of our conference are the following:

- to discuss options for the development and conservation of temperate deserts;
- to raise awareness of advanced technologies for sustainable land management (SLM);

- to disseminate knowledge on biodiversity conservation in ecosystems of temperate deserts.

As the Chairman of the State Committee on Forestry, I would like to express my special gratitude for your support and assistance in the joint projects and I would like to emphasize our readiness to work together.

I would like to take this opportunity to express my respect to you and wish you success in your endeavours!

Thank you for your attention!

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Thematic session I
Biodiversity and conservation

Biodiversity conservation, as an essential part of life on our planet is one of the most urgent tasks of our time. Each ecosystem of the planet is unique and unrepeatable. Located in the central part of Eurasia, stretching from the northern Islamic Republic of Iran through the countries of Central Asia and Mongolia, are the deserts of the temperate belt – natural territories characterized by an arid, sharply continental climate with extremely hot summers and cold winters.

The desert territories located between Kazakhstan, Turkmenistan and Uzbekistan represent a single complex of ecosystems adapted for natural migrations and movements of mammals. Migration corridors of more than 300 species of birds pass through these territories.

Most of the temperate desert areas are located in Central Asia, and thus this region bears a huge responsibility for their conservation and sustainable use. This internationally significant cause has been supported for several years by the CADI (Central Asia Desert Initiative) project, which is implemented jointly by the University of Greifswald, the Michael Succow Foundation (Greifswald) and the Food and Agriculture Organization of the United Nations (FAO), the subregional office for Central Asian countries in Ankara and focused on the research, sustainable use, and conservation of temperate deserts.

The Cold Winter Desert conference – is set to convene the leading experts of the region in a platform for the discussion of achievements and existing challenges, including the issue of the transboundary movement of ungulates (saiga, goitered gazelle, kulan, Ustyurst urial) throughout the territories of Kazakhstan, Turkmenistan, and Uzbekistan. Linear infrastructure facilities, roads, railways, pipelines, barbed wire fences were identified as significant threats for the movement of many species inhabiting the temperate deserts. Therefore, it is imperative that efforts of the region's states are united to facilitate safe transboundary migrations of ungulates that ensures the fulfilment of obligations under the Concention on the Conservation of Migratory Species of Wild Animals (CMS).

Equally important is the strengthening and expanding the network of protected areas in the desert territories of the Central Asian countries. In the current conditions of extensive and rapid economic development of the region, this solution will be the most sustainable in the matter of nature protection. One of the relevant options would be to call on the government of the Republic of Kazakhstan to accelerate the process of the creation of the Southern Ustyurt cluster of the Ustyurt State Nature Reserve.

Acknowledging the importance of preserving natural resources for future generations, it is important to unite the efforts of the governments of the Central Asian Republics in order to initiate and support national and transboundary projects aimed at preserving the unique biodiversity complexes of the temperate deserts, which contributes to the commitments towards international agreements in the field of biodiversity conservation.

Findings of International Union for Conservation of Nature (IUCN) world heritage thematic study for Central Asia

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Keywords: World Heritage, deserts, UNESCO, biodiversity

Introduction, scope, and main objectives

The World Heritage Convention identifies, protects, and promotes cultural and natural heritage of outstanding universal value (OUV) around the world (UNESCO, 1972). Sites with OUV are defined in the Convention's Operational Guidelines (OG) as areas "*so exceptional as to transcend national boundaries and to be of common importance for present and future generations of all humanity*" (UNESCO, 2017). Stemming from the Convention concerning the Protection of the World Cultural and Natural Heritage, IUCN is the official advisor on nature to the UNESCO World Heritage Committee. IUCN evaluates sites nominated for the World Heritage List and monitors the state of conservation of listed sites.

Based on a global strategy for a balanced and representative WH List adopted by the WHC in 1994 (Decision WHC 28 COM 13.1), IUCN in collabouration with the WH Centre, UN Environment-World Conservation Monitoring Centre (UN Environment-WCMC) and the Ramsar Convention, have produced a series of thematic studies providing overview assessments of major themes relating to natural sites. Thematic studies are aimed to providing guidance for the implementation of the World Heritage Convention, identifying gaps in the WH List, and advising State Parties and interested stakeholders on World Heritage nomination and management.

A first WH thematic study for Central Asia was published in 2005, identifying a series of sites with high potential for nomination under criteria (viii), (ix) and (x) (Magin, 2005). In order to overcome certain limitations observed during the preparation of the 2005 study, IUCN embarked on the development of a new study in 2018, aimed at identifying sites with high potential for World Heritage nomination under criteria (ix) and (x) and focusing on the terrestrial realm. The geographic scope of the new study was on five Central Asian countries: Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan. The need for the new study has also been confirmed by the World Heritage gap analysis on terrestrial biodiversity published by IUCN in 2013. The study concluded that the mountains of Central Asia represent one of the broad gaps in the coverage of global biodiversity conservation priorities when it comes to World Heritage (Bertzky *et al.*, 2013).

Methodology

The process of the preparation of this study followed three main phases. A desk assessment and overview of sites having potential to meet the requirements of the World Heritage Convention for inscription on the WH List (January–June 2018); Three regional consultations on priority sites for potential WH nomination (June, October and November

2018), involving 40-50 international and local experts and specialists; And the preparation of the WH Thematic Study in consultation with the relevant State Parties, scientists and expert organizations and individuals (October 2018-March 2019).

A number of tools exist which may facilitate and guide the process of prioritising sites for potential nomination. These tools include - but are not limited to - existing PAs and biodiversity related designations. Such areas have been delimited according to rigorous criteria that, although not always meet the standards for WH listing, may provide indications as to whether a site offers potential for nomination. These tools are presented below in this regard.

The analysis is mainly based on the framework used by World Conservation Monitoring Centre (UNEP-WCMC) during the IUCN WH evaluation process, for the comparative analysis of sites nominated under biodiversity criteria (Belle E. *et al.*, 2014); it covers only those prioritisation tools/systems which are relevant for Central Asia – and giving results for the study area.

The recommendations do not include likely all sites in the study area having a strong potential for nomination under biodiversity criteria. They reflect a certain level of knowledge that is tentative and should be strengthened in the future, in order to ensure that the sites selected have the highest potential for nomination.

However, the sites recommended have appeared repeatedly during the study, whether through analysis of literature, or in discussions with experts and specialists of the region during the three workshops and along the whole consultative process. They have been prioritised based on their value, level of integrity, exposure to potential threats, legal regime of protection and effective adequate management, by cross-referencing the available information and data detailed above.

Several sites recommended are serial and/or transboundary. In all cases, the sites' territories, component parts and boundaries will need further detailing more precision.

High attention should be given to the comparative analysis that must be carried out to characterise the OUV of each site nominated; by experience, the quality of these comparative analyses is very often unsatisfactory. There is no unique model for drawing comparisons with properties expressing potentially the same values as the site nominated; State Parties should use the most relevant local information they have and, ideally, design and analyse that best support their justification, for nomination. Their first task after defining what combination of potential OUV and the related features and attributes should be compared, is to ascertain whether this combination of values, features and attributes is already represented on the WH List or not.

Comprehensive guidance will be found in the WH Resource Manual "*Preparing World heritage Nominations*" (IUCN, 2011) and, for further detail, in the IUCN/UNEP "*Comparative Analysis Methodology for World Heritage nominations under biodiversity criteria*" report (Belle *et al.*, 2014).

Results

The World Heritage Thematic Study for Central Asia has been produced as a contribution to supporting the implementation of the World Heritage Convention in Central Asia. It provides a response to a Decision of the World Heritage Committee (Decision WHC 39 COM 8B.4) requesting IUCN to update the 2005 Central Asia Regional Thematic Study on natural World Heritage (Magin, 2005) with the goal to identify at a regional scale outstanding areas with

potential for future nomination to the WH List with primary focus on criteria (ix) and (x). Criteria (ix) and (x) are clearly the primary ones for recognition of extant biodiversity values, and they have been applied to a wide range of biodiversity features including ecosystems, species and ecological and/or biological processes.

As a result, nine sites and areas have been identified as having high potential for nomination under biodiversity criteria (ix) and/or (x), in combination with other WH natural criteria (vii) and (viii):

Status	Sites and areas	Country
Sites already inscribed in the WH List that could be extended	Golden Mountains of Altai	Russian Federation (potential for extension in Kazakhstan)
	Saryarka – Steppe and Lakes of Northern Kazakhstan	Kazakhstan
	Western Tien-Shan	Kazakhstan, Kyrgyzstan, Uzbekistan
Sites currently included on Tentative Lists	Tigrovaya Balka	Tajikistan
	Badhyz	Turkmenistan
	Kopetdag mountains	Turkmenistan
	Northern Tien-Shan	Kazakhstan
	Cold Winter Deserts of Turan	Kazakhstan, Turkmenistan and Uzbekistan
Areas not included on Tentative Lists	Southern Ustyurt Plateau	Kazakhstan, Turkmenistan and Uzbekistan

Source: Author's own elaboration.

Table 1 sites having strong potential for nomination under biodiversity criteria (ix) and/or (x)

In all cases, any areas, component parts and specific boundaries will need further detailing and more precision in the process of preparation of a nomination.

Finally, it is worth noting that local communities inhabit some very remote areas prioritized here above, at least seasonally and sometimes throughout the year. Unfortunately, it was beyond the scope of this survey to address the cultural aspect and indigenous matters, but it is fundamental to underline that rights issues have to be appropriately considered during every nomination process. The State parties and all experts and organizations associated in such a process are strongly advised to address this central topic and refer to the existing "good practices" in relation to human rights and World Heritage when starting their work[a].

Additional recommendations

Drawing on a series of workshops and consultation meetings with a broad range of stakeholders from the five Central Asian countries which included government agencies, research organisations, academia representatives and civil society organisations, it has been decided to prepare a list of additional recommendations with a view to providing additional support to the States Parties in Central Asia and facilitate WH nomination process. The recommendations are as follows:

1. create and/or update current Tentative Lists;
2. improve the protection regime of areas and ecological corridors that have the highest values for natural heritage;

[a] Larsen, P.B. (2012) a) and b); IUCN/ICOMOS/ICCROM (2014).

3. consider a range of international designation mechanisms to recognize areas of global importance;
4. foster transnational cooperation and transboundary sites to support ecological functionality that guarantees the maintenance of the natural processes;
5. develop a continuous dialogue among the stakeholders;
6. improve enforcement and compatibility between local, national and international regulatory frameworks;
7. conduct training sessions and activities on how to prepare nominations.

Discussion

Since Magin (2005), significant progress has been made in better recognising the unique value of natural heritage in Central Asia. In the past few years, several natural properties from the region have been listed on the WH List; others have been inscribed on TLs of the relevant countries, pending more in-depth analyses for potential nomination.

The work and consultations carried out during the present study enabled stakeholders involved in the consultation process to better appreciate the current context and based on improvement of the knowledge over the past fifteen years, to initiate a programme of work including data collection and updating available information to facilitate identification of areas and sites with the highest potential for nomination, under the prioritized biodiversity criteria.

The recommendations follow and reflect this current level of knowledge, and should be strengthened in the future, in order to ensure that areas and sites identified and prioritised have the strongest assets for nomination; therefore, these recommendations should be interpreted as a starting point for further technical analysis.

The sites recommended have been prioritised, based on their value, level of integrity, exposure to potential threats, and an initial assessment of their legal protection regime and management, by cross-referencing the available information and data; several areas and sites recommended are serial and/or transnational or transboundary.

Nine areas and sites have been recognised as having strong potential for nomination under biodiversity criteria (ix) and/or (x), in combination sometimes with other WH natural criteria (vii) and (viii) (Table 1).

The study once again confirmed high potential for the nomination if new World Heritage sites in Central Asia despite the fact that only criteria (ix) and (x) have been taken into account. Another important observation is there is high potential for transboundary or serial transnational sites which only exacerbates the importance of transboundary and regional cooperation in identifying and preparing WH nominations. At the end, it is worth noting that the study didn't look into marine but only terrestrial ecosystems.

It is important to stress that the findings and recommendations presented in this report stem from the desk review, internet sources based on available data, and consultations with national and international experts. Significant efforts have been made to validate the data with national and international experts and field specialists who have contributed to the online consultation and participated in discussions in workshops and engaged in further exchanges with IUCN and the lead author during the drafting process. Therefore, the

findings of the study should be interpreted as indicative and are subject to change upon further updates and consultation.

Acknowledgements

We are very grateful for the invaluable contribution of the State Parties of Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan and all organisations, national and international experts in the development of the thematic study. Its development wouldn't be possible without input received from all participants in the three workshops held in Bishkek, Kyrgyzstan (19-20 June 2018), Asghabat, Turkmenistan (11-12 October 2018), and Tashkent, Uzbekistan (28-29 November 2018) (Annex 1).

Maps were prepared by the Michael Succow Foundation (MSF) in the frame of the Central Asian Desert Initiative (CADI) as part of the International Climate Initiative. The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety supports this initiative on the basis of a decision adopted by the German Bundestag.

We also acknowledge with deep gratitude all experts and specialists, substantive and peer reviewers for their advice and review of the draft documents.

This project was funded by the German Federal Environment Ministry's Advisory Assistance Programme (AAP) for environmental protection in the countries of Central and Eastern Europe, the Caucasus and Central Asia and other countries neighbouring the European Union. It was supervised by the Federal Agency for Nature Conservation (BfN) and the German Environment Agency (UBA).

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Flora and vegetation of the Bereketli Garagum nature reserve

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Keywords: Bereketli Garagum, Karakum, Unguz, flora, vegetation, formations

The Bereketli-Garagum Nature Reserve, established on 18 July 2013, is currently the youngest protected area in Turkmenistan to cover the unique sandy-desert complexes of the Karakum desert.

Introduction, scope, and main objectives

Being at the junction of landscapes, the protected area is geographically confined to both the Central Lowland and Zaunguz Karakums. In addition, the reserve partially includes the chain of Unguz saline drawdown - remnants of the ancient Amu Darya riverbed, which crosses the Karakum Desert from east to west along its entire width. The diversity of landscapes impacts the composition of flora and vegetation of the region.

It should be noted that no study of flora has been conducted since the establishment of the reserve, so our data is the first material on plant and floristic biodiversity. Undoubtedly, further studies of biodiversity will bring some additions to the flora composition of the area.

Methodology

This work describes the plant communities and characterises the species composition of the reserve's flora.

The material is based on data from the 2019-2020 expeditions carried out during the spring and autumn periods as part of the CADI project. A large amount of herbarium material (over 400 leaves) and photographic material was collected during the work. The trial plots of 1 to 4 acres were used to describe the vegetation (Yaroshenko, 1969; Mirkin and Rosenberg, 1978). Ten trial plots (transects) were established, and an ecological profile from the Unguz Depression deep into the sand massif was laid (Yunatov, 1964). All plants were identified to species and presented according to modern nomenclature (IPNI).

Results and discussion

In the course of the research, 181 species of higher vascular plants were recorded on expeditions to the territory of Bereketli Garagum Nature Reserve. All species belonging to 33 families (Table 1).

Table 1. Floristic composition of the Bereketli Garagum State Reserve.

№	Families	Number of genuses	Number of species	Life forms
1	*Amaranthaceae*	17	27	10
2	*Asteraceae*	12	25	8
3	*Brassicaceae*	13	24	4
4	*Fabaceae*	6	19	11
5	*Poaceae*	8	12	5
6	*Boraginaceae*	7	10	4
7	*Apiaceae*	5	8	3
8	*Polygonaceae*	3	8	5
9	*Caryophyllaceae*	3	5	4
10	*Euphorbiaceae*	2	4	3
11	*Convolvulaceae*	1	4	3
12	*Liliaceae*	2	3	1
13	*Papaveraceae*	2	3	1
14	*Amaryllidaceae*	1	3	1
15	*Zygophyllaceae*	2	2	2
16	*Tamaricaceae*	2	2	2
17	*Lamiaceae*	2	2	1
18	*Ranunculaceae*	2	2	2
19	*Asphodelaceae*	1	2	1
20	*Rutaceae*	1	2	1
21	*Orobanchaceae*	1	2	1
22	*Ephedraceae*	1	1	1
23	*Cyperaceae*	1	1	1
24	*Araceae*	1	1	1
25	*Asparagaceae*	1	1	1
26	*Iridaceae*	1	1	1
27	*Berberidaceae*	1	1	1
28	*Geraniaceae*	1	1	1
29	*Nitrariaceae*	1	1	1
30	*Thymelaeaceae*	1	1	1
31	*Plantaginaceae*	1	1	1
32	*Rubiaceae*	1	1	1
33	*Caprifoliaceae*	1	1	1
	Total:	**105**	**181**	**-**

Source: Author's own elaboration.

As in most parts of Asian deserts, the predominant family by species composition is Amaranthaceae, with 27 species in 17 genera. The *Halimocnemis genus* has the highest number of representatives (four species) in this family. The second most numerous is the family *Asteraceae* (25 species from 12 genera). In the family *Brassicaceae*, there are 13 general and 24 species. The legumes include 19 species in six genera, and the genus Astragalus is the most representative of the reserve's flora (14 species). In addition to *Astragalus*, the most representative genera are *Isatis*, *Strigosella*, *Ferula*, *Artemisia* and *Convolvulus*. The above families with 95 species represent 52.5 percent of the reserve's flora.

According to the ecological and morphological system of life forms of desert plants (Nechaeva, 1973), there are representatives of 47 life forms on the territory of SPNR. The tree type includes four subdivisions, with one representative in each of them. Microphyllous deciduous are represented by *Ammodendron conollyi*; deciduous with non-deciduous twigs

- *Eremosparton flaccidum*; deciduous with succulent twigs - *Calligonum eriopodum*; multi-stemmed and bushy with succulent articulate twigs - *Haloxylon ammodendron*. The next group, shrubs, is divided into eight subgroups: with cylindrical, early falling leaves (four species of the genus *Calligonum*); leafless, not forming adventitious roots - *Haloxylon persicum*; with cylindrical leaves, 1 - 3 m high - *Xylosalsola richteri*; with salt-producing small leaves - *Tamarix ramosissima*; with succulent leaves that persist until autumn - *Xylosalsola arbuscula* and *Reaumuria oxiana*; with cylindrical, quickly dropping leaves - *Calligonum setosum*; with compound leaves with leaflets dropping by the summer - *Astragalus paucijugus*; geoxy plants 1 to 2 m tall with erect stems - *Ephedra strobilacea*.

No representatives of shrubs were observed.

Semishrubs in five groups: small-leaved, particulate with vegetative and generative shoots - *Artemisia eriocarpa* and *A. dimoana*; all shoots generative, close to shrubs - *Astragalus ammodendron* and *A. squarrosus*; with cylindrical leaves - *Halothamnus subaphyllus*; large-leaved, root-shaped shoots - *Smirnowia turkestana*; bark of one-year shoots is photosynthesised, and leaves fall off at flowering - *Convolvulus erinaceus*.

We divide the semi-shrubs into four groups: close to shrubs with succulent cylindrical or scaly leaves - *Halocnemum strobilaceum, Caroxylon orientale* and *Arthrophytum lehmannianum*; with narrow prickly leaves - *Acanthophyllum elatius*; with buds of regrowth at the height of 5-10 cm, particulating - three species of the wormwood subgenus *Seriphidium*; buds of regrowth at the height of 0-5 cm, not particulating - two species of *Acanthophyllum*; buds of regrowth at soil level, transitional to herbs - *Convolvulus eremophilus*, *C. divaricatus* and *Zygophyllum eichwaldii*.

Perennial grasses are divided into two series of groups: monocotyledons and dicotyledons. The monocotyledons, in turn, are divided into seven groups: dense-bush, turfy - *Stipa hohenackerana*; loose-bush, turfy - *Centropodia forskalii* and three species of *Stipagrostis*; with polycyclic, above-ground shoot tops - Phragmites australis; with polycyclic underground shoots - *Carex physodes* and *Convolvulus arvensis*; with short vertical rhizomes - *Iris, Asparagus and Eremurus*; with tuberous thickening - *Eminium lehmannii* and *Leontice ewersmannii*; onion plants - six species of *Gagea, Tulipa* and *Allium*.

The dicotyledonous perennial herbs are divided into 11 groups: polycarps with unbranched main root - *Peganum harmala* and *Heliotropium dasycarpum*; non-crowned small-headed polycarps - *Glycyrrhiza glabra* and five species of the genus *Astragalus*; rosette polycarbines - *Astragalus flexus*; tuber polycarbines - *Scorzonera sericeolanata* and *Takhtajaniantha pusilla*; one-headed polycarbines with a considerably thickened root - *Rheum turkestanicum*; one-headed spindle-shaped polycarps - *Prangos ammophila*; monocarpics with thickened roots - four species of the genus *Ferula* and *Dorema sabulosum*; vegetatively motile, root-sprouting polycarps - *Alhagi pseudalhagi*; roots thin, unstemmed, sprouting at shallow depth - two species of *Haplophyllum, Heliotropium arguzioides* and *Argusia sogdiana*; roots succulent - *Jurinea derderioides*; grasses parasitic - genus *Cistanche*.

Monocarpic biennials include *Cousinia oxiana* and *C.schistoptera*.

The annuals are divided according to their phenological characteristics and include six groups: winter-spring (six species) - *Ranunculus falcatus*, two species of *Alyssum, Meniocus linifolius*, *Streptoloma desertorum* and *Veronica campylopoda*; Early spring includes 35

species of the families *Poaceae* (5), *Caryophyllaceae* (1), (3), *Brassicaceae* (15), *Fabaceae* (2), *Geraniaceae* (1), *Boraginaceae* (6) and *Asteraceae* (two species). Mid-season includes 18 species - *Poaceae*, *Caryophyllaceae*, *Ranunculaceae*, *Boraginaceae*, *Caprifoliaceae* one species each, *Asteraceae* 8, *Fabaceae* 3 and *Brassicaceae* 2. Early summer annuals include 20 species from eight families. Summer annuals include seven species, five representing *Amaranthaceae*, *Chrozophora gracilis* and *Tribulus terrestris*. The group of summer-fall annuals includes 12 species, ten of which are from the family *Amaranthaceae* and *Euphorbia cheirolepis* and *Polygonum aviculare*.

Simplifying the system of life forms, we present the following figures: a total of four species of trees (2.2 percent), 12 species of shrubs (6.6 percent), no shrubs, seven species of semi-shrubs (3.9 percent), 12 species of semi-shrubs (6.6 percent), 46 species of perennial grass (25.4 percent), two species of biennials (1.1 percent) and 98 species of an annual grass (54.2 percent) are found in the PA. Early spring annuals are the largest group and account for 19.3 percent of the floristic composition of the surveyed PAs.

According to geobotanical zoning, this protected area belongs to two districts: Zaunguz and Central Karakum within the Karakum group of districts of the West South Turan subprovince of the South Turan province of the Turan-Gobi subregion of the Ancient Mediterranean subkingdom of the Holarctic (Kamelin, 2018; Geobotanical zoning, 1947).

The species occurring in the reserve's flora have diverse ranges - from spreading over the entire land (Convolvulus arvensis, Capsella bursa-pastoris, Phragmites australis, etc.) to being limited to the Karakum territory (*Artemisia dimoana, Crucianella sabulosum, Ferula karakumica*). We have identified nine types of habitats for the Berketley-Garagum Reserve. According to the number of species, the most representative is Iranian-Turanian, with 57 species (31.5 percent). *Rheum turkestanicum, Climacoptera lanata, Strigosella grandiflora, Papaver pavonium*, etc., are included in this group. Turanian is represented by 52 species (28.7 percent), including such outstanding representatives as *Eminium lehmannii, Delphinium camptocarpum*, six species of *Calligonum, Ferula foetida, F.litwinowiana* and *Dorema sabulosum*. The southern Turanian range includes 20 species (11.0 percent), e.g. *Asparagus turkestanicus, Acanthophyllum korolkowii, Cithareloma lehmannii* and *Ferula karakumica*. Iranian-Turanian-Jungarian and Turan-Jungarian each have four species (2.2 percent each). The first includes *Xylosalsola arbuscula, Arthrophytum lehmannii, Horaninovia ulicina* and *H.anomala*. To the second: *Astragalus petunnikowii, Euphorbia turczaninowii, Turania sogdiana* and *T.aperta*. There are 25 *Mediterranean species* (13.8 percent). These include *Cutandia memphitica, Valerianella leiocarpa, Koelpinia linearis, Epilasia hemilasia, Carthamus oxyacanthus* and several others. There are 13 species (7.2 percent) from the Nearctic, such as *Eremopyrum orientale, Stipagrostis plumosa, Diarthron vesiculosum, Peganum harmala* and *Erodium oxyrhynchum*. Holarctic range with only one species, *Stipa hohenackeriana*. five pluregional species (2.8 percent) are *Phragmites australis*, *Capsella bursa-pastoris*, *Polygonum aviculare*, *Descurainia sophia*, *Atriplex tatarica* and *Convolvulus arvensis*.

Thus, taking Turanian supraprovince as the core, it includes 72 species (together with South Turan). The number of Turanian species in the adjacent ranges (Iranian and Dzungarian) is 65. Hence, there are 137 (75.7 percent) species associated with Turan. The range is wider for 13 Fore-Asian species, and 25 species are distributed throughout the Ancient-Mediterranean subkingdom of the Holarctic. The pluri-regional ones are mainly weeds distributed all over the globe.

There are few localised species, namely endemic and sub-endemic representatives. Among the endemics are the Karakum species: *Artemisia dimoana, Crucianella sabulosa* and a recently described species, one of the type specimens of which was collected in the territory of this NNP is *Ferula karakumica* (Pavlenko, 2019). Of the sub-endemics found in the Karakum and neighbouring Kyzylkum, the following occurs in the Bereketli Garagum area: *Chartoloma platycarpum, Prangos ammophila* and *Cousinia annua*.

We want to mention some interesting species confined to the Khorasan-Kopetdagh mountain system but found in the PA area. These are *Allium regelii, Caccinia macranthera* and *Leontice ewersmannii*. The northern boundaries of their main habitat, *the Kopetdag-Khorasan* mountains, are 250 km from the reserve's areas. Along the meridian of the reserve, a narrow strip of sparse populations of these species are located, and the Bereketli-Garagum section of the reserve is the northernmost limit of their distribution. Consequently, the reserve's flora, being a typical desert flora, is not only influenced by neighbouring desert habitats but is also supplemented by typical mountain species and will probably continue to be supplemented in the future.

It should be noted that some formations belonging exclusively to the desert type of vegetation on grey-brown, takyr-like and solonchak soils and sandy substrates of varying degrees of consolidation are present within the reserve. Most areas are occupied by *Haloxylon persicum* formations, occupying almost all sandy areas. Notable are *Haloxylon ammodendron* communities dominating along the sides of solonchak depressions. The grey-brown soils are dominated by the boyalych and camel-grass (*Xylosalsola arbuscula* and *Artemisia kemrudica*) communities. In areas where saxaul was heavily harvested for fuel before establishing the reserve, shrub communities of *Xylosalsola richteri* and *Ephedra strobilacea dominate*. *Ephemera-adrasana* association (*Ephemerae - Peganum harmala*) dominates in the near-solonchak areas, knocked out by cattle. On the bottoms of solonchak depressions, there are synusions of *Halocnemum strobilaceum*, often with low-growing and depressed *Reaumuria oxiana*. On highly saline areas, there is no vegetation at all. The saxaul community Arthrophytum lehmannianum, located along Unguz in areas with minimal salinity, is remarkable. Apart from Unguz, there are no other communities dominated by this species in Turkmenistan.

In order to describe the vegetation and determine its distribution pattern, an ecological profile was created from the bottom of the Unguz Depression along the side of the depression to the Murze-Chirla cordon across the sand massif. This cordon is located in the easternmost part of the reserve. The work was conducted in April 2019. The length of the profile is 2100 m.

The Black Saxaul Formation was observed directly at the bottom of the depression, with specimens of the edificator being stunted, not exceeding 1 - 1.2 m in height and with crowns no more than 1 m wide. This is explained by increased soil salinity and, consequently, the floristic composition here is extremely small - only 16 species. We note several associations in the formation: boyalych-black saxaul (*Xylosalsola arbuscula - Haloxylon ammodendron*) with Asparagus turkestanicus; Cherkezoan black-saxaul (*Xylosalsola richteri + Haloxylon ammodendron*) with *Zygophyllum eichwaldii* along the middle of the depressive ridge; motley grass black-saxaul (*Ephemerae - Haloxylon aphyllum*) in the upper part of the ridge. As one moves upwards from the bottom of the depression, soil salinity decreased markedly, the amount of stony inclusions and clay in the soil decreased, and the substrata became sandier.

A narrower strip was the boyalych formation with several associations in which it was difficult to identify the edificator, but the number of plants per hectare and productivity of boyalych exceeded other species. Soils are sandy loamy, with minimal clay and stony inclusions. The floristic composition contains 33 species. In this formation, we note the following associations: Saxaul- Saxaul- Saxaul-Boyalych (*Arthrophytum lehmannianum - Xylosalsola arbuscula*) with the participation of Reaumuria oxiana; saxaul-cherkez-boyalych (*Arthrophytum lehmannianum - Xylosalsola richteri - Xylosalsola arbuscula*) on compacted soils; kemrud-sagebrush-saxaul-arbuscula (*Artemisia kemrudica + Arthrophytum lehmannianum - Xylosalsola arbuscula*). In addition to the above phytocenoses, several other combinations of sub-edificators are present in this formation, but their ranges are relatively small and have not been considered.

The next formation, represented by 36 species, is the *Cemerodonta*, located on horizontal plots above the slopes of the hollow. The soils are slightly compacted. The main campanulate association is boyalych kemrud (*Xylosalsola arbuscula - Artemisia kemrudica*), with perennial and annual grasses in the lower tier.

The white saxaul formation is the main phytocoenosis of the reserve, occupying at least 80 percent of its area. It was also represented on the profile by a very wide strip of at least 1.2 km. The formation is represented by 138 species, with about 100 species found only in white-saxauls. The phytocoenosis is located on sandy substrates. The condition of all members of the formation was in satisfactory condition. We note the following associations in this phytocenosis: Kadym-Singren white-saxaul grass (*Calligonum setosum - Astragalus squarrosus - Haloxylon persicum*) with herbs and cereals in the lower tier; cherkez-kemrud-sagebrush white-saxaul grass (*Xylosalsola richteri - Artemisia kemrudica - Haloxylon persicum*) with herbs and mixed cereals; kandym-suzen white saxaul (*Calligonum setosum - Ammodendron conollyi + Haloxylon persicum*) with the active participation of *Convolvulus eremophilus* and herbaceous grasses; cherkez white saxaul (*Xylosalsola richteri + Haloxylon persicum*) with *Calligonum setosum, Ammodendron conollyi, Ephedra strobilacea, Artemisia eriocarpa* and *Poaceae* in the lower tier.

The last link in the profile was the herb-harmel peganum association (*Ephemerae + Peganum harmala*) in an area of increased anthropogenic pressure. It should be noted that this is in the vicinity of the active Yoloten well, and before the reserve was established, cattle used to drink here, especially in the summer. The area is sandy takyr in places, almost completely devoid of usual vegetation. The association includes a number of introduced plants: *Suaeda arcuata, Tribulus terrestris, Carthamus oxyacanthus* and others. The characteristic flora is represented by single specimens of the genus *Eremopyrum* and *Carex physodes, Astragalus flexus, A.squarrosus* and Smirnowia turkestana. The latter three species must have appeared here after the cessation of grazing. Along the edge of the site, *Convolvulus divaricatus* is notable.

Thus, this profile characterises the majority of sections of the Prigunguz, i.e. areas immediately adjacent to the Unguz chain of depressions. In the remaining areas, namely those to the north and south of the Unguz, the White Saxaul Formation prevails with a complex of associations in which *Calligonum, Xylosalsola richteri, X.arbuscula* and, less frequently, *Ephedra strobilacea*, *Ammodendron conollyi* are the most common sub-edificators. In areas where intensive grazing and collection of saxaul for fuel was undertaken, the dominant role of the latter is significantly reduced.

Conclusions

The following conclusions can be derived from the above:

1. According to the geobotanical zoning, the territory of Bereketli-Garagum State Reserve is located in the South Turan province and is located at the junction of Low and Zaunguz Karakums, including a chain of solonchak depressions. This location affects the composition of flora and vegetation of the protected area.
2. During three short expedition surveys, 181 species of higher vascular plants from 33 families were recorded in the protected area, of which eight families belong to Liliopsida, 24 to Magnoliopsida and one to Chlamydospermae. All species belong to 105 genera.
3. As in all desert areas of Central Asia, the dominant family is *Amaranthaceae*, with 27 species. In addition, the dominant genus is Astragalus (*Fabaceae*), with 14 species.
4. A 47 desert plant life forms were recorded, dominated by early spring annuals with 35 species.
5. Geographical elements are represented by 9 habitat types. The most representative are the Turanian areal and its associated elements. There are 137 such species, representing 75.7 percent of the floristic composition.
6. The main vegetation formation that occupies at least 80 percent of the reserve area is the white saxaul forest, with many associations and combinations of sub-edificators.
7. The areas which were under increased anthropogenic load before the establishment of the reserve have seen a gradual restoration of vegetation. In particular, the perennial herbaceous flora and the presence of young and immature specimens of tree and shrub vegetation are restored everywhere in such areas.

Acknowledgements

The comprehensive research of the Bereketli Garagum State Reserve was initiated and funded by the CADI (Central Asia Desert Initiative) project, which is jointly implemented by Greifswald University, the Michael Succow Foundation (Germany) and the Food and Agriculture Organization of the United Nations (FAO). The project is part of the International Climate Initiative (IKI). The initiative is supported by the Federal Ministry of the Environment, Nature Conservation and Nuclear Safety (BMU) based on a decision by the German Bundestag. In addition to Turkmenistan, teams from Kazakhstan, Uzbekistan, Mongolia, and China participate in the projects. The author would like to thank the staff of the M. Succow Foundation for their comprehensive assistance and close cooperation.

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Assessment of the conflict situation between the Bukhara Deer *(Cervus Hanglu)* and the local population in the lower Amudarya biosphere reserve

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Keywords: Bukhara deer, conflicts, Lower Amudarya State Biosphere Reserve, camera traps.

Introduction

Conflicts between wildlife and humans have a long history, exacerbating as humans have developed areas inhabited by wild animals. One of the most significant types of damage is the consumption of crops by wild animals (Nath and Sukumar, 1998; Newmark *et al*., 1994; Delibes-Mateos *et al*. 2011; Kroos *et al*. 2012; Haney and Conover 2013). This is due to the fact that the agricultural intensification has reduced the availability of natural food sources in the wild, forcing animals to feed on agricultural crops (Barrio *et al*. 2013).

The territory of the Republic of Uzbekistan is no exception - conflicts between wildlife and humans exist throughout the country. Despite relevance, there is practically no assessment of the actual damage caused by mammals to the local population, and there have been no effective measures implemented to reduce it.

The Bukhara deer population in the Lower Amudarya State Biosphere Reserve (LABR) is increasing every year, which certainly gives pride to our country, while at the same time adversely affecting the lives of local population. Complaints from farmers about the devastation of agricultural fields by the Bukhara deer began in 2010, and the conflict particularly escalated in 2013 (BMZ Report..., 2016). The main conflict zone is located along the territory of the reserve - in the Amudarya and Beruni districts of Karakalpakstan. The abundance of deer in the territory of the reserve is more than 2000 individuals (Cornelis *et al*. 2020), which exceeds the allowable amount of food land (Marmazinskaya, 2008; 2018), and is the main reason for deer to go beyond the tugai areas.

Data and methods

LABR is located along the Amudarya River at the foot of the Sultanuizdag remnant mountains in the territory of the Republic of Karakalpakstan. The area is 68,717.8 hectares. Three tugay areas of the PA - Baday-Tugay, Tallik and Jumurtau are inhabited by deer.

Field surveys were conducted by installing eight camera traps (Wildkamera 3G GSM; SVMUU 14MP 1080P; Wildkamera.net, SecaCam 12.0 MP w/sound SD 8Gb) in fields with crops - cotton (one camera), in a field intended for planting cotton (one), rice (one) and wheat (two cameras for two days and three cameras before the harvest). Rationale behind the installation of cameras was the presence of main deer trails leading from tugai areas to the fields. The cameras operated for 532 trap-days and made 7180 images. The images were processed using Re-name Lite, DataOrganizer (Ver. 4.2.2, August 08, 2019), and DataAnalyze (Ver.7.1, January 25, 2018) software. The target time for determining auto camera captures was 60 minutes. A survey of agricultural fields (winter, spring, summer) was conducted to

determine the extent of the problem. On-foot routes were laid in four sections of fields (Jumurtau, Tallik)(12169 m). The density of traces and excrement was recorded. Farmers (74 people) were surveyed and the information obtained was verified by searching for traces of deer presence to determine the range of deer invasion outside the tugai areas. The length of the route and the locations of conflict zones were determined using a smartphone with the LocusPro program installed. Four field trips were conducted: December 23–29, 2018; April 23-29, 2019; June 22-30, 2019; November 23-26, 2019.

Results

The survey confirmed that the deer regularly invade farm fields. Traces, excrement, and frequently used main trails running from tugai areas to the fields were found. The average density (per m^2) of deer excrement was 0.0046 in harvested rice fields (December), and 0.0114 in cotton fields. Thus, cotton fields were invaded slightly more frequently. During the spring routes, the excrement density in wheat fields was 0.013 to 0.0004 depending on the vegetation stage; it was 0.026 in rice fields, zero in cotton fields (cotton was just starting to sprout), and 0.0067 on average. Wheat fields were invaded by deer slightly more frequently in late April. The figures obtained gave us a general idea of deer invasion to the fields. Below is the per-area information:

Tallyk area: the tugai forest is separated from the fields by a dam along which an unpaved road passes. Along the dam, there is a channel, which is crossed by deer (clear main trails), then they climb the dam, cross the road and go to the fields.

Jumurtau area: A large number of fresh excrement, deer traces, broken bushes by males, and stripped trunks of turanga were observed near the fields. However, there were no clear main trails leading from the tugai to the fields. There is an asphalt road with high traffic near the northern part of Jumurtau. On the other side of the road, there are quarries and stone-crushing plants - there is a thick cloud of dust and pollution from exhaust gases and dust. The current environmental situation is not compatible with the objectives of the PA and causes great harm to the ecosystem. All this has led to the fact that the deer rarely go beyond the tugai in the northern part. There is a permanent grouping in Jumurtau, as suggested by the well-established biological field of deer, however, the density of deer is lower than in other areas. Nevertheless, a conflict between the deer and the farmers is ongoing.

It was observed that during the daytime, the fields invaded by the deer are used for livestock grazing. It is a purposeful grazing in winter, but during the vegetation season, it is occasional visits. Obviously, a large herd of cattle can cause much more damage in a shorter period of time than a group of deer. However, the local people do not attach much importance to this and focus on the damage caused by deer.

Based on the data analysis, it was determined that the number of deer invasions to the fields in the winter is significantly lower, which is due to the fact that the crops are harvested, and only insignificant vegetation remains on the fields. However, fresh traces and excrement are observed, which once again confirms the lack of fodder inside the tugai areas. The period of the most intense deer invasions falls on the growing season of agricultural crops up to the full harvest. This is the period from March (winter cereal fields) to the end of October. Farmers cultivate the fields for different crops in different months. Wheat sprouts

first (March-April), then cotton (April-May), rice is planted only in June. It is worth mentioning that wheat is completely removed from the fields by the end of May.

Obviously, farmers rotate fields every year to plant different crops. As a result, at the end of April, agricultural fields have different levels of cultivation: completely uncultivated (there are still residues of cotton and rice stalks); ploughed and leveled (sown and not sown); washed; with low wheat seedlings and high wheat seedlings; with wheat already in ear. Thus, deer have access to forage resources of fields during the entire period from March to October.

Tallyk area which is closer to tugai massifs features cotton and wheat, while Jumurtau area features mostly rice and cotton. Corn grows in small vegetable gardens near houses; fields of chili pepper and sesame occupy only a small percentage of the sown area (no more than 5 percent). It was observed that there is no pattern in planting any particular crops closer or farther from the tugai. According to the farmers, some of the fields ceased to be cultivated due to high deer pressure (around 638.54 ha), but other reasons are also possible. The total area of the fields regularly grazed by deer is about 3034.33 hectares (2286.02 ha – in Tallyk; 748.31 – in Jumurtau). The length of the cultivated conflict fields along the boundaries of the reserve is 63.38 km. The maximum distance of deer invasions to agricultural fields is 4.5-5 km in the Tallyk area, and 2.5-3 km in Jumurtau area (data confirmed by traces of deer presence in the fields).

One of the minor limiting factors that hinder deer invasions is the availability of roads and settlements. However, there is evidence which suggests that the deer were seen in the immediate vicinity of or in settlements, as well as road crossings with low, medium and high traffic.

In addition to the foregoing, it has been confirmed that in the spring the deer cross the highway to Nukus and go to the Sultan-Uvaiz remnant, which is up to 8-10 km from the tugai. Such behavior of the deer of the Badai-Tugai population has been observed for a long time and is not associated with a lack of forage in the tugai but is a behavior typical for the Bukhara deer in all its habitats – the deer always go out to graze on early-spring ephemerals in the surrounding tugay deserts and remnant highlands. A survey of feeding places along the remnant was conducted, and deer traces and excrement were found. Such deer invasions present the risk of their death on roads and pose a danger to drivers and passengers.

Given the facts of deer grazing in the fields, it was the next logical step to clarify the frequency of their invasion during the year. For this purpose, eight camera traps were installed. In total, 535 images of Bukhara deer and 415 images of livestock in the fields were obtained during the period of operation of the camera traps. According to the results of auto camera captures (an interval of 60 min), the number of empty captures was the highest (504); humans working in the fields came second in terms of occurrence (495), cattle were the third (121), and the deer came fourth (61 captures only) (see Table 1). Thus, the number of auto camera captures showed the prevailing number of livestock in the fields than the deer. At this stage, it is safe to say that the damage from livestock in agricultural fields outweighs the damage caused by the deer.

Based on the image analysis, we can clearly state that the number of deer invasions to the fields begins increasing in April, reaching its peak in May, and decreases in June (Table 2). The deer stop invading the fields from July to September. Invasions resume in October. There is no clear pattern related to the type of crop grown in the field, which is related to the location of the fields in relation to tugais and the vegetation season. Livestock are observed in greater numbers in the fields in July-August and in October-November (Table 3).

Table 1. Species arranged in descending order of number of available auto camera captures and percentage of captures

Captured object	**Total**	**percent**
Empty captures	504	39.0698
People	495	38.3721
Livestock	121	9.3798
Bukhara deer	61	4.7287
Jackals	27	2.0930
Machines	25	1.9380
Insects	14	1.0853
Dogs	13	1.0078
Unidentified birds	10	0.7752
Magpie	9	0.6977
Khiva pheasant	9	0.69771
Jungle cat	1	0.0775
Hoopoe	1	0.0775
Total captures	1290	100.0000

Source: Author's own elaboration.

If we compare auto camera captures in the same fields, then, for example, in the cotton field (LABR003), where the camera trap worked for the longest period, from vegetation to harvest, it can be seen that the number of auto camera captures of deer for the entire period of camera operation (213 trap-days) is 19, while for cattle it stands at 94. In contrast, in the rice field (LABR002), the number of camera captures of deer and cattle is almost the same - 21 and 20, respectively, the same is true for the empty field, which was equally invaded by deer and livestock. However, during the active vegetation period, no livestock was recorded on the wheat fields, while there were regular deer invasions (16 camera captures) (Tables 2 and 3).

Table 2. Number of auto camera captures of deer in the fields by months.

Camera No.	Crop	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Total
LABR001	empty	0	1	3	1	0	0	0	0	0	0	0	0	5
LABR002	rice	0	0	0	0	3	10	8	0	0	0	0	0	21
LABR003	cotton	0	0	0	0	2	6	0	0	0	0	8	3	19
LABR004	wheat	0	0	0	0	4	1	0	0	0	0	0	0	5
LABR005	wheat	0	0	0	0	2	0	0	0	0	0	0	0	2
LABR006	wheat	0	0	0	0	3	6	0	0	0	0	0	0	9
LABR007	wheat	0	0	0	0	0	0	0	0	0	0	0	0	0
LABR008	wheat	0	0	0	0	0	0	0	0	0	0	0	0	0

Source: Author's own elaboration.

Table 3. Number of auto camera captures of livestock in the fields by months.

Camera No.	Crop	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Total
LABR001	empty	2	2	1	2	0	0	0	0	0	0	0	0	7
LABR002	rice	0	0	0	0	7	8	5	0	0	0	0	0	20
LABR003	cotton	0	0	0	0	0	4	0	9	12	0	32	37	94
LABR004	wheat	0	0	0	0	0	0	0	0	0	0	0	0	0
LABR005	wheat	0	0	0	0	0	0	0	0	0	0	0	0	0
LABR006	wheat	0	0	0	0	0	0	0	0	0	0	0	0	0
LABR007	wheat	0	0	0	0	0	0	0	0	0	0	0	0	0
LABR008	wheat	0	0	0	0	0	0	0	0	0	0	0	0	0

Source: Author's own elaboration.

From July to September, there are no deer invasions to the fields, which is most likely due to the increased level of protection of the fields and the presence of people/machines around the clock (information also obtained from camera traps). In addition, in late August - early September, the deer come into rut. During the rut, males do not eat much and are mostly busy demonstrating, courting females and agonistic interactions with other males, which potentially results in the deer not going beyond the tugai areas.

Important information is provided by the deer activity hours depending on the month of the year (Table 4) – the deer do not go out to the fields between 09:00 and 19:00, regardless of

the season of the year. The highest hours of active grazing in the fields in all months is between 1 a.m. and 5 a.m., which is the safest time to visit the fields.

Table 4: The Bukhara deer activity hours (60-minute auto captures).

Hours	Number all months	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**
00:00-01:00	3	0	0	0	1	2	0	0	0	0	0	0
01:00-02:00	11	0	0	0	1	6	1	0	0	0	2	1
02:00-03:00	11	0	0	0	1	7	2	0	0	0	1	0
03:00-04:00	13	0	1	1	3	5	1	0	0	0	2	0
04:00-05:00	11	0	0	0	4	4	2	0	0	0	0	1
05:00-06:00	5	0	0	0	2	1	0	0	0	0	2	0
06:00-07:00	1	1	0	0	0	0	0	0	0	0	0	0
07:00-08:00	0	0	0	0	0	0	0	0	0	0	0	0
08:00-09:00	1	0	1	0	0	0	0	0	0	0	0	0
09:00-10:00	0	0	0	0	0	0	0	0	0	0	0	0
10:00-11:00	0	0	0	0	0	0	0	0	0	0	0	0
11:00-12:00	0	0	0	0	0	0	0	0	0	0	0	0
12:00-13:00	0	0	0	0	0	0	0	0	0	0	0	0
13:00-14:00	0	0	0	0	0	0	0	0	0	0	0	0
14:00-15:00	0	0	0	0	0	0	0	0	0	0	0	0
15:00-16:00	0	0	0	0	0	0	0	0	0	0	0	0
16:00-17:00	0	0	0	0	0	0	0	0	0	0	0	0

17:00-18:00	0	0	0	0	0	0	0	0	0	0	0	0
18:00-19:00	0	0	0	0	0	0	0	0	0	0	0	0
19:00-20:00	1	0	0	0	0	1	0	0	0	0	0	0
20:00-21:00	2	0	0	0	0	1	0	0	0	0	1	0
21:00-22:00	1	0	0	0	1	0	0	0	0	0	0	0
22:00-23:00	3	0	0	0	0	1	1	0	0	0	0	1
23:00-24:00	7	0	1	0	4	1	1	0	0	0	0	0
Total	70	1	3	1	17	29	8	0	0	0	8	3

Source: Author's own elaboration.

If we talk about livestock grazing, we have the following picture (Table 4). - The grazing was observed in the fields practically all day long, except for the period from one to three a.m., and from six to seven a.m. Livestock were not observed in the fields only during September. What was the reason for the absence of cattle on the fields is difficult to say.

According to the Bukhara deer and livestock activity graphs, it becomes clearly visible how ungulates replace each other during the day - mainly deer are active at night, cattle are active during the day. Thus, in fact, ungulates eat and trample crops to varying degrees in the agricultural fields around the clock during the periods of activity described above.

Table 5: Livestock activity hours (60-minute auto captures).

Hours	Number all months	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**
00:00-01:00	1	0	0	0	0	0	0	0	0	0	1	0
01:00-02:00	0	0	0	0	0	0	0	0	0	0	0	0
02:00-03:00	0	0	0	0	0	0	0	0	0	0	0	0
03:00-04:00	1	0	0	0	0	0	0	0	0	0	1	0
04:00-05:00	0	0	0	0	0	0	0	0	0	0	0	0
05:00-06:00	1	0	0	0	0	0	0	0	0	0	0	1
06:00-07:00	0	0	0	0	0	0	0	0	0	0	0	0
07:00-08:00	5	0	0	0	0	0	0	0	0	0	2	3
08:00-09:00	13	0	0	0	0	3	0	4	4	0	1	1
09:00-10:00	15	0	0	0	1	1	0	0	3	0	8	2
10:00-11:00	11	0	0	1	0	0	0	0	0	0	5	5
11:00-12:00	8	0	0	1	1	0	0	0	0	0	1	4
12:00-13:00	10	0	0	0	2	1	2	0	0	0	0	5
13:00-14:00	13	0	0	0	2	2	1	0	0	0	0	8
14:00-15:00	18	0	1	0	1	3	1	1	1	0	3	6
15:00-16:00	12	1	0	0	2	2	1	1	1	0	2	2
16:00-17:00	13	1	0	0	0	2	0	0	0	0	8	1
17:00-18:00	5	0	0	1	0	0	0	0	1	0	4	0
18:00-19:00	5	0	0	0	0	0	0	3	1	0	0	1

19:00-20:00	3	0	0	0	0	0	0	1	0	0	0	2
20:00-21:00	2	0	0	0	0	0	0	0	0	0	1	1
21:00-22:00	1	0	0	0	0	0	0	0	0	0	1	0
22:00-23:00	2	0	0	0	0	0	0	0	1	0	1	0
23:00-24:00	1	0	0	0	0	0	0	0	1	0	0	0
Total	140	2	1	3	9	14	5	10	13	0	39	42

Source: Author's own elaboration.

Conclusions

The total area of fields subject to regular deer invasions is about 3,034.33 hectares, of which 2,286.02 ha – in Tallyk and 748.31 ha – in Jumurtau areas. The length of cultivated conflict fields along the boundaries of the reserve is 63.38 km. The maximum distance of deer invasions is 4.5-5 km (in Tallyk) and 2.5-3 km (in Jumurtau). In the spring, in search of forage, the deer cross the highway and migrate to the Sultan-Uvaiz remnant, which is up to 8-10 km from the tugai.

535 captures of deer and 415 captures of livestock in the fields have been taken. The number of 60-minute auto camera captures showed a prevailing number of livestock (121 camera captures) over deer (61 camera captures). Thus, the damage from the livestock in agricultural fields outweighs the level of damage from the deer. The number of deer invasions to the fields begins increasing from April, reaching its peak in May and decreases in June. The deer do not invade the fields from July to September, in October the invasions resume. Livestock are observed in greater numbers in the fields in July-August and in October-November. Deer do not come to the fields between 09:00 am and 19:00 regardless of the season of the year. Deer invasions to the fields were not observed from July through September. In late August and early September, the deer come into rut and do not go beyond the tugais. Livestock grazing was observed in the fields practically all day and night. Livestock were not observed in the fields only during September. Ungulates replace each other during the day; while the deer are active at night, livestock are active during the day. Thus, crops are eaten and trampled in the fields around the clock.

Recommendations

1. Conduct negotiations at the level of the State Committee for Ecology with the leadership of the khokimiyats of Beruni and Amudarya districts in order to reduce, completely stop planting or change planted crops on the first (closest to the tugai) line of fields.
2. Obtain legal advice aimed at identifying the mechanism of functioning of biosphere reserves and develop a draft agreement between the khokimiyat and LABR, as well as LABR and farms on the use of economic zones for crops. The contract should spell out all the conditions of use and risks on both sides.
3. Conduct regular monitoring of deer invasions to the fields.
4. Conduct awareness-raising activities among local people.
5. Use the scheme of planting crops in the form of strips. The strip of fields closest to tugais should be used as forage fields for deer (about 500 m wide). The next strip should be solanaceous crops (potatoes, tomatoes), which are the least attractive for deer as a feed object (500 m), and on the third line, cotton and rice that are in demand in the region should be planted. The fourth strip is wheat. Such approach of management of sown areas can significantly reduce the damage from deer, and partially address the problem of fodder shortage.
6. Develop a scheme for planting forage fields and organizing feeding grounds to distribute the deer more evenly across LABR territory and diverting them from agricultural fields.
7. Provide all possible assistance to farmers in the construction of protective fences and planting vegetation.
8. Develop ecotourism - use part of the income to organize forage fields, feeding grounds, resettlement of deer.
9. Organize velvet antler farms at the reserve and use the proceeds to resolve conflict situations.
10. Organize a profitable hunting farm in suitable habitats in the future. Part of the proceeds received from trophy hunting should be directed to the prevention of conflicts between the Bukhara deer and local population.
11. Conduct regular fundraising aimed at reducing the level of conflicts between the deer and humans.
12. Regulate the abundance of the deer through resettlement.
13. Elabourate and develop a system of crop insurance against deer invasions.

Acknowledgements
The research was conducted as part of the project of the Government of Uzbekistan, GIZ and the Succow Foundation "Ecosystem-based approach to land use and conservation of ecosystems in the lower reaches of the Amudarya River", which is part of the International

Climate Initiative. The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety supports this project pursuant to the decision of the German Bundestag.

The authors express their gratitude to the State Committee for Ecology of the Republic of Uzbekistan, the State Forestry Committee of the Republic of Uzbekistan, the Institute of Zoology of the Academy of Sciences of Uzbekistan, the management and staff of LABR and NGO ""KRASS" for their assistance in the research.

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Prospects for a state nature reserve in South Ustyurt in Kazakhstan

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Keywords: South Ustyurt, Kaplankyr cliff, Kazakhstan, state nature reserve

Introduction

Southern desert ecosystems are among the least protected areas in the Republic of Kazakhstan (RoK), with less than 1 percent of the total area protected. According to experts, one of the most promising areas for establishing protected areas in this zone is the southern part of the Ustyurt plateau, including the Kaplankyr cliff, located near the junction of state borders Kazakhstan, Uzbekistan and Turkmenistan. This area is one of the most inaccessible, least studied, and the least inhabited and transformed by man in the Mangistau oblast of Kazakhstan.

The proposal to establish an inter-republican nature reserve in South Ustyurt was first formulated in the USSR in 1978. A year later, the Kaplankyr (Gaplangyr) reserve in Turkmenistan (currently covering 540 000 ha) was established. In Kazakhstan, the Ustyurt Reserve was created in 1984 (about 223 000 ha), but it is located on the Western Cliff of Ustyurt and includes only small fragments of southern desert ecosystems. In Uzbekistan, the State National Nature Park (SNNP) "South Ustyurt" (area - over 1.4 million hectares) was established in 2020.

These circumstances determined the main objective of the complex expedition research conducted in 2017-2019: rapid assessment of the current state of biodiversity of higher plants and vertebrates in Southern Ustyurt within the Karakiya district of Mangistau oblast of Kazakhstan. Zoological and botanical studies (Pestov *et al.*, 2019) were carried out as part of the Central Asian Desert Initiative (CADI) project, whose main partner in Kazakhstan is the Biodiversity Preservation Association of Kazakhstan (BPAK). The project is part of the International Climate Initiative (ICI) and is supported by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) based on a decision of the German Bundestag. The studies aimed to collect data for the natural scientific basis for establishing the South Ustyurt State Nature Reserve (SSR) in Kazakhstan. The initiative to establish this nature reserve has been pre-approved by the Committee on Forestry and Wildlife of the Ministry of Ecology, Geology and Natural Resources (CFW MEGNR) of the RoK.

Methodology

Standard zoological and botanical research methods were used as a basis for the assessment of flora and fauna biodiversity in the study area. The study of flora and vegetation in the study area included laying 36 geobotanical plots of 10x10 m with Global Positioning System (GPS) coordinates, selected in advance based on satellite image analysis. Data on the species

composition, spatial distribution, biotopic distribution and relative abundance of amphibians, reptiles, birds and mammals were collected by road and foot. The total length of road routes was approximately 3130 km, the total length of the day walking routes was approximately 235 km and the total length of the night walking routes using artificial lighting in the places where the expedition team spent the night was approximately 20 km.

Additional important zoological information was obtained by installing 16 camera traps at watering points, animal trails and sandfly colonies. In some cases, scent baits were used, which greatly increased the efficiency of the camera traps.

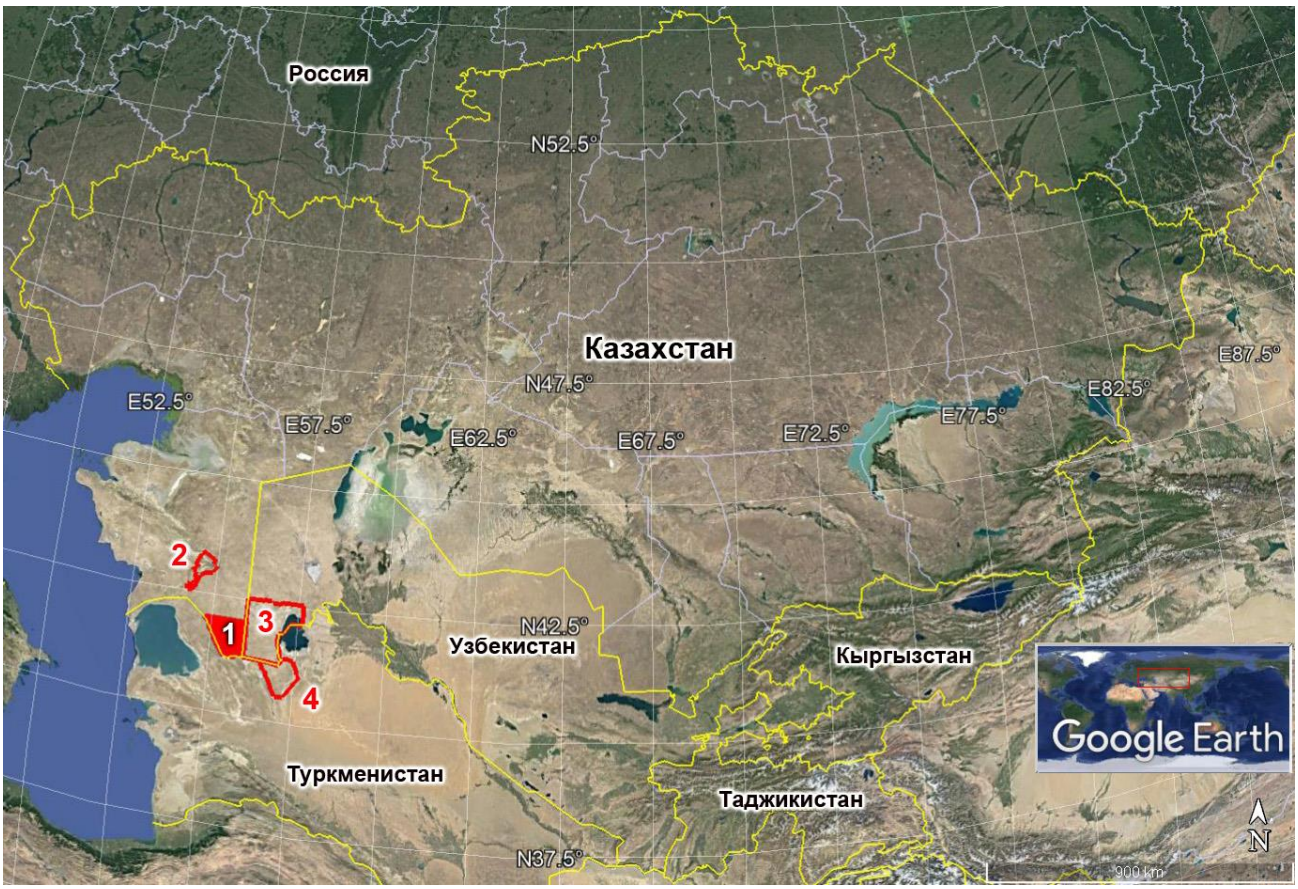
Results

According to the results of botanical research, 219 species from 39 families of higher vascular plants, including five species included in the Red Book of Kazakhstan, were identified in South Ustyurt: Xylosalsola chiwensis, Crambe edentula, Euphorbia sclerocyathium, Malacocarpus crithmifolius, Tulipa biflora. An outline of the flora of South Ustyurt was prepared, descriptions of all identified plant communities were given, and a map of ecosystems at a scale of 1:350 000 was drawn up.

Zoological surveys in South Ustyurt identified one amphibian species, 17 reptile species, 88 bird species (at least 34 species are likely to breed in the area), 32 mammal species. Including *Elaphe sauromates, Aquila chrysaetos, Aquila nipalensis, Aquila heliaca, Neophron percnopterus, Falco cherrug, Chlamydotis undulata, Pterocles orientalis, Bubo bubo, Caracal caracal, Mellivora capensis, Gazella subgutturosa, Ovis vignei, Equus onager* are included in the Red Book of the Republic of Kazakhstan. Annotated lists of amphibians, reptiles, birds and mammals of Southern Ustyurt prepared.
Full data on the results of biodiversity assessment in South Ustyurt are given in the Report "Results of complex expeditions to South Ustyurt in 2017–2019". (Biodiversity Assessment) (Pestov *et al*., 2019).

Discussion

The area proposed for creating the South Ustyurt State Nature Reserve includes a large section of the Ustyurt Plateau, the entire Kazakh part of the Kaplankyr Cliff and a small fragment of the Kazakhlyshor depression at the foot of the Cliff (Figure 1). The total area of the proposed reserve is about 625 000 ha, and the protected area of the reserve is about 35 000 ha (Smelyansky *et al.*, 2020).



Map 1 Source: (Cartography: Google Earth). [online]. [Cited 3 January 2022]. https://earth.google.com/web/@42.86762209,70.99126483,1166.97314832a,3127983.61267626d,35y,0h,0t, modified to comply with UN. World map (2022).

Map 2: Projected South Ustyurt gas treatment plant area

Source: Topographic map of Mangistau. 2003. [online]. [Cited 4 January 2022]. https://mangyshlak.kz/god-topograficheskaya-karta-mangistau/

А – Localization of protected areas of national importance in South Ustyurt

– boundaries of protected areas of national importance

1 – Projected GPP "South Ustyurt" (Kazakhstan);

2 – The projected South Ustyurt gas treatment plant (Kazakhstan);

3 – South Ustyurt SNPP (Uzbekistan);

4 – Kaplankyr gas treatment plant (Turkmenistan)

Б – Character of the terrain of the South Ustyurt Nature Reserve

– the boundary of the proposed nature rese

The following natural features of the area determine the importance and appropriateness of giving it the status of a State Nature Reserve (gas treatment plant).

1. Outstanding preservation of natural complexes. The proposed protected area is characterized by a largely undisturbed (preserved) landscape, land cover, vegetation and flora structure. In the composition of fauna, the disappearance of several species of large mammals (saiga, kulan, and cheetah) is noticeable, but this objectively reflects the state of the fauna of the whole region. However, the area stands out as particularly important for the conservation of the two remaining key ungulate species, the gazelle and the Ustyurt argali (Urial), as well as being important for the conservation of the honeyeater, caracal and possibly the anterovarian leopard (Panthera pardus tulliana), which periodically enters Kazakhstan from Turkmenistan.

2. Presence of endemic plant and animal species. Endemics of different levels are 13 plant species, including nine species endemic to the East Pre-Caspian region, one species for the Kyzylkum and Ustyurt remnants, two species for Ustyurt and Mangyshlak and one species for the Kopetdag-Kharasan region. Endemics of Ustyurt and Mangyshlak are the Chinook subspecies of Saker Falcon and Ustyurt Urial.

3. Diversity and large areas of rare and endemic plant communities and associated ecosystems. In particular, most of the proposed area is covered by wormwood and sagebrush communities of southern deserts dominated by Kemrud sagebrush, represented by many different associations. Such communities are rare in Kazakhstan, and only South Ustyurt plays a significant role in the vegetation cover. On the Kaplankyr cliff, there are widely developed communities of "mottled outcrops", typical for Central and Western Asia but relatively rare in Kazakhstan; with these communities, most of the endemic rare and vulnerable plant species are associated.

4. The role of the reference area of the southern desert sub-zone. This natural subzone occupies the south of Kazakhstan's plains and is currently not protected in any protected area of republican significance (except for a small fragment within the Ustyurt gas treatment plant). The landscapes, ecosystems, soil and vegetation cover, flora and fauna of the southern desert subzone - both zonal landscape elements proper and non-zonal, but characteristic and typical for the southern desert subzone (associated with cliff and sub cliff solonchak depression, with outliers, says, deflation depressions and karst forms on the plateau) are representative on the projected area.

5. The role of a benchmark for the natural complexes of the Ustyurt Plateau. The proposed area is representative and benchmarked against the Ustyurt Plateau as a large physiographic and landscape unit. Almost all of Ustyurt's major landform elements and their associated ecosystems and landscapes are represented here.

6. An important role in conserving rare and endangered species of flora and fauna. At least five plant species growing in the proposed area, six bird species, one reptile species and four mammal species are listed as rare and endangered on the Red Data Book of the RoK. Three bird species nesting in the area are assessed as globally threatened on the IUCN Red List, while another two bird species, three mammal species and one reptile species are classified as vulnerable. A number of bird and mammal species are protected under the CITES International Convention on Transboundary Trade in Endangered Species and the Bonn Convention on the Protection of Migratory Species.

7. Key to the conservation of a number of large mammal species. The area is of key importance for gazelle conservation in western Kazakhstan - it is home to the core of the Ustiurt population of this gazelle and represents both the seasonal (spring and autumn) staging areas of this species and the migration corridors connecting them (Figure 2). The area is also particularly important for conserving the endemic Ustiurt urial (Figure 3) and rare four-legged predators such as the caracal and honeyeater. The area may also be a migration corridor for the leopard, which periodically enters Kazakhstan from Turkmenistan.

8. Key to the recovery of a number of large mammal species. Historically, the proposed area was the last breeding ground of the South Ustyurt population of saiga, kulan and Asiatic cheetah in Kazakhstan. The area is also currently the most promising site for the future natural or induced recovery of these species lost in Kazakhstan or in the Kazakh part of Ustyurt.

The establishment of the South Ustyurt Nature Reserve (preferably as a cluster section of the Ustyurt Nature Reserve) will significantly complement the set of ecosystems, landscapes, flora, and fauna protected in the Kazakhstan part of the Ustyurt Plateau. After such addition, the natural complexes of the Southern and Western Ustyurt will be representative and sufficiently represented in the SPNA.

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Figure 2: Gazella subgutturosa gazelles at a natural watering point in the Kazakhlyshor Depression at the Kaplankyr Cliff base in the South Ustyurt project area gas processing plant. Photo from a camera trap installed as part of the CADI project, 2019.

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Figure 3: Female Urial Ovis vignei with cubs at the base of the Kaplankyr cliff in the project area of the South Ustyurt gas treatment plant. Photo from a camera trap installed as part of the CADI project, 2019.

The establishment of a nature reserve in the proposed area is possible and feasible due to a number of its socioeconomic and geographical characteristics.

1. Remoteness and geographical isolation. The project area is the most remote and inaccessible corner of the Karakiya district, surrounded on three sides by territories of other countries (Turkmenistan and Uzbekistan) and only to the north has access inside Kazakhstan.

2. Lack of population, infrastructure and economic use. The reason and condition for the preservation of the natural complexes of the territory is the absence of population and economic use here, and the almost complete absence of infrastructure (except for the presence of the Border Guard Service of the National Security Committee of the RoK, expressed in the installation of border wire fences along the state border and the maintenance of a number of unpaved roads).

3. No third party rights holders for land, subsoil and biological resources. The lack of use of the proposed area is ensured and secured for the near future by the fact that there are no land or subsoil plots owned, used or leased by individuals or organizations. There are also no subsoil areas that are promising for research and development. There are no third-party rights for water resources and hunting resources (no water users or hunting users). It seems to be the only sufficiently large area of Karakiya district and Mangistau oblast as a whole, where land, subsoil and other natural resources, including biological resources, are completely free from the property rights of any persons, except for the state.

4. Existing restrictions on use and visitation exist due to the border situation. Almost the entire proposed area (more than 70 percent of the area) has a border zone regime. On the edges of the area and on the whole of its most valuable part, the Kaplankyr cliff, a much stricter border zone regime is in force. This makes potential economic use and even just visiting the area much more difficult.

Due to the above-mentioned features, the establishment of a protected area regime would not entail significant changes in the actual use of the area, would not violate the rights of local residents (as they do not exist) and would not cause economic losses to citizens and legal entities.

The establishment of the reserved regime will not complicate the activities for the protection of the state border, since the Border Guard Service, in order to implement its tasks and perform its functions following the legislation of the Republic of Kazakhstan, has the right to be in any area (place border guards), including the areas of specially protected and nature conservation areas. At the same time, activities on protection of the state border will not entail significant violations of the reserve regime since the border strip and all the territory to the south of the boundary wire fences running along the Kaplankyr cliff may be allocated to the protection zone of the reserve. On the contrary, the establishment of the reserve will enable the Border Guard Service to effectively exercise its right and duty to assist the environmental authorities of the Republic of Kazakhstan in the protection of natural resources and the environment.

The transboundary nature of the ecosystems and the area's international importance should be noted. The natural complexes in South Ustyurt that require protection are shared between the three countries - Kazakhstan, Turkmenistan and Uzbekistan. Among others, populations of all vulnerable and demanding vertebrate species (including gazelle, urial, caracal, honeyeater,

Chinook salmon, etc.) are common to the three countries. Leopard inhabiting the Kazakh part of South Ustyurt is possible only because of its migration from the neighbouring territory of Turkmenistan. Natural restoration of the saiga and kulan groups here in the future may be possible through their migration from the adjacent territory of Uzbekistan. Conservation of biodiversity, landscapes and ecosystems on the territory of Kazakhstan is an important condition for the long-term conservation of the entire internationally important micro-ecosystem of Southern Ustyurt. The formation of the proposed reserve will complete the formation of the highest category protected area system (category 1a according to the classification of the World Conservation Union - IUCN), ensuring the conservation of the entire macro-ecosystem of the Southern Ustyurt in the territory of all three countries. In the future, it will make it possible to nominate the system of SPNAs of South Ustyurt as a transboundary UNESCO World Natural Heritage site.

Anthropogenic threats to the project area are currently minimal. However, there is a need to address the problem of boundary wire fences, which, contrary to Kazakhstan's obligations under the Bonn Convention, prevent traditional transboundary migrations of ungulates and sometimes directly cause their deaths (Pestov *et al*. 2020).

Conclusion. The data obtained during the 2017–2019 comprehensive expedition research on biodiversity assessment in South Ustyurt formed the basis for preparing a natural scientific rationale (NSR) for establishing a nature reserve in the Kazakh part of South Ustyurt. In 2020. BPAK submitted the prepared UAS to the Committee of Forestry and Wildlife of the Ministry of Ecology, Geology and Natural Resources of the Republic of Kazakhstan. Unfortunately, as of early November 2021, the document has not yet been reviewed and approved. If approval is received by the end of that year, it is possible to obtain funding for a feasibility study to create the South Ustyurt Nature Reserve as part of the CADI project.

The creation of artificial watering places for animals based on artesian wells and provision of opportunities for transboundary migration of ungulates through the creation of passages in the boundary wire fences following the RoK obligations under the Bonn Convention on the conservation of migratory species of wild animals were recommended as specific measures to preserve biodiversity in the territory of the projected reserve. It is clear that implementing these measures will optimize habitat conditions and probably significantly increase the number of specially protected species.

With establishing the South Ustyurt gas treatment plant in Kazakhstan, forming a representative and sufficient network of national PAs in South Ustyurt will be completed, ensuring the conservation of the unique biological and landscape diversity of the region.

Acknowledgements

The authors would like to sincerely thank the CADI project management for their long-term financial support of the research in Southern Ustyurt and the preparation of NFR for the establishment of a nature reserve in the area, and BPAK for coordinating the expedition research and preparation of NFR as the main partner of the CADI project in Kazakhstan. We also thank all those who participated in the 2017–2019 expedition research in South Ustyurt and participated in processing the data obtained.

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Addressing mass animal mortality caused by permanent trenches unlawfully used to safeguard agricultural lands in southern Kazakhstan

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Key words: Reptiles, mass mortality, trenches, safeguarding agricultural lands, Southern Kazakhstan

Introduction

Mass mortality of reptiles and other vertebrates caused by permanent deep trenches used to safeguard agricultural lands in the southeast of Turkestan province of Kazakhstan was initially discovered back in 2019, when 365 reptiles of five species were found doomed to die of starvation and dehydration without the human assistance during a double survey of around ten kilometres-long trench safeguarding a farm field with grain crops in May-June, 2019 (Chirikova *et al.*, 2019).

According to the Preliminary analysis of the legislation of the Republic of Kazakhstan (RK), the use of permanent trenches to safeguard agricultural land causing mass animal mortality and destruction of fertile soil (land damage) represents a violation of a number of provisions of the Environmental Code of RK dated January 2, 2021 No. 400-VI, the Law of RK "On protection, reproduction and management of wildlife" dated July 9, 2004 No. 593-II, and the Land Code of RK dated June 20, 2003 No. 442-II. However, repeated publications in the media[b] and appeals to the state authorized bodies of RK in 2019-2020, have not resulted in real actions of officials to address this problem.

Due to COVID-19 restrictions, it was possible to obtain updated data on the impact of trenches on terrestrial vertebrate populations only in May 2021 during an international zoological expedition organized by the ASBC as part of the gazelle research and conservation project supported by the IUCN Save Our Species program. The key objective of the research was to update the 2019 data in order to prepare another reasoned appeal to the state authorized bodies to address this problem.

Methodology

Before the start of the expedition research we analysed the satellite images of the south-eastern part of Turkestan province (Keles and Saryagash districts) using the Google Earth Pro to identify as much as possible trenches safeguarding the agricultural lands, which were clearly visible on satellite images (Figures 1 and 2). In addition, one of the land plots located near the Atakonys - Jaskeshu asphalt road near the border between Saryagash and Keles districts was selected in advance for the field survey using the satellite image. The first survey of this trench fragment was conducted on May 19-21, 2021. A trench about 2 m deep and around 1.5 m wide

[b] Media: https://livingasia.online/2020/06/03/poisk-vyhoda-iz-smertelnoj-lovushki/

surrounds a plowed field of about 4,700 ha (Figures 3 and 4). The soil excavated from the trench forms an embankment about 3 m wide and about 1 m high. The total length of this trench is about 36 km, of which 7 km were surveyed. Obviously, this trench was excavated at least a year ago, as ruderal vegetation is present on its bottom. The following annual species were found: *Eremopyrum orientale*, *Eremopyrum triticeum*, *Aegilops cylindrica Spinacia turkestanica*, *Bromus sp.* An unpaved road runs along the trench at a distance of 2-3 to 50-100 m (Figure 3).

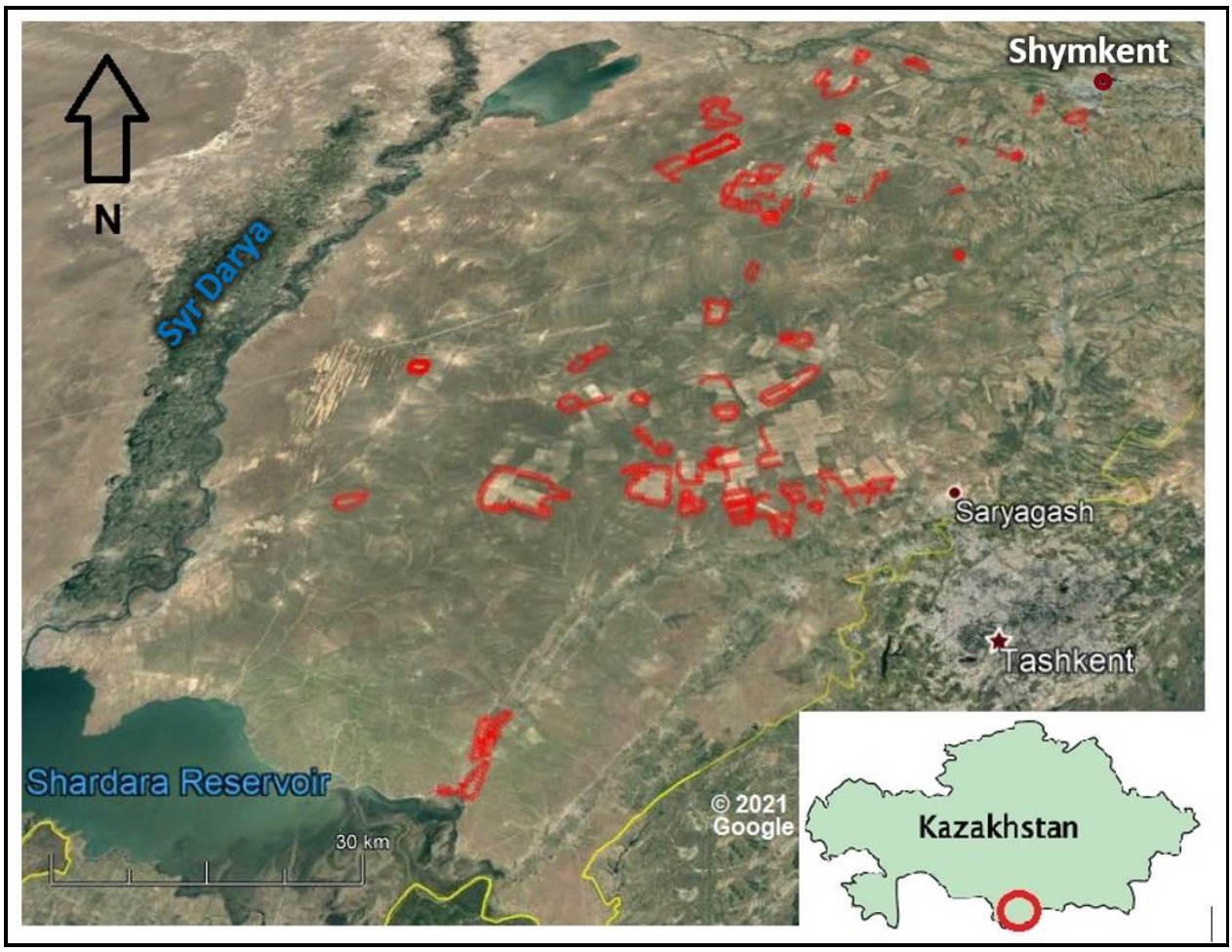

Fig. 1. Localization of land plots unlawfully safeguarded with trenches in the Turkestan province (Southern Kazakhstan), visible from space (total length - at least 800 km). Red lines: trenches. Yellow line: state border between Kazakhstan and Uzbekistan.
Map of Kazakhstan: (Cartography: Google Earth). [online]. [Cited 3 January 2022]. https://earth.google.com/web/@41.44370832,69.11130154,413.18028482a,28070.92533819d,35y,0h,0t,0r, modified to comply with UN. World map (2022)

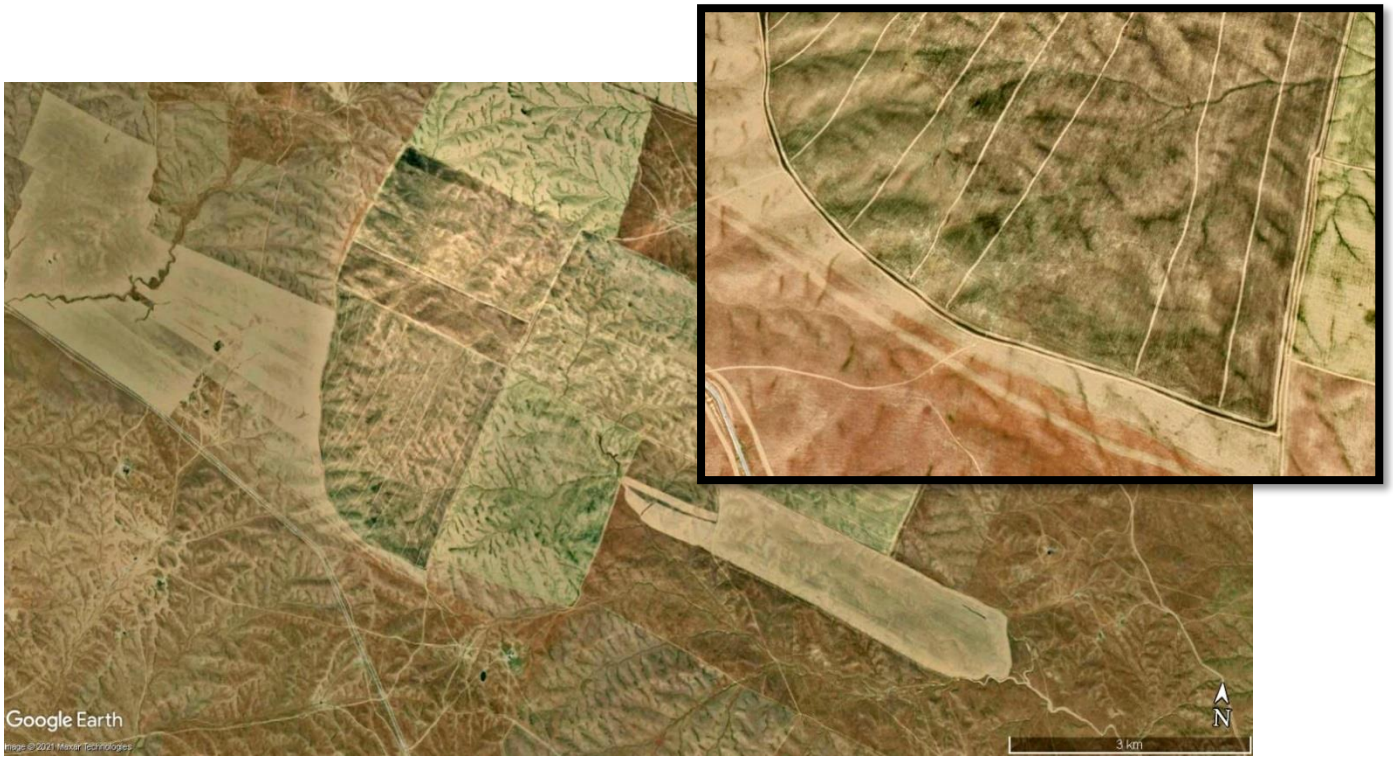

Fig. 2. Land plots unlawfully safeguarded with trenches are clearly visible on satellite images (Cartography: Google Earth). [online]. [Cited 3 January 2022]. https://earth.google.com/web/@41.44370832,69.11130154,413.18028482a,28070.92533819d,35y,0h,0t,0r

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Fig. 3. A section of an unlawful trench to safeguard the field (on the right) from cattle grazing.

In the course of the survey, the researcher descended to the bottom of the trench and moved in the selected direction, checking all available hiding places: niches, burrows, clumps of ruderal vegetation, etc. Along the way, he noted and, when possible, collected all vertebrate animals, both alive and dead, which he put in bags and periodically passed to his colleagues on the above to identify their species and their subsequent return to natural habitats at a sufficient distance - at least 4-5 km away from the nearest trenches (Fig. 4).

The trench was re-inspected on June 8-9, 2021, when a section of about 15 km was examined.

© FAO/M.Pestov. Fig. 4. Til Dieterich handing over the tortoises and glass-lizards he collected in the trench to back to the surface.

Results

In May, during a thorough survey of a 7 kilometres-long trench, which was randomly selected from among satellite images, safeguarding the farm lands at the junction of the borders of Saryagash and Keles districts of the Turkestan province (the total length of the trench is 36 km), we discovered 272 reptiles (on average – 38.9 specimens per 1 km of trench), including 184 Central Asian tortoises *Testudo horsfieldii* (the species is listed in the IUCN Red List, VU - vulnerable), 27 European glass lizards (the species is listed in the Red Book of the Republic of Kazakhstan), 45 steppe-runners *Eremias arguta*, 15 Tartar sand boas *Eryx tataricus* and one spotted whip snake *Hemorrhois ravergieri*, as well as an active African wildcat and the remains of seven foxes, three sheep and one foal. During the survey, 16 tortoises, two glass-lizards and two sand boas were found dead. The obvious causes of death were overheating, dehydration and lack of food. It is worth mentioning again that all reptiles and most mammals which fall into the trenches are unable to climb up and are doomed to death. Probably the only exception is the African wildcat and perhaps, in some cases, foxes.

We retrieved all live reptiles from the trench and released in suitable habitats at least 5 km away from the nearest trenches. Numerous feeding tortoises were also observed in the area near the trenches on these days in the morning and evening (before the maximum air and soil surface temperatures).

In June (08.06.2021), a section of the trench previously examined in May was re-examined. As a result, 14 live and three dead tortoises and one glass-lizard were found. The next day (09.06.2021), an inspection of another 8 km of the same trench found only three dead tortoises. No active tortoises were found in the area near the trenches. Apparently, by the end of the first decade of

June, all tortoises had already dug into burrows and went into seasonal hibernation due to increase in daytime temperatures and disappearance of ephemeral vegetation, which generally is in line with literature data (Bondarenko and Peregontsev, 2018).
Summarized results of the two-time trench survey are given in Table 1.

Table 1. Results of two-time survey of a trench section of about 7 km around a farm field in the south-eastern part of the Turkestan province in May and June 2021.

Animal species	May 2021		June 2021		Total	Number of specimens per 1 km of trench
	Live	Dead	Live	Dead		
Central Asian Tortoise *Testudo horsfieldii*	168	16	14	-	201	28.7
European glass lizard *Pseudopus apodus*	25	2	1	-	28	4.0
Steppe-runner *Eremias arguta*	45	-	-	-	45	6.4
Tartar sand boa *Eryx tataricus*	13	2	-	-	15	2.1
Spotted whip snake *Hemorrhois ravergieri*	1	-	-	-	1	0.1
Total reptiles: 5 species	252	20	15	-	287	41.0
Long-eared Hedgehog *Hemiechinus auritus*	-	1	-	1	2	0.3
African wildcat *Felis lybica*	1	-	-	-	1	0.1
Fox *Vulpes vulpes*	1	7	3	-	11	1.6
Sheep *Ovis aries*	-	3	-	-	3	0.4
Horse *Equus caballus*	-	1	-	-	1	0.1
Total mammals: 5 species	2	12	3	1	18	2.6

Source: Author's own elaboration.

In the next two days (10-11.06.2021), small sections (from 300 to 500 m) of trenches safeguarding more than 20 plots of agricultural land located in different parts of Saryagash, Keles, Arys and Kyzygurt districts of Turkestan province were examined. All sections were also pre-selected on Google Earth Pro. The main purpose of this express inspection was to confirm the real presence of trenches, unlawfully used for safeguarding land plots. The results of satellite image analysis were confirmed in about 90 percent of cases. In the remaining three cases, the trenches were "old", with crumbling walls, or were used for land reclamation as ditches and did not pose an increased danger to animals. No live animals were found in these trenches, but several dead tortoises, a foal and a donkey were discovered.

In Keles and Saryagash districts, we identified the cases of using fences of various designs to fence agricultural land (Fig. 5), which clearly confirms the existence of alternative options for safeguarding agricultural land, excluding mass animal mortality when using permanent deep trenches.

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Fig. 5. Fence section used in Keles district to safeguard agricultural land plot is a positive alternative to trenches.

Discussion. Keles and Saryagash districts of Turkestan province located along the state border of Kazakhstan and Uzbekistan are densely populated; both livestock breeding and agriculture are actively developing here, which determines a high degree of anthropogenic transformation of natural ecosystems. The total area of arable land is currently about 99.5 thousand hectares (13.1 percent of the total area of the districts) and, obviously, continues to increase (On Approval of the Plan..., 2020).

According to our updated estimates obtained using GIS, the total length of trenches unlawfully used to safeguard the agricultural lands in the south-eastern part of the Turkestan province (to the south of Shymkent city) is at least 800 km (Fig. 1).

Obviously, our surveys give somewhat underestimated results: obviously, some of rodents, snakes and lizards in trenches are eaten by terrestrial and, possibly, aerial predators (foxes and steppe cat), which is confirmed by finding of partially eaten Tartar sand boa. Considering the data received by us from selective inspection of trenches - about 40 individuals of reptiles per 1 km of a trench - it is possible to assume confidently, that the quantity of reptiles, annually dying in trenches in territory of Turkestan province, can reach some tens of thousands of individuals. Obviously, the results of trench inspections are very dependent on season.

The cases of domestic animal deaths in the trenches such as sheep, horses and donkeys deserve special attention. According to local residents, such cases are observed regularly, which causes significant damage to livestock farmers, causes their serious concern, and appeals to the state authorized bodies.

In addition to the problem of unlawful use of permanent trenches causing the death of a huge number of animals, including species included in the Red Book of Kazakhstan, there is a problem of quite legal destruction of vast areas of desert ecosystems during the plowing of virgin and fallow lands.

In the spring of 2021, thanks to the organizational support of the Akimat's staff and personally S. A. Kalkamanov, Deputy Akim of Turkestan province, the problem of the unlawful use of trenches for safeguarding agricultural lands caused wide public outcry this time: a film crew of the regional television, accompanied by 15 volunteers, came directly to our workplace in the trench to help rescue animals, as well as the staff of the Land Inspection Department of Turkestan province. Later, we also met with a representative of the Provincial Territorial Inspectorate for the Protection of Wildlife.

Shortly after our meeting with representatives of the Land Inspectorate, they promptly began issuing orders requiring landholders and landowners to remove the trenches. In case of non-compliance, sanctions are possible up to the termination of land lease agreements. As a result, in June 2021, the process of trench removal began, which was confirmed by our personal observations (Fig. 6) and reflected in the media[c].

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Fig. 6. Process of removal of trenches unlawfully dug to safeguard the agricultural land in Saryagash district of Turkestan province. 10.06.2021.

In an official response dated 26.08.2021 to a request sent by ASBK to the Land Inspectorate of the Turkestan province, it is reported that the owners of 145 plots unlawfully safeguarded with trenches were issued orders to bring them to administrative liability for violations under Article 65, paragraph one, subparagraph nine of the Land Code of the Republic of Kazakhstan. As of the end of August 2021, trenches were eliminated around 66 land plots. In addition, akimats

[c] Media: https://www.youtube.com/watch?v=_roxKoXBMaQ

mobilized volunteers to rescue animals from trenches. Unfortunately, the results of these activities are not known.

Conclusions

Thus, as a result of successful interaction between biologists, public organizations (ASBK), the management of the Akimat of Turkestan province, state authorized bodies and the media, in 2021, real actions to address the problem of unlawful use of permanent trenches for safeguarding agricultural land in the south of Turkestan province have begun. Obviously, it is necessary to continue monitoring the situation in the Turkestan province and clarify the situation in other provinces of Kazakhstan, widely implement the practice of rescuing animals from trenches before their liquidation and, possibly, make amendments to the regulatory framework of the Republic of Kazakhstan, including a direct ban on the use of permanent trenches for safeguarding agricultural land to comprehensively address the problem of mass animal mortality due to trenches.

We also believe it is necessary to put in place a mechanism for compensating direct damage to biodiversity due to irreversible transformation of natural ecosystems and destruction of their components, arising in the process of plowing virgin and fallow lands based on the example of the Turkestan region. Obviously, the work of many specialists at the national level is required to assess the impact of agriculture on biodiversity and develop measures to minimize this impact. In this regard, we plan to send a corresponding request to the Government of Kazakhstan.

Acknowledgements

The authors express their heartfelt gratitude to:

Mr. Saken Amangeldievich Kalkamanov, Deputy Akim of Turkestan province - for administrative support and assistance in organizing interaction with state authorized bodies;
Ms. Vera Vladimirovna Voronova, Director of the Kazakhstan Association for Biodiversity Conservation (ASBK) - for establishing official contacts with the Akimat of Turkestan province and state authorized bodies;
Heads of the IUCN Save Our Species program and the Nature and Biodiversity Conservation Union (NABU) for financial support of expeditionary zoological research in Southern Kazakhstan in 2021;
Volunteers - for their participation in rescuing animals from the trenches.

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Conservation value and need for special protection of northern Ustyurt in Atyrau Oblast (Kazakhstan)

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Keywords: Northern Ustyurt, Donyztau Chink, Atyrau Oblast, Kazakhstan, biodiversity, protected areas

Introduction

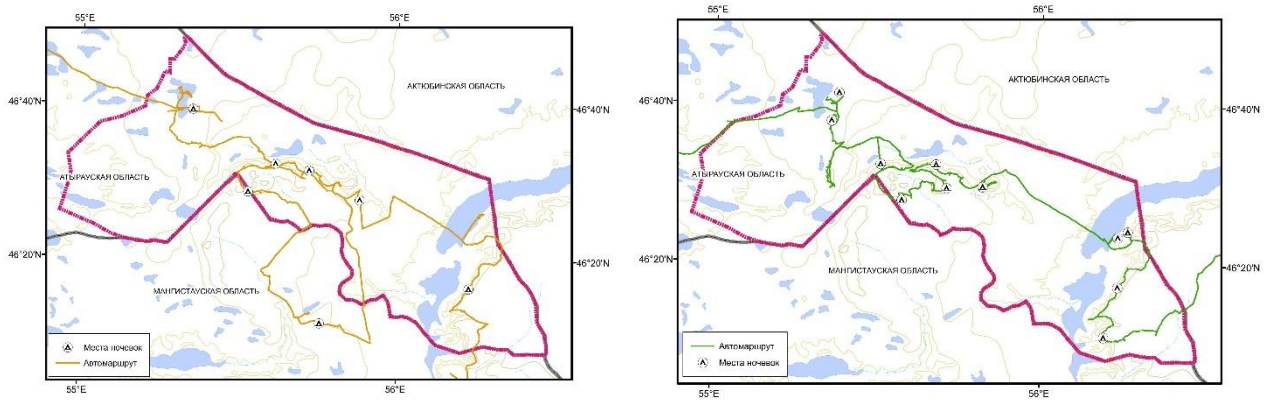
Atyrau oblast of Kazakhstan is located mainly within the Caspian lowland, with its eastern part also entering the Podural plateau. A flat terrain characterises the oblast's territory with a predominance of flat, gentle-sloping and gentle-swollen plains. There are relatively greater height differences and contrasts in relief in the area of the Baer knolls on the Caspian coast and the slope of the Podural Plateau, but sharp relief forms are virtually absent there too.

The only exception is the south-eastern ridge of the region, which is administratively part of the Zhylyoi region and covers a relatively small area of Northern Ustyurt. It includes the western end of the Donyztau chink, the Zheltau tabletop, and the Sholkar ridge, which serves as the northern end of the Kolenkeli chink ridge (located in the territory of the Mangistau oblast already).

Only here within Atyrau oblast typical for Ustyurt plateau relief forms are spread, first of all - table plateaus with characteristic elements of chinks relief - steep, precipitous erosive slopes, formed by ancient marine abrasion and large landslides, with deeply incised "bays", a series of residual ridges sloping away from the main slope, and residual table uplands - turtles (Atlas..., 2014).

Methodology

In 2017–2019, we surveyed the flora, vegetation, vertebrate fauna and nesting population of large raptors of the Northern Ustyurt area within the Atyrau region. Standard methods of zoological and botanical research were used. Flora and vegetation survey was conducted by vehicle and pedestrian routes supplemented by descriptions of 18 geobotanical plots of 100 m2 each. Data on species composition, spatial distribution, biotopic distribution, amphibians, reptiles, birds and mammals were also collected along the road and pedestrian routes in May, June and September. The total length of road routes for the survey was over 600 km, the total length of daytime walking routes was over 100 km, and night-time (overnight sites) was approximately 10 km (Figure 1).



(a) (b)

Figure 1. Vehicle routes, long overnight and day sites during the zoological and botanical survey of the proposed North Ustyurt Nature Park: (a) in May 2018, (b) in June 2018. Map Source: Google Maps, modified to comply with UN. World map (2022).

We also used data from photo traps installed at 20 points on the chinks working in the study area during 2018–2019 and in the adjoining territory of Aktobe oblast in 2017–2018. The total recording effort of the camera traps was 2807 trap-days in Atyrau oblast 2,341 trap-days in Aktobe oblast for 5148 trap-days.

The information on small mammals was based on archive materials of the Atyrau anti-plague station (APS), collected from 2008 to 2017 in the south-eastern part of the Zhylyoi district of the region during a planned epizootological survey of this area by the zoogroup of Zhylyoi anti-plague department of the APS. During this period, they captured and identified 5,160 small mammals in 31 locations, more or less evenly distributed in the territory in question and its immediate vicinity.

Data on the economic use of the territory were obtained from public information sources: materials of the Bureau of National Statistics of the Agency for Strategic Planning and Reforms of RK, interactive map of the Land Cadastre Department and AIS of SLC of the Land Cadastre Department of the State Corporation "Government for Citizens" non-commercial joint-stock company (http://www.aisgzk.kz/aisgzk/ru/content/maps/), Interactive Map of the Committee for Geology and Subsoil Use (https://gis.geology.gov.kz/geo/).

Results and discussion

The peculiarities of relief and geological history have determined the unusual character of landscapes and ecosystems in this part of the Atyrau oblast (Figure 2).

(a)

(b)

(c)

(d)

Photos a-d: © FAO

Figure 2. Landscapes of Northern Ustyurt in the Atyrau Region: (a) clay ledges of the upper tier of the Tamdy remnant chink; (b) cliff and breakdown of limestone armour plate blocks in the upper tier of the Zheltau cliff; (c) lower tier of the Donyztau cliff and (d) lower tier of the Zheltau cliff.

Only here the middle desert sub-zone is included within the region's boundaries, while the rest of the territory lies within the semi-desert and northern desert sub-zones. Accordingly, this is the only part of the oblast where grey-brown desert soils occupy a zonal position in the soil cover. Only here in Atyrau oblast black-brown desert soils common for more southern and eastern regions are spread. Only here there are typical for Ustyurt chinks petrophytic desert communities formed by a specific set of plant species (*Zygophyllum turcomanicum*, *Onosma staminea*, *Haplophyllum versicolour*, *H. obtusifolium*, *Inula multicaulis*, *Gypsophila diffusa*, *caudex species Anabasis* and others) and petrophytic communities with Arthrophytum lehmannianum dominating (Figure 3).

(a)

(b)

(c)

(d)

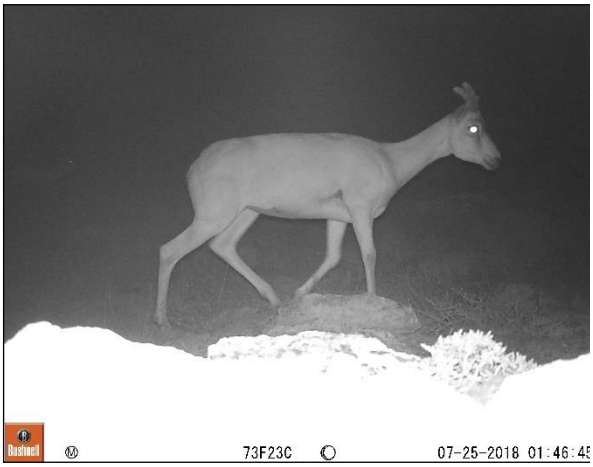
Photos a-d: © FAO

Figure 3. Some plant species in Northern Ustyurt in Atyrau oblast: (a) *Arthrophytum lehmannianum*, (b) *Onosma staminea*, (c) *Inula multicaulis*, (d) *Zygophyllum turcomanicum*.

The peculiarity of landscapes and spatial relationship with the deserts of Ustyurt explain a number of unique for the Atyrau region features of vertebrate fauna. For instance, within the boundaries of the oblast, only the cliff subspecies of saker falcon (*Falco cherrug korelovii*) (Pfeffer, Karyakin, 2010) (Figure 4a), the long-eared urchin (*Paraechinus hypomelas*, previously known in Kazakhstan only for Mangistau oblast) (Figure 3b) and the pallasian snake (*Elaphe sauromates*) (Figure 4c) are found here. It is the only place in the province (and generally in Kazakhstan outside Mangistau) where Ustyurt urial (*Ovis vignei arkal*) occurs (Figure 4d) and the main habitat of the Ustyurt saiga (*Saiga tatarica*) population in Atyrau province.

(a)

(b)



(c)

(d)

Photos a-d: © FAO

Figure 3. Some vertebrate species in Northern Ustyurt in Atyrau oblast: (a) saker falcon (troll at the nest), (b) long-eared hedgehog, (c) Ustyurt urial, (d) Pallas' snake.

In addition to these striking features of fauna, the Ustyurt section of the region is also notable for the diversity and abundance of vertebrate species included in the Red Book of the RoK. In particular, viable breeding groups of the golden eagle (Aquila chrysaetos), Imperial Eagle (*A. heliaca*), steppe eagle (*A. nipalensis*), saker falcon and eagle-owl (*Bubo bubo*) are maintained in this section of Northern Ustyurt. These bird species are widespread but scarce and vulnerable everywhere, and the area is of particular importance for their conservation in the region.

Overall, according to the literature (Belyalov, 2014; Gubin, 2015; Karyakin *et al.*, 2005, 2008, 2009, 2011; Kireev, 1981 *et al.*) and according to the results of our inventory works of 2017–2019, about 230 species of higher plants are shown to grow in the territory in question, 28 mammal species (including urial and long-eared urchin have not been previously recorded for North Ustyurt), at least 128 bird species (including 22 species not previously recorded in the region), 12 reptile species and one amphibian species. Of this number, at least 11 bird species, at least two-three animal species, and one reptile species are included in the Red

Book of Kazakhstan. According to our estimates, based on extrapolation of the results of surveys, about seven pairs of Golden Eagle, 15 pairs of Eastern Imperial Eagle, 30 pairs of Steppe Eagle, eight pairs of Saker Falcon and 30 pairs of northern owl are supposed to nest here.

Being unique for Atyrau oblast, the considered area of Northern Ustyurt is typical for this natural region and can be considered a reference in many respects. All main types of relief, characteristic ecosystems and plant communities of Northern Ustyurt (including hypsophytic clay deserts on the bozengen, petrophytic deserts along the ridge of chink, extrazonal shrub-steppe communities in chink bogs, wormwood and boyaly deserts and pyrogenic tirsik desert steppes on the plateau, etc.), typical flora and fauna are represented here.

Additionally, it should be noted that there are numerous traces of biodiversity of past geological eras - paleontological monuments of ancient seas of scientific and tourist interest - preserved in the characterised area.

In addition to its natural value, the area has outstanding cultural value. There are some necropolises and cult complexes of the XVIII-XX centuries, revered graves of saints (the most famous is Sherligul grave), many barrows and sanctuary of the early Iron Age (VIII-III centuries B.C.). It is also the only place in Atyrau oblast where one can see arans - geoglyphs, monuments of ancient hunting and cattle-breeding culture found in Ustyurt, Mangistau and Turgai (Barge *et al.*, 2016).

In the historical past, the main anthropogenic pressure on the desert and landscape-related various intraoral ecosystems of the Northern Ustyurt was determined by the use of the territory for cattle grazing. The widespread overgrazing led to the degradation of ecosystems and the predominance of the desert component in semi-desert complexes. Despite the significant area and depth of these changes, they remained reversible, were not associated with a long-term disturbance of the relief and hydrological regime (except for areas of irrigation in the Predusturt depression) and were mainly reduced to a change in the territorial balance between communities of northern deserts and desert (desolate) steppes.

After the collapse of the USSR and the collapse of the economy in 1991, there was a rapid and significant reduction in the number of livestock. Including in the Zhylyoi district, the number of sheep decreased fourfold between 1992 and 1995, and in the XXI century, it is kept half or three times lower than in 1990. The number of wintering, zhailau and artesian wells has also decreased considerably. The reduction in grazing pressure has been particularly marked in remote and inaccessible parts of the area - in large parts of the Ustyurt "corner", there has been an almost complete cessation of grazing for long periods. As a result, large-scale restoration of ecosystems occurred in Northern Ustyurt, a significant increase in the frequency and area of landscape fires and the associated change of some variants of northern deserts to pyrogenic desert steppes. At present, cattle ranching does not pose a serious threat to ecosystems here (although it remains a cause of localised degradation around pens and watering places).

A much greater risk to biodiversity is associated with the prospect of industrial and infrastructural development in the region - primarily due to the development of hydrocarbon production. Atyrau oblast is known for its large oil and gas deposits. Their exploration and production are the main focus of the region's economy. Development of

North Ustyurt in the region began in the 1970s-80s but was hampered for a long time by the region's difficult access and other costs. However, the situation is now changing. Infrastructure development (roads, railways, pipelines, etc.) and the oil and gas sector are mutually conditioning and accelerating each other, which creates the risk of degradation of not local areas, but of entire vast territories, with the possible loss of certain types of ecosystems and landscapes. At present, the area under consideration in North Ustyurt is divided by about 80 percent of the area between five contract areas for exploration or production of minerals - hydrocarbons (HC) or groundwater (GW). The largest of these are Kosbulak (subsoil user KazAzot LLP) and Sholkara-Akkuduk (IPC-Munai LLP). All contract areas are still under exploration (or only planned). The fields may not be prospective and will not be developed. However, there is a risk of a different outcome.

An additional risk factor is the recent construction of the Beyneu-Shalkar railway line, significant improvements in the Atyrau-Aktau and Borankul-Beyneu roads and the commissioning of the Beineu-Bozoi-Shymkent gas pipeline. These highways pass outside the area in question but are relatively close to it (40-100 km) and could significantly affect the profitability of field development.

The level of poaching is also important for the fate of some rare and vulnerable vertebrate species in Northern Ustyurt (primarily the Ural, saiga and saker falcon). It has not been quantified, but poaching is known to occur here and may have a significant negative impact on the populations of these species.

Conclusion
All of the above determines the need to pay special attention to measures for conserving the natural ecosystems of Northern Ustyurt, protecting their key animal and bird species, and protecting traditional livestock use of desert and semi-desert landscapes. With low wintering densities, semi-nomadism and grazing norms, the latter do not threaten Ustyurt ecosystems and can be regarded as part of a long-established natural and economic complex.

First, the most vulnerable and valuable area needs protection - the cliff band is understood broadly as the plateau slope line itself with the residual uplands (turtles) and wide, flat-bottomed depressions between them. Many rare and endangered animal and plant species are concentrated in the cliff zone, including such iconic species of Kazakhstan as saiga antelope, Ustyurt urial, saker falcon, all three species of true eagle and owl. Not necessarily related to chinks, but also found in this strip are Houbara bustard, two grouse species, Sage grouse and Pallas's grosbeak.

The only effective way to ensure their conservation, as defined by the current legislation of the RoK, is to establish a specially protected natural area. Given the already established complex structure of property rights to land and subsoil, and taking into account the scenic, cultural value and tourist attraction of the area, the best solution would be to create a regional nature park or national park with a protected area around it and recreational zoning of the area.

Within the framework of the CADI (Central Asian Desert Initiative) project, since 2017, negotiations with the leadership of the Atyrau region on the creation of a nature park are underway. In 2021, with the Ministry of Energy of the RK, a dialogue with most companies - subsoil users operating in the territory had been initiated. It is planned to prepare a natural

scientific rationale (NSR) to create the natural park by spring 2022. In case of effective support of the Oblast administration, the documentation for creating the North Ustyurt Park may be completed by the end of 2022.

Acknowledgements
The authors would like to thank CADI and BPAK for their support and participation and all those who participated in the field surveys and data processing.

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Stability of protected areas is key for the sustainable use of deserts in Uzbekistan

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Key words: Deserts, ecology, system, protected areas, stability, effect.

Introduction and key objectives.

Protected Areas (PA) - areas of land and/or water space with priority ecological, scientific, cultural, aesthetic, recreational and sanitary-hygienic value, fully or partially, permanently or temporarily withdrawn from economic activity. They are created to conserve, reproduce, and restore nature complexes and objects by establishing a regime of their protection and use [1]. PAs constitute an integrated ecological system designed to ensure biological and landscape diversity and to maintain ecological balance. The system is currently incomplete and not efficient enough, it includes seven categories of PAs. The system may also include biosphere reserves, national parks, and interstate protected areas [1]. The area of land category for nature protection purposes is 732 thousand hectares [2].

The system's low efficiency is caused by inadequate powers of the management of PAs which have a status of a legal entity, while PAs without legal entity status have practically no real powers to manage and protect. A number of PAs do not have preserved areas in their structural plan, and the financial resources allocated for their activities are inadequate as well. Many PAs do not have or do not implement their management plans for various reasons; there is practically no system for their efficiency evaluation. There is weak institutional staffing, while the protection regime of protected areas is violated by their employees, and local population. Local authorities and public organizations do not pay due attention to the development and activities of PAs. As a result, many PAs are unable to operate stably, and the PA system as a whole is not efficient enough and does not fully serve its purpose.

Taking the foregoing into account and a number of other shortcomings in the management and activities of the country's PAs, we believe it is necessary to investigate the causes of their unsustainable activities and develop effective measures to eliminate negative factors or reduce their negative impact on the efficiency of the activities of individual PAs and the system as a whole.

Research

The PA system is dynamic, evolving and manageable. The selected PA categories form a subsystem of the first level, and individual PAs form a subsystem of the second level, which should be given due credit in planning the management of the system. PAs are the primary elements i.e. units of the system. Protected areas are areas of land (or water space) completely or partially, permanently or temporarily withdrawn from economic exploitation. They are created with or without establishing a legal entity. PAs can have a structural zoning of the territory with a preserved area, a preserved area without zoning of the territory, without zoning of the territory and without preserved areas.

The dynamic and evolving nature of the system indicates at quantitative (an increase in the number of PAs, the area of the system) and qualitative changes in the system. The manageable nature of the system indicates at the need to regulate the processes of development and activities of the system.

An important concept of a PA system is its stability. Stability in natural, economic and other systems is understood as a balance of system-building and system-destroying forces [3].

The PAs, as a rule, are created (located) on the territory of other systems. In a desert natural and climatic zone, for example, PA land areas are often pasture and forest land (pasture and forest systems). In this regard, both the internal forces of the PA system and the external forces of adjacent systems affect the PA system (including each of its primary elements). In this regard, both internal and external forces are the causes destabilizing the PA activities. The need to eliminate the impact of negative forces on the PAs dictates the need to study and prevent (or reduce) the negative impact of destabilizing causes of both internal and external nature.

Practice shows that the established regime of protection and use is observed mainly for core PA zones, for which land plots have been provided for permanent or temporary use. In all other zones of all PA categories, which are located on lands of other economic entities or on lands not provided for use to anyone, the regime of protection, use and management is not adequate. First, the PA management (if available) does not have enough real powers to manage the preserved, buffer, transition and third (resort natural areas) zones. They have no powers to enforce compliance with the regime of these zones upon legal entities and individuals who have been granted these land plots. Second, legal entities and individuals on whose land plots PAs are located have virtually no incentive or interest in complying with the zone regime. Third, practice shows that the provision of Article 7 of the Law "On Protected Areas" on the withdrawal of land plots from legal entities and individuals who do not fulfill their duties to protect PAs is not implemented in reality. Fourth, intensive economic activities (e.g. agricultural activities) are often carried out in these zones without proper control of local authorities, citizens' self-government bodies, and non-governmental non-profit organizations to ensure the zone protection regime. Particularly unsystematic is the grazing of private cattle on pastures in the desert natural and climatic zone, which damages the lands of PAs without fencing. Fifth, the worst situation is with PAs without legal entity status and are located on vacant (or reserve category) lands, despite the fact that that legally the functions of protection are assigned to specially authorized state bodies.

The main destabilizing internal and external causes (forces) are shown in Tables 1 and 2. They are of organizational-economic, ecological and legal nature. PAs and their system may be stabilized by introducing innovative and market mechanisms, which mitigate or eliminate the negative impact of these forces.

In the economic context, first of all, it is required to modernize the ecological system of PAs, including the land cadaster and monitoring, based on investment and innovation. It includes optimization of organizational structure of the system and technical, informational, organizational, and economic, environmental, technological, legal aspects of its management. It is necessary to commercialize research and innovative solutions in the field of protection and use of protected areas. Innovative activities should pursue not only the

stabilization of PAs, but also the development of environmentally-friendly technologies for the use of natural resources with their further introduction into agriculture. Additional income should be made available from the use of land and water resources in protected areas and its part (reasonable percentage) should be directed to self-financing of institutions through these technologies and creation of “green economy” zones. It is necessary to intensify the creation of private reserves and nurseries.

Table 1

Internal destabilizing forces and recommended measures to mitigate or eliminate their impact on PAs

No.	Internal forces (causes) that have a negative impact on the PA activities	Recommended measures to stabilize the PA activities
1	2	3
1.	Lack of research on the development of environmentally friendly agro-technologies of land and water use in areas with permitted economic activities.	Strengthen innovative activities in research institutes of the industry based on the necessary investments.
2.	Lack of scientific and methodological bases for the creation of agricultural "green economy" zones	Provide recommendations for the creation of agricultural "green economy" zones in preserved (including buffer and transition) zones.
3.	Lack of preserved zones and quality protection of PAs in some types of PAs.	It is recommended to create preserved areas for all categories and types of PAs to ensure quality protection.
4.	Lack of real powers of PA administration to take measures to prohibit violations in the use of natural resources in areas where activities of other business entities are permitted.	It is recommended to provide land plots for buffer zones of SBRs for permanent use. Encumbrances for the protection of PA land plots provided for use by other business entities should be set in the Land Code, providing for liability for violation of this provision, including compensation for damage caused to the PAs.
5.	Lack of quality protection in PAs without legal entity.	Enforce compliance with protection according to the departmental affiliation of the PA.
6.	Insufficient funding of PA activities from non-budgetary sources. The sources of funding listed in Art. 48 of the Law "On Protected Areas", except for the state budget and the Environment Fund, are essentially advisory in nature and their revenues are not significant.	Establish by law that part of the additional income of economic entities from introduction of environmentally-friendly and resource-saving technologies, optimization of the structure of land plots and sown areas, increase in land productivity and other innovations shall be directed to the PA account in the form of interest.
7.	Failure to comply with the protection regime and restrictions on the use of natural resources by business entities in PA zones.	Enact provisions enforcing compensation on business entities for damage caused to the PA. Develop an assessment scale for the effectiveness of PA activities.
8.	Inadequate technologies of use of natural resources in the PA zones with permitted economic activity.	Prohibit by law the use of harmful technologies of land cultivation and crop management, which cause damage to PAs, and enact provisions enforcing compensation on business entities for damage caused to PAs.
9.	Low efficiency of land and water use in zones with permitted activities	Business entities shall fully use environmentally-friendly and resource-saving technologies
10.	Lack of modernization of organizational and functional structures of PA system.	Modernize the ecological system of PA, its organizational and functional structures.

Table 1 continued

1	2	3
11.	Violations of mechanized cultivation and irrigation technologies in zones with permitted economic activities, but with environmental restrictions.	Eliminate violations in existing land cultivation technologies, constantly monitor the condition and use of land in preserved areas, and introduce penalties for causing damage to PAs.
12.	Lack of proper reproduction of soil fertility by biological methods	Enforce restoration of soil fertility through the Land Code and the Law on Protected Areas. Impose penalties for damage PAs.
13.	Lack of proper fencing of PA land plots	
14.	Failure to implement Management Plans by a number of Pas	Make annual reports on the implementation of PA Management Plans mandatory.
15.	Lack of measures to combat natural resource degradation in the PA Management Plans.	Include combating natural resource degradation section in the PA Management Plans and cost estimates for these purposes on a mandatory basis.
16.	Lack of land management in PA zones, where economic activities are permitted.	In creating PAs and their activities, make it mandatory to carry out land management of the territories of their zones with permitted economic activities.
17.	Lack of pasture rotation, unsystematic livestock grazing in PAs of the desert natural and climatic zone	Land management of pastures in protected areas should provide for the introduction of pasture rotation and systemic grazing.
18.	Harvesting wild plants in forest covered PA zones (not core) is in violation of the activities of the forestry enterprises, which are the economic entities in these PA zones. The same is true for the PAs located on the pastures of the forestry enterprises.	It is necessary give right to forestry enterprises as economic entities in the PA zones, but not PAs, to harvest wild products in the forests. The same is true for pasture use.
19.	Lack of PA KPI system	It is necessary to develop a KPI system for PAs and the network as a whole.
21.	Inadequate implementation of land legislation in terms of the use of pastures in the PA zones in the desert natural and climatic zone.	Increase liability for violations of land legislation in terms of the use of pastures in the desert natural and climatic zone.
22.	Weak staffing of many PAs.	Strengthen training of specialists and create favorable employment conditions in PAs.
23.	Lack of interest by local communities in sustainable use of PA pastures in the desert natural and climatic zone.	In case of use of PA pastures by local people, enforce the rules of land reproduction, systemic grazing on pasture rotation on them.

Source: Author's own elaboration.

Table 2

External destabilizing forces and recommended measures to mitigate or eliminate their impact on PAs

No.	External forces (causes) that have a negative impact on the PA activities	Recommended measures to stabilize the PA activities
1	2	3
1.	Poor knowledge of the impact of PA ecological system on sustainable use of desert lands in the context of modernization of pasture and forest land use systems.	It is necessary to significantly increase the number of PAs and the area of the network (up to 15-20 percent of the area of deserts in the country), strengthen investment and innovative activities.
2.	Lack of modernization of PA ecological system, aspects of the system and individual PA management.	Provide for modernization of PA ecological system through technical and technological re-equipment.
3.	Lack of consistency in the areas of PAs and the entire ecological network according to the State Committee for Ecology and the Cadaster Agency.	The State Ecology Committee should include in the PA area only those land plots which had been provided to them under permanent or temporary use.
4.	Lack of real powers of PA management (if any) to hold liable those who violate the regime of use of land and other natural resources in the PA areas.	Grant powers to the PA management to take comprehensive measures to prevent violations in PA zones.
5.	Lack of mechanism for monitoring the impact of global climate change on the system and certain PA types.	It is necessary to strengthen research in this field.
6.	Impact of demographic factor on anthropogenic pressure on natural resources in PA zones.	It is necessary to balance the land (soil) productive capacity and the impact of the demographic factor.
7.	Insufficient compliance of local authorities, local self-government bodies and NGOs with environmental requirements in PA zones.	Hold accountable those failing to fulfill their functions of protection of PAs.
8.	There is no withdrawal of land plots from legal entities and individuals who do not fulfill their duties on PA protection.	Strengthen the relevance and practical implementation of Art. 7 of the Law "On Protected Areas"
9.	Lack of logistical capabilities of PAs to conduct full and prompt land survey and monitoring using aircraft.	Investments are needed in innovation and modernization of the logistical support of PA's ecological network.
10.	Inadequate funding of PAs from state budget.	Replace part of state budget funding with extra-budgetary funds.
11.	Insufficient creation of private PAs.	Strengthen awareness-raising activities among the population and nature management specialists on the creation of private PAs, and simplify organizational procedure for their creation.

12.	Inadequate staff training in the field of nature management, ecology and PAs.	Provide university courses in these fields.
13.	Inadequate engagement of PAs with local population on adjacent areas.	Awareness-raising among the population on environmental policy of the state.

Source: Author's own elaboration.

It is necessary to substantiate the optimal ratio of areas of PA zones. In PA zones with permitted economic activities, it is necessary to carry out land management, including in PAs on pasturelands. It is advisable to include a section on combating and preventing land and vegetation degradation in PA management plans. It is necessary to strengthen traditional forms of commercial activities, including ecotourism, hunting sports, shooting of excessive animals in PAs, advertising activities, etc. As for harvesting wild forest products, this type of economic activity is the prerogative of the forestry enterprises on whose lands the PAs are located.

In the environmental context, for areas of protected areas with permitted economic activities the key is the priority consideration of the impact of environmental factors on the protection and use of natural resources. Use of mineral fertilizers and pesticides in soil and crop cultivation needs to be prohibited, mechanized tillage be reduced to a maximum, innovative methods of crop irrigation be adopted, intensive crops be removed from cultivated areas, the PA management plans need to provide for measures to prevent land and vegetation degradation and funds for their implementation. On PA pasture zones, it is necessary to strictly observe the systematic grazing of livestock, including pasture rotation and ensuring the permitted number of livestock on pastures. Environmental tax needs to be imposed on economic entities in PA zones of PAs in favor of these PAs.

In legal context, it is necessary to improve land legislation, including the Land Code, the Laws "On Pastures" and "On Protected Areas" in terms of provision, use and reproduction of land productivity of PA lands owned with or without permanent (temporary) use right. It is advisable to transfer land plots of the BR buffer zones to permanent use of PAs.

Recommended measures to mitigate and/or prevent the negative impact of internal and external forces on the stability of PAs are shown in Tables 1 and 2.

Case study. Stabilizing the activities of the Lower Amudarya State Biosphere Reserve (Amudarya and Beruni regions of Uzbekistan). Its purpose is the sustainable use of natural resources; objectives are to preserve and restore biodiversity, landscapes, the Bukhara deer population and natural objects, scientific research, creation of a mechanism for sustainable land use, economic and social development of the area.

The area of the SBR is 68 717.8 hectares, core zone lands (16.8 percent) are granted for permanent use, the buffer (9.8 percent) and transition (73.4 percent) zones are used by other entities. In the buffer and transition zones, economic and other activities are carried out; farms in both zones grow cotton and grain. Land use in the zones is inefficient, the share of cotton is high, mineral fertilizers and pesticides are used extensively, irrigation rates are often not controlled, and fields are exposed to numerous mechanized cultivation. There is practically no reproduction of soil fertility, soils are largely depleted, saline and degraded, and cotton and cereals yield is not high. SBR does not operate stably, the balance in its system-building and system-destroying processes is broken.

Abandoning cotton and corn growing, as well as the use of mineral fertilizers and pesticides in the buffer zone is key for modernizing the land use in SBR. In both zones it is recommended to introduce resource-saving technologies for crop cultivation, introduce crop rotations with legumes and pasture rotations, increase doses of applied organic fertilizers; create forest belts; prohibit cultivation of new lands, increase the area under perennial plants.

Modernization of PA land use and aspects of land use management shall ensure the following: transition to a sustainable model and integrated land use management; optimization of the structure of land and crops; ecological and economic planning of lands and prevention of land degradation, reduction of anthropogenic pressure on lands; introduction of biological methods of reproduction of soil fertility; introduction of resource-saving technologies of crop cultivation and increasing crop productivity; creation of "green economy zones"; restoration of pasture ecosystems; increasing economic efficiency of land use; achievement of target tasks by zones and achievement of stability of PAs. Recommendations have been developed to improve the activities of NAGBR [4].

Results

The whole set of external and internal causes (forces) destabilizing the PA activities has been identified, and measures for mitigation/elimination of their negative impact on the PA system have been developed.

The main causes of PA instability are inadequate consideration of the impact of environmental factors in the use of PA natural resources, inadequate funding of PAs, inability of economic entities to protect PAs in which economic activities are permitted, lack of real powers of PAs to manage these zones.

The content of modernization of the system and aspects of PA management has been determined in order to ensure their integrated management and stability, as well as the system as a whole.

Modernization of SBR creates conditions for the development of environmentally friendly technologies for crop production and organization of "green economy" zones in the buffer and transition zones, and scaling-up of experience in maintaining ecological balance in other adjacent areas.

Conclusions

The key in PA stabilization is modernization of their system and aspects of management in the context of new economic policy in nature management, development of innovative and market economy.

The PA stability in the desert pastures ensures not only conservation, but also contributes to sustainable use of desert natural and climatic zones in which they are located, prevention of land degradation and economic damage, growth of employment and incomes, and improvement of the environment.

In the meantime, the PA ecological system has an economic essence, as it includes the processes of economic activities in the zones of many types of PAs.

Acknowledgements

We express our gratitude to the organizers of the Conference on temperate deserts (CADI) for the invitation to participate in its work.

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Impact analysis of infrastructure and energy facilities on desert biological community of Uzbekistan

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Key words: investment projects, solar power plant, transportation network, man-made transformation, desert fauna

Introduction and key objectives

For over the last five years, Uzbekistan has been experiencing a sharp increase in the number of investment projects implemented by foreign companies. A significant part of these projects is aimed at the development of the road and rail network, transfer of energy resources (oil and gas pipelines, power lines). Significant attention is attached to the development of alternative or "green" energy - construction of solar and wind power plants.

Geographically, most of these projects are implemented in the desert zone. This is not only due to the infrastructure necessity, but also to the lower economic demand for desert lands and, consequently, their lower cost.

All investment projects are subject to state environmental impact assessment (RCM No. 949), as well as mandatory socio-environmental assessment in accordance with international standards of lending banks.

Between 2019 and 2021, the authors of this paper were hired as experts to assess biodiversity and possible threats that might be caused by a number of the abovementioned investment projects in different desert areas of Uzbekistan - in the Ustyurt Plateau, in the central, western and northwestern parts of the Kyzylkum desert, in the Sundukli sands and in the Karnabchul steppe.

The paper provides an analysis of the relationship of desert fauna components with various project impacts, as well as possible ways to prevent or mitigate possible threats to biodiversity.

Methodology and data for the analysis

Table 1 provides general information on the facilities' location, timeframe and scope of research conducted to assess the impact on biodiversity.

Table 1

No	Project title	Geographical and administrative location	Timeframe/scope of research
1	Reconstruction of the A-380 Guzar-Bukhara-Nukus-Beyneu highway	Ustyurt plateau, Kungrad district of the Republic of Karakalpakstan	April 2019 / 11 points, 204 km of survey routes
2	Construction of the 500 kV Navoi - Bessopan Industrial Site overhead line route	Central part of the Kyzylkum desert, Tamdy district of Navoi region	May-October 2019/ 30 points, 286 km of survey routes
3	Electrification of the Bukhara-Misken railroad section	Western and northwestern part of the Kyzylkum desert, Bukhara and Khorezm regions; Republic of Karakalpakstan	March 2020/ 44 points, 518 km of survey routes
4	Construction of a 100 MW solar power plant in the Tutli village	Karnabchul Steppe, Nurabad district of Samarkand region	August 2019, March-April 2020 and 2021/ 12 days of observations
5	Scaling up solar energy in Uzbekistan (Project No. TT3183-UZBEK SOLAR 3-R01)	Sundukli sands and the northwestern part of the Kyzylkum desert, Bukhara and Khorezm regions	May-July 2021/ 48 hours of static observations, 18 routes (36.5 km)

Source: Author's own elaboration.

The biodiversity impact assessment methodology for all project sites included three components:

1. review of vertebrate fauna of the project area based on literature data and other relevant sources of information;
2. field assessment of biodiversity of the project area;
3. critical analysis of possible threats and impacts, recommendations for their mitigation - with a focus on rare and endangered species (IUCN 2019-2; Red Book of the Republic of Uzbekistan, 2019).

In accordance with the International Finance Corporation Performance Standard on Environmental and Social Sustainability (2012), the review and analysis covered not only the declared development project site, but also the full range of habitats within the likely direct and indirect/secondary impacts - a "discrete management unit".

Desk study and analysis of the available relevant biodiversity information as per each selected site, depending on the previous study, included ten to 40 different sources, a brief landscape-geographical description, fauna composition and whereabouts of reptiles, birds and mammals in these areas.

Field observations were conducted using standard methods for in vivo studies of reptiles, birds, and mammals (Novikov, 1949; Bibby *et al*, 2000; Sutherlan, 2006). Vantage Points

observations and impact assessment on fauna components were conducted in accordance with the Scottish Natural Heritage Guidelines and Recommendations (SNH, 2016).

Results

This section provides brief information on the terrestrial vertebrate fauna and possible impacts from the project with regard to each of the five studied sites (Table 1).

Site No.1. Studies have shown that 17 species of reptiles, 150 species of birds and 26 species of mammals will most likely enter the impact zone during construction and subsequent operation of the A-380 highway.

Three rare and endangered reptile species in the project area - the Central Asian tortoise *Agrionemys horsfieldii*, the Tatary sand boa *Eryx tataricus* and the blotched snake *Elaphe sauromates* face the following types of threats: death during road crossing; consumption as food by construction workers, poaching for resale, extermination due to traditional fear of snakes; extermination by watch dogs.

Thirty-two species of rare and endangered bird species may appear in the project area. Waterfowl and wetland birds do not interact directly with the facility and are not exposed to any threats. Only the great black-headed gull *Larus ichthyaetus* can feed on the asphalt roadway with crushed reptiles and rodents and die in a motor-vehicle crash. Terrestrial ground-nesting birds such as great bustard *Otis tarda*, Macqueen's bustard *Chlamydotis macqueenii*, pin-tailed sandgrouse *Pterocles alchata* and sociable lapwing *Chettusia gregaria* are extremely unlikely to be seen near the facility. However, threats to these species still exist - poaching by construction workers and hunters passing along the highway. All four species may be drawn to the facility by an open water. Birds of prey are the most threatened in the project area. As noted above, a rich food base (rodents) attracts birds to the roadway embankment, where they can be run over by a moving vehicle. Power lines nearby the facility also cause a serious threat to these species.

Five rare and endangered mammal species may be identified directly in the project area. One of the main threats to the Brandt's hedgehog *Hemiechinus hypomelas* is the death on highways. In addition, rare Brandt's hedgehogs can be trapped by the facility's technical staff along with more numerous eared hedgehogs for medicinal purposes. A certain threat to the corsac fox *Vulpes corsac*, marbled polecat *Vormela peregusna*, steppe polecat *Mustela eversmanni* and sand cat *Felis margarita* is posed by guard dogs, as well as death on the road, to which they are drawn by the abundance of rodents. The Turkmenian caracal *Caracal caracal* and the goitered gazelle *Gazella subgutturosa* need water sources during the hot season, which they can find near the construction site and thus be at risk of chasing. Taking into account the extremely low numbers of saiga *Saiga tatarica* and its local distribution in the Ustyurt Plateau, we believe the threat to this species from the project facility is extremely low.

Site No. 2. The Navoi-Bessopan overhead power transmission line (185 km) passes through plateau areas and foothill plains, takyr-like depressions of the Karakat closed basin, sandy plains with saxaul and slopes of remnant lowlands.

In different seasons, 47 rare and endangered bird species can be found here. Twenty-five of them are waterfowl, interacting with power lines during the fall and spring migration periods on their way to water bodies. The main "risk group" in this area includes 17 species of birds of prey, such as large falcons, eagles and vultures. Eight of them nest in the remnant lowlands of Arystantau, Muruntau, and on the cliffs of the Karakat and Ayakagita depressions. The remaining 9 species are observed in the project area only during flyby, migration and wintering periods. A significant part of raptors uses power line towers for nesting and perching while hunting. Another group is the houbara bustard, little bustard *Tetrax tetrax* and pin-tailed sandgrouse, which nest in desert landscapes, sometimes directly under power lines. All of them need watering places, thus need to cross the power lines regularly, and face the risk of colliding with wires.

In addition, seven reptile species (including four rare ones) and ten mammal species (including four rare ones) permanently inhabit the foregoing landscapes. Small lizards, snakes and rodents are numerous and widespread here and represent prey for rare birds of prey, determining their distribution and state of populations.

Key sites within the project area include bird migration routes to Shorkul Lake and further to the IBA "Tudakul and Kuyumazar reservoirs"; the northwestern end of Ayakagitma Lake (Kashkarov *et al.*, 2008); intersection of the power lines of the Karakat depression; the power line section on the Muruntau hilly-foothill plain; and plateau areas to the west of Kokcha town.

The Navoi-Muruntau power line passes mainly from south to north, i.e. "along" the flyways, significantly reducing the risk of collisions. Our studies have shown that three rows of parallel overhead lines are better visible to birds, help avoid collisions and make the facility safer.

Site No.3. The Bukhara-Misken Railway is a linear facility and crosses various landscapes of the Kyzylkum Desert from southeast to northwest for 274 km, mostly within Bukhara Province. There are several important bird areas in the wider vicinity of the facility - IBA (Kashkarov *et al.*, 2008), Breeding Center for Houbara bustards, Kuljuktau remnant lowlands - nesting places of large birds of prey.

The herpetofauna of Bukhara region includes 32 species. Twelve species permanently inhabit the railroad area, among them four rare ones (the Central Asian tortoise, the desert monitor *Varanus griseus*, the tatary sand boa and desert sand boa *E. miliaris*). Studies have shown that the Central Asian tortoise interacts with the facility most often.

The bird fauna of Bukhara region includes 332 species (Turaev *et al.*, 2015). Forty-nine rare and endangered species may be present in the project area. Eleven of them do not interact with the facility in any way due to the peculiarities of their biology. Twenty-six species may be at risk within the project area under certain conditions. Twelve species regularly interact with the facility and thus face high risk.

There are 51 species of mammals in the region. Twenty of them most closely interact with the construction site. Seven of them are listed in the international and national Red Books and, accordingly, require conservation measures during construction and operation of the

facility. The remaining 13 may somehow affect the stable functioning of the facility or represent prey for rare bird species.

Our research shows that the main impact on the fauna is caused by three man-made components:

1. *Power lines, guiding lines, and lighting masts.* Twelve rare species, mostly birds of prey, use them for perching and nesting; at least 18 waterfowl and near-water species also interact with them when flying to stopover places during migration; the risk group includes the houbara bustard.
2. *Earthworks.* Embankments and open-pit excavations attract common species of rodents and turtles to road facilities, followed by birds of prey. The excavation sites are filled with groundwater, overgrown with reeds, and may attract migratory waterfowl to the site. Rodent digging activity significantly reduces the stability and integrity of the roadbed embankment and similar structures.
3. *Obstacles for movement of terrestrial vertebrates.* The Central Asian tortoise, desert monitor, tolai hare, goitered gazelle, and others may die when crossing the railroad tracks. However, this primarily poses a danger to the movement of high-speed trains, so the project plans to build a continuous rail fence. Throughout the entire railroad length, there are 17 crossings under the project section of the railroad designed for vehicle passage, cattle creep, and seasonal watercourses. Once fully fenced off, these crossings will also allow wildlife to move under the rail line, but the narrow-fixed passages could make them vulnerable to poachers.

Site No. 4. The project area of 350 hectares is located in the clay-saline desert (Karnabchul steppe) and represents a gentle slope in the northern direction of the foothill plain of the Zirabulak and Ziadi remnant mountains. The construction of a solar power plant involves horizontal leveling, respectively - a complete change in the soil and vegetation cover, and landscaping work.

There are one species of amphibians and 15 species of reptiles in the project area. Three of them are rare and endangered species. The most abundant reptile species at the project site is the Central Asian tortoise (from two to ten thousand individuals at the proposed construction site). Two other rare species - the desert monitor and the Tatary sand boa, are observed regularly here, but are not abundant. Widespread species in the project area are three species of lizards. The reptile group will be most affected during construction period, as they are closely related to the substrate and have no opportunity to leave the area. If no measures are taken, the loss of a globally endangered species - the steppe tortoise - during the construction period may reach several thousand individuals.

In different seasons, 106 species of birds can be observed in the project area, of which 15 are sedentary. These are the marsh harrier *Circus aeruginosus* and long-legged buzzard *Buteo rufinus*, preying on small rodents and reptiles; synanthropic representatives of pigeons and ravens, nesting in the surrounding villages; nesting inhabitants of desert landscapes – sand grouses, larks and wheatears. These are widespread and numerous species, so the transformation of 350 hectares of clayey desert will not have a negative impact on the state of their populations. Of the 13 rare and endangered bird species, the Egyptian vulture *Neophron percnopterus* and the golden eagle *Aquila chrysaetos* are closely interact with the project area. The yellow ground squirrel *Spermophilus fulvus*, the tolai hare

and the numerous steppe tortoise inhabiting here are their main prey. Post-construction artificial landscaping may attract the extremely rare wintering great bustard to the project area and pose certain threats to it.

The mammal species composition in the project area includes 18 species, of which four are rare and endangered. The steppe polecat and marbled polecat will lose their prey - rodents – due to landscaping. However, the abundance of these two species listed in the Red Book are naturally low, with no more than a few individuals inhabiting the project site and moving to neighboring areas. On the contrary, the two most abundant species of rodents in the project site - great gerbil and red-tailed gerbil - may pose a problem for construction as carriers of especially dangerous natural focal infections and as sources of bio-damage.

Site No.5. The project area for the construction of solar power plants included two sites in the desert zone: the Khorezm site, three km east of the Lebap village - a flat gravel-sandy upland of 250 hectares, which gradually descends to the east and passes into the cellular sands of the northwestern Kyzylkum desert; the Alat site with a total area of 1100 hectares on the northern border of Sundukli sands, 11 km from the northern bank of Dengizkul Lake, represented by pit-and-mount fixed sands.

The fauna of the two adjacent desert regions, Bukhara and Khorezm, where the project sites are located, includes 32 species of amphibians and reptiles, more than 330 species of birds and 51 species of mammals. As in the previous site, the construction of the solar power plant involves landscaping, altering soil and vegetation cover, greening.

Most of the reptiles inhabiting here face a threat of direct extermination associated with earthworks and traffic during the construction period. Some reptile species (desert monitor, desert boas) are used in folk medicine and are poached by local residents. The local population traditionally dislikes some species (mainly snakes). As a result, 16 species, including six rare and endangered species, are most exposed to project impacts.

During the observation period, 32 bird species were identified at the project sites. Of them, ten species used the site for nesting, the remaining 22 species were observed during migration, feeding and watering. Anthropogenic transformation of the site will not be detrimental for these species, as there are enough similar habitats in the immediate vicinity. Two rare and endangered species - mute swan *Cygnus olor* and pin-tailed sandgrouse *Pterocles alchata* were recorded only at the Alat site.

Mammals inhabit the project area permanently, but, unlike reptiles, are less conservative and can avoid project impact by moving to similar habitats. However, some Raptors and Ungulates are rare and require protection measures; mass species of desert rodents pose a danger as carriers of especially dangerous natural infections and may be sources of bio-damage for structures and communications. The group of mammals most important for the project sites includes 22 species, including eight rare and endangered ones.

Discussion and Conclusions

Deserts are characterized by vast areas of homogeneous landscapes and water scarcity. Our research shows that any man-made transformations (earthworks, laying of pipelines,

creation of road embankments, and installation of power transmission towers) are perceived by desert inhabitants as new terrain elements and they begin to actively reclaim them. Typical examples of this are the use of power lines by birds of prey for nesting and perching, and the settlement of road embankments by rodents. Irregularities in the road surface, water leaks from water conduits contribute to the appearance of temporary watering places for various animals. Similarly, food waste dumps in construction and shift camps are attractive to various animals. The concentration of mass species attracted by these "preferences", in turn, attracts aerial and terrestrial predators, snakes, among which the percentage of rare species is quite high. Obviously, the risk of their death in such man-made sites is much higher than in natural landscapes. The described impacts take place mainly on linear facilities (roads and railroads, oil and gas pipelines, power lines) and are permanently active from dozens to hundreds of kilometres.

The construction of solar power plants, at first, has much narrower impact, since it leads to the complete transformation of only a small part of the habitat (from 300 to 700 hectares). However, even in this case, serious threats are possible if the site is a habitat for a significant abundance of rare species (in particular for reptiles), or if during operation it will pose a threat to visiting species.

Thus, when building infrastructure and energy facilities in the desert zone, it is necessary to minimize the transformation and change of the surrounding landscapes. Whereas it is not possible, it is necessary to apply biodiversity management methods. These methods include the control of the abundance of mass species of rodents - prey for rare species; installation of bird deterrents (markers) and modern bird control (protection) devices on power lines; relocation (of rare species outside the project sites to similar habitats. These efforts should be based on a preliminary thorough analysis of trophic and biocenotic relationships of species in project areas.

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Protecting the cats of the cold winter deserts in Turkmenistan and western Kazakhstan

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Keywords: camera trapping, cats, cold deserts, conservation, conflict, leopard, poaching, Central Asia

Introduction, scope, and main objectives

The Central Asian grassland, semi-desert and desert ecosystems are incredibly rich in biodiversity because of their location at the interface between different biogeographic areas and different ecological regions. These habitats are still largely continuous and interconnected and are home to wildlife assemblages that rival those of better-known regions like East Africa, with large herds of highly mobile large herbivores, rich communities of rodent herbivores, and many large, medium and small predators including mammals and birds. However, the cold deserts represent a globally unique ecosystem with rather distinctive community assemblages often consisting of both tropical and temperate species. For example, on a broad scale the wild cat community contains up to seven species: namely the Persian leopard (*Panthera pardus tulliana*), caracal (*Caracal caracal*), Eurasian lynx (*Lynx lynx*), Pallas cat (*Otocolobus manul*), Asiatic wild cat (*Felis lybica ornata*),

Jungle cat (*Felis chaus*), and sand cat (*Felis margarita*) (Kitchener et a. 2017). Asiatic cheetah (*Acinonyx jubatus venaticus*) was present in the ecoregion but has been extinct for >50 years (persisting today only in Islamic Republic of Iran).

Unfortunately, Central Asia is currently an understudied region from the point of view of ecology and biodiversity. This is especially true in the past three decades since the post-Soviet transition. At present there is very little in the way of up-to-date information available on the status and distribution of species that can be used to inform conservation measures, such as better planning of anthropogenic development on the one hand and establishing an effective network of protected areas on the other. This task is becoming increasingly urgent as the whole region is coming under intense anthropogenic pressure from multiple sources (recreational pressures, poaching, mining, hydrocarbon extraction, renewable energy development, border security fencing, water extraction, farming and livestock grazing pressure) in addition to the ever-present specter of climate change.

The objective of this communication is to summarise what is known about the status of these iconic wild cat species in Turkmenistan and southwestern Kazakhstan, presenting for the first time the results of camera-trapping and field surveys conducted during the last decade. Based on these preliminary results we present some initial recommendations for conservation actions.

Methodology

The data presented here consists of the results from camera trapping and multiple field surveys conducted in the following protected areas; in Turkmenistan - Badhyz and Koytendag reserves (since 2013) the Kopetdag and Sunt Hasardag reserves (since 2018) and Kaplankyr reserve & adjacent parts of the Ustyurt plateau (since 2019), and the Uly Balkan range (since 2019); in Kazakhstan - the Ustyurt reserve with surrounding areas in the Mangystau region (since 2016). Approximately 100 camera traps have been deployed at multiple locations across these sites. They have been deployed opportunistically, typically on wildlife trails or sites used by wildlife, with a particular emphasis on locations more likely to be used by large predators like leopards. During field surveys, some direct observations were recorded, but most importantly we also compiled the accumulated experience and observations of the field staff in the protected areas, in addition to some informal interviews with shepherds and other local observers.

Results

In Turkmenistan, the best guestimates indicate that 60 to 100 Persian leopards may still inhabit the southwestern and western mountainous regions (Heptner & Sludskii 1972, Lukarevsky 2001, Red Book of Turkmenistan 2011). The opportunistic nature of our camera trap data can neither confirm nor reject these estimates, but we can verify parts of the distribution. So far for Turkmenistan, we can confirm that there are important population pockets in the Kopetdag mountains, in the Badhyz State Nature Reserve, and in the Sunt Hasar range. All these regions border unto the Islamic Republic of Iran, and research from Islamic Republic of Iran confirms that animals move to and from across this border

(Farhadinia 2018). In the Uly Balkan range, camera trapping suggests that there could be as many as 7 individual leopards, some of which possibly travel north along the Garabogaz-gol depression towards the Ustyurt Plateau (Fig. 1).

In Kazakhstan, three different leopard individuals (likely dispersers from Turkmenistan), have been recorded on the Ustyurt Plateau in Mangystau, in 2007, 2015 and from 2018–2021 (Pestov *et al*, 2019). Leopard presence in 2007 and 2015 was confirmed by eyewitness accounts and photographs. On both occasions, the leopards had been killed by shepherds. Interviews with locals revealed further anecdotal reports and images of several additional leopard encounters over the past fifty years on the Ustyurt Plateau. Camera trapping confirmed the presence of a male leopard on the Ustyurt in the period 2018-2021, but the individual was confirmed to have died in June 2021. Although the Kazak leopards are all likely to have come from Turkmenistan, connectivity between the two countries is impacted by the extensive border fence between Turkmenistan and Kazakhstan (Pestov *et al*. 2018). The closest confirmed leopard population to the Ustyurt reserve in Kazakhstan is 370 km away in the Uly Balkan Mountain range in Turkmenistan. However, in 2020 a leopard was seen in Arsary Baba in Turkmenistan, which is about 120 km north of the Uly Balkan and about 270 km south of the Ustyurt SNR in Kazakhstan (Fig. 1).

So far, Eurasian lynx presence has only been documented in the higher mountain ranges of Koytendag reserve in Turkmenistan where their presence is frequently reported by camera traps. Individual lynx were present in the central Kopetdag mountains in 2002-2011 (Agryzkov and Fateev 2011), but have been absent from the western Kopetdag for decades. So far, our camera traps have not confirmed lynx presence anywhere in the Kopetdag range at present. From a global perspective these lynx populations represent an extreme outlier at the southern edge of their range, together with the Eurasian lynx recorded on Bamyan plateau in Afghanistan (Jahed, personal communication 2021). Caracal, on the other hand, have been recorded with camera traps on the Ustyurt Plateau in Kazakhstan, and in the foothills of the Kopetdag, and the Kaplankyr reserve, in Turkmenistan. These observations are consistent with observations in adjacent areas in Uzbekistan.

In Turkmenistan, Pallas's cat (also referred to as Manul) are historically considered rare (Shukurov 1962). Nevertheless, our camera traps documented their presence in the Kopetdag reserve on seven occasions between 2019 and 2020, and in the Uly Balkan range in 2020. They have not been recorded in Mangystau, Kazakhstan, though according to historic records they used to be present. Pallas's cats in Turkmenistan (and formerly in Mangystau) belong to a peripheral part of the Western Asian population (mainly inhabiting the Islamic Republic of Iran) and the nearest other (not-Iranian) records of the species are known in Afghanistan, including on Bamyan plateau– about 820-850 km away (Jahed, WCS Afghanistan, Manul Working Group database).

Jungle cat are found across the Kopetdag, including Sunt Hasar range, in southern Turkmenistan. Asiatic wild cats are widely distributed and found in all camera trapping sites. We also documented reproduction (in Badhyz and Kopetdag), including behavior during the kitten rearing period (female-kitten interaction, and movement of kittens to a different den).

Unfortunately, there are no records of sand cats in Turkmenistan since at least the 1960s. There is a report speculating on their continued presence in 1990 in the Karakum desert (Lukarevskiy 2001), but this was outside our camera trapping areas.

Discussion

The focal area is huge and funding to maintain the camera traps has been variable so that monitoring is still far from being systematic and hence it is not yet possible to document trends. Also, unfortunately, several of the cameras placed in the Ustyurt reserve in Kazakhstan were stolen. Notwithstanding these constraints, even this initial information, has already provided valuable information on the current distribution and the threats these cat species face. With the help of camera traps, we have been able to confirm the presence of several distinct Persian leopard individuals in the Kopetdag range, in Badhyz, and the Uly Balkan range in Turkmenistan and document the presence of a single leopard in the Ustyurt reserve in adjacent Kazakhstan.

Human-wildlife conflict and retaliatory killing and poaching of prey species, especially Urial sheep (*Ovis vignei*), bezoar goat (*Capra aegagrus aegagrus*), and goitered gazelles (*Gazella gutturosa*) are some of the threats facing Persian leopards together with the impermeability of long sections of the border fence with Islamic Republic of Iran, Afghanistan, Uzbekistan, and Kazakhstan, which severely limit connectivity for leopards and the prey they depend upon. Persian leopards have large home ranges (mean of 103.4 ± SE 51.8 km^2 for resident males along the Islamic Republic of Iran-Turkmenistan borderland) compared to other leopard subspecies (Farhadinia *et al*. 2018), indicating their large spatial requirements. They are also known to move long distances, (e.g. >150 km between Caucasian countries, Askerov *et al*. 2015) and even establish cross-border territories (e.g. between Islamic Republic of Iran and Turkmenistan, Farhadinia *et al*. 2018).

Lynx are apparently confined to the higher areas of Koytendag. They have been present in the Kopetdag mountains, with records from the central Kopetdag from 2002-2011, but have been absent from the western Kopetdag for decades. Lynx observations have also been reported from the lowlands, but these were likely misidentifications of caracal or jungle cats. Lynx are frequently picked up by camera traps in Koytendag, but videos make it hard to identify individuals to get population estimates. The large number of hares (*Lepus tolai*) in the camera trap videos suggests that Koytendag may be a lynx-hare system similar to that found in Türkiye (Mengulluoglu *et al*. 2018) which may result in relatively high lynx densities (Kaczensky *et al* 2019).

Caracal used to be historically present across much of Turkmenistan's desert areas and the Ustyurt plateau. It has been recorded on camera traps in the Kaplankyr reserve and in Mangistau including the Ustyurt reserve (including reproduction) in Kazakhstan since 2018. Based on information from local communities, caracal reportedly predate on domestic livestock, triggering retaliatory killing.

Of all small cat species found in this region, it was a positive surprise to document the presence of the rare Pallas's cat both in the Kopetdag reserve and the Uly Balkan range. Jungle cats have been camera trapped and observed by some of the co-authors in Badhyz,

Sunt Hasar range, and in the vicinity of Mary. Collision with vehicles has been reported as a threat as well as killing by hunting dogs. Asiatic wild cats seem to show the greatest resilience. It is the only cat species in the region for which we recognize no serious threats, with the exception of crossbreeding with domestic cats and retaliatory killing, documented as recently as October 2021.

Most of the information we have on sand cats in Turkmenistan is based off some very old literature (Heptner and Sludskii in 1972). The degradation of Saxaul vegetation through logging and overgrazing has likely impacted severely sand cat habitat. Sand cats can also easily fall prey to hunting dogs. However, 90-100 kn from the border with Turkmenistan, in the Kyzylkum desert in Uzbekistan, sand cats have been recorded (Barashkova and Grytsina, 2021). We recorded no observations of Asiatic cheetahs outside of Islamic Republic of Iran.

On the basis of the information collected, especially with regard to Persian leopard distribution, we recommend establishing a protected area encompassing the Uly Balkan range, an important leopard stronghold. In the new five-year Forest Programme of Turkmenistan for the period 2021-2025 the establishment of the new Nature Reserve in Balkan Mountains is under consideration. We also recommend establishing a wildlife corridor that includes the section of the Ustyurt plateau coasting the Garabogaz gol depression all the way to the border of Turkmenistan with Kazakhstan. This would also embrace an area important for Pallas's cat.

Designating a wildlife corridor that stretches from the Uly Balkan to the border with Kazakhstan could help strengthen wildlife movement and restore connectivity.

We also recommend establishing a strict nature reserve in the southern part of the Ustyurt in Kazakhstan, including the Kaplankyr chink, on the border between Kazakhstan, Turkmenistan and Uzbekistan, where caracal and the Asiatic wild cat are found, and where 50 years ago an Asiatic cheetah was last recorded. The cheetah subspecies has since gone extinct but hinging on other future conservation efforts in the region, a reintroduction here could be envisaged. Scientific justification for the creation of the reserve has already been developed by Association for the Conservation of Biodiversity of Kazakhstan (ACBK) as part of the CADI project and is under consideration by the government of Kazakhstan.

Measures to set up new protected areas and wildlife corridors should be complementary to addressing barriers to movement such as border fences, especially those on the border of Turkmenistan with Kazakhstan and Islamic Republic of Iran, by creating gaps in the fence for unrestricted movement (Linnell *et al*, 2016). A good basis for solving this problem has been Turkmenistan's joining of CMS in 2020. Finally, it would appear to be necessary to address issues associated with livestock husbandry to reduce conflicts with wild cats.

Conclusions

These recent field surveys indicate the presence of 6 species of wild cat in the cold winter deserts of our study region. Most of our studies were conducted in protected areas indicating that these continue to serve an important function in safeguarding the regions wildlife. However, our studies also indicate that there are still considerable wildlife values in areas outside these protected areas, as the Uly Balkan range shows. We strongly recommend some form of protection for this region as it serves an important potential

dispersal corridor to Kazakhstan. This underlines the need to begin expanding both wildlife survey efforts and conservation activity to embrace the wider landscape in addition to the protected areas, which is essential to long term conservation. This includes taking steps to provide transboundary connectivity.

Acknowledgements

We would like to thank: Michael Succow Foundation, CADI Project, the Royal Society for Protection of Birds (RSPB); the Center for Large Landscape Conservation, Critical Ecosystem Partnership Fund (CEPF), Cheryl and Rob Fimbel and Pallas's cat International Conservation Alliance (PICA) for facilitating and/or supporting and funding the work in Turkmenistan and Kazakhstan.

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Fig. 1: Opportunistic camera trapping records of wild cat species confirmed in Turkmenistan and south-western Kazakhstan 2013-2021. Map Source: Rosen, T., modified to comply with UN. World map (2022)

Birds of the southern Ustyurt (Uzbekistan)

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Keywords: avifauna, ornithological complex, rare species, Southern Ustyurt.

Introduction and objectives

The creation in December 2021 of a new protected natural area, the South Ustyurt State National Nature Park (from now on referred to as NNP), was an important step in conserving the unique ecosystems of Ustyurt. The NPP area, covering an area of 1 447 143 ha, occupies most of southern Ustyurt (Figure 1).

In the past, detailed complex ornithological studies of this part of the Ustiurt plateau have not been conducted, but there are several papers devoted to individual species (Gubin, 2007) or areas of the study area (Meklenburtsev, 1949; Kostin, 1956; Chernov, 1990), or covering the whole of Karakalpakstan (Ametov, 1981; Mambetjumaev, 1995). In recent years, there have been several papers on the bird fauna or distribution of individual species in Ustyurt (Kashkarov, 2010; Mitropolsky, 2009). In 2010, a survey of Lake Sarykamysh was conducted by the Society for the Protection of Birds of Uzbekistan, based on which the Important Bird Area (IBA) "Lake Sarykamysh and adjacent part of Ustyurt plateau" was described (Ten et el. 2012).

This article analyses data from research organised by the Michael Succow Environmental Foundation (Germany) in 2012 and the Central Asia Desert Initiative (CADI) in 2017 in the southern part of Karakalpak Ustyurt.

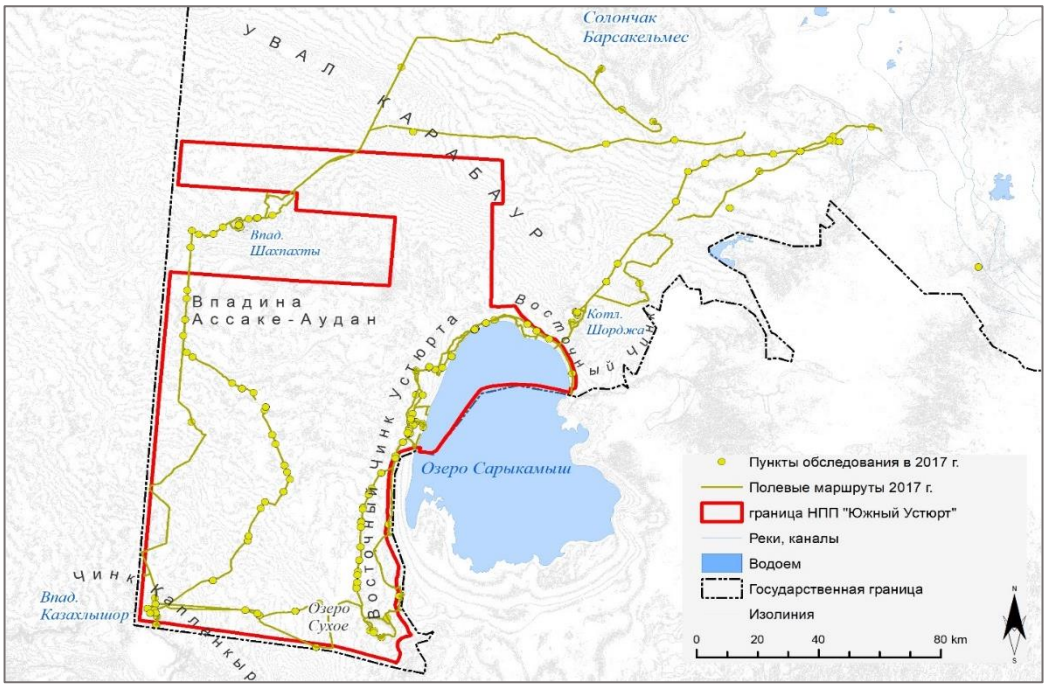

Figure 1 Routes and survey points in May and September 2017, South Ustyurt.

Map Source: Ten, A., modified to comply with UN. World map (2022)

Research objects and methods.

The material was collected using standard methods (point and line surveys (Novikov, 1949; Bibby *et al.*, 2000). During the survey, optical instruments were used: binoculars (10x) and trumpets (x60). Photographs of birds were used to refine species identification. E.A. Koblik and V.Yu present the systematic list of bird species. Arkhipov (2014). This article contains materials obtained during the survey in May 2012 and in May and September 2017 and publications (Ten *et al*. 2012, Mitropolsky 2009, Kashkarov 2010).

Results

The avifauna of South Ustyurt consists of 224 bird species: three species belong to the family Galliformes. Galliformes, 19 species of *Anseriformes*, four species. *Pelecaniformes*, nine *Ciconiiformes*, one *Phoenicopteriformes*, five *Podicipediformes*, 23 *Falconiformes*, five *Gruiformes*, 50 *Charadriiformes*, three *Pterocliformes*, three *Columbiformes*, one *Cuculiformes*, two *Strigiformes*, two *Caprimulgiformes*, two *Apodiformes*, three *Coraciiformes*, one *Bucerotiformes* and 88 *Passeriformes* (see appendix 1). Of these, 40 species are rare: 24 have international conservation status, are included in the IUCN species lists, and 33 have national status (Red Book of Uzbekistan, 2019)(see Table 1). There is also one endemic of Central Asia, the saxaul jay Podoces panderi.

Table 1. Rare bird species of Southern Ustyurt

№	Scientific name	Uzbek name	Russian name	RL RUz 2019	IUCN Red list
1	*Cygnus olor*	Вишилдоқ оққуш	Лебедь-шипун	3(NT)	

2	*Cygnus cygnus*	Бақироқ оққуш	Лебедь-кликун	2(VU:R)	
3	*Aythya ferina*	Қизилбош	Красноголовый нырок		VU
4	*Aythya nyroca*	Оққўз ўрдак	Белоглазый нырок	2(VU:D)	NT
5	*Oxyura leucocephala*	Оқбош ўрдак	Савка	1(EN)	EN
6	*Pelecanus onocrotalus*	Пушти сақоқуш	Розовый пеликан	2(VU:D)	
7	*Pelecanus crispus*	Жингалак сақоқуш	Кудрявый пеликан	1(EN)	NT
8	*Phalacrocorax pygmeus*	Кичик қоравой	Малый баклан	3(NT)	
9	*Ardeola ralloides*	Сариқ қарқара	Жёлтая цапля	2(VU:R)	
10	*Egretta garzetta*	Кичик оқ қарқара	Малая белая цапля	2(VU:D)	
11	*Plegadis falcinellus*	Қоравой	Каравайка	2(VU:D)	
12	*Platalea leucorodia*	Қошиқбурун	Колпица	2(VU:D)	
13	*Phoenicopterus roseus*	Қизил ғоз	Розовый фламинго	2(VU:D)	
14	*Podiceps auritus*	Қизилтомоқ қанжир	Красношейная поганка		VU
15	*Falco naumanni*	Дашт миққийси	Степная пустельга	3(NT)	
16	*Falco cherrug*	Итолғи	Балобан	1(EN)	EN
17	*Pandion haliaetus*	Сувқийғир	Скопа	2(VU:R)	
18	*Haliaeetus leucoryphus*	Узундумли сувбургут	Орлан-долгохвост	1(EN)	EN
19	*Haliaeetus albicilla*	Оқ думли сувбургут	Орлан-белохвост	2(VU:R)	
20	*Aegypius monachus*	Тасқара	Чёрный гриф	3(NT)	NT
21	*Neophron percnopterus*	Жўрчи	Стервятник	2(VU:D)	EN
22	*Circaetus gallicus*	Илонхўр бургут	Змееяд	2(VU:D)	
23	*Circus macrourus*	Дашт бўктаргиси	Степной лунь	3(NT)	NT
24	*Aquila clanga*	Катта бургут	Большой подорлик	2(VU:R)	VU
25	*Aquila nipalensis*	Чўл бургути	Степной орёл	2(VU:D)	EN
26	*Aquila heliaca*	Қиронқора	Орёл-могильник	2(VU:D)	VU
27	*Aquila chrysaetos*	Бургут	Беркут	2(VU:R)	
28	*Otis tarda*	Тувалоқ	Дрофа	1(CR)	VU
29	*Chlamydotis macqueenii*	Йулға тувалоқ	Дрофа-красотка	2(VU:D)	VU
30	*Tetrax tetrax*	Бизғалдоқ	Стрепет	2(VU:D)	NT
31	*Haematopus ostralegus*	Зах лойхўрак	Кулик-сорока		NT
32	*Vanellus vanellus*	Қизқуш	Чибис		NT
33	*Limosa limosa*	Катта веретенник	Большой веретенник	2(VU:D)	NT
34	*Limosa lapponica*	Кичик веретенник	Малый веретенник		NT
35	*Numenius arquata*	Катта узунбурун балчиқчи	Большой кроншнеп	2(VU:D)	NT
36	*Calidris ferruginea*	Қизилтомоқ мошак	Краснозобик		NT
37	*Glareola nordmanni*	Чўл жиқтоқ	Степная тиркушка	2(VU:R)	NT
38	*Larus ichthyaetus*	Қорабошли балиқчи	Черноголовый хохотун	2(VU:D)	
39	*Pterocles alchata*	Оқбовур	Белобрюхий рябок	2(VU:D)	
40	*Anthus pratensis*	Йилқичи	Луговой конёк		NT

Note 1: КрК РУз *2019 - species included in the Red Data Book of Uzbekistan (2019: 1 (CR) - endangered species, 1 (EN) - endangered species; 2(VU:R) - vulnerable naturally rare species; 2 (VU: D) - vulnerable species with declining numbers; 3(NT) - near-threatened species. 2. IUCN Red list - the Red List of Threatened Species of the IUCN - EN - endangered species; VU - vulnerable species; NT - near threatened species*

Source: Author's own elaboration.

The avifauna of South Ustyurt can be divided into the following bird assemblages: birds nesting on the plateau; birds nesting on cliffs; birds associated with water bodies (waterfowl and water-related species); and migratory species.

Birds nesting on the plateau

The ornithofauna of the Ustyurt plateau is quite poor, which is quite natural due to the extreme aridity and homogeneity of this landscape. However, among nesting birds, important for conservation are Houbara bustard, white-bellied grouse, saxaul jay (endemic) (Table 1). In general, species of this complex can be divided into two groups:

1. open-nesting and species nesting in rodent burrows. These are the species most suited to nesting in desert conditions: houbara bustard, plovers (thick-billed *Charadrius leschenaultii* and Caspian *Ch. Asiaticus*), sand grouse (black-bellied *Pterocles orientalis* and white-bellied *P. alchata*), Pallas' sandgrouse Syrrhaptes paradoxus, Egyptian nightjar *Caprimulgus aegyptius*, skylarks, desert stoner *Oenanthe deserti*, stoner-dancer *O. isabellina*.
2. nesting in a tree and shrub vegetation (saxaul, saltwort, etc.): long-legged buzzard *Buteo rufinus*, saxaul jay, desert shrike *Lanius pallidirostris*, desert warbler *Sylvia nana*, streaked scrub warbler *Scotocerca inquieta*, Syke's warbler *Iduna rama*, desert finch *Rhodospiza obsoleta*. The composition of birds nesting in coastal woody and shrub vegetation (tamarisks, rare reeds, saxaul) is different. The marsh harrier *Circus aeruginosus*, scrub robin *Erythropygia galactotes*, bluethroat *Luscinia svecica*, Syke's warbler *Iduna rama,* and northern *I. caligata*, oriental black crow Corvus orientalis, and others nest here.

Birds nesting on bluffs

In May 2017, a survey of chinks, karst sinkholes, and depressions from the southern part of the Eastern Chink of Ustyurt (Yerburun tract, Akshaimak, Kotl. Shordzha, inflow. Dry Lake, Sarykamysh hollow chinks), as well as Kaplankyr chink and Shakhpakhty hollow. We identified 27 species, but literature analysis expanded this list to 33. Rare species are saker falcon, Egyptian vulture, black vulture, steppe kestrel, and golden eagle (Table 1). Common stoneflies on small cliffs and generally on chinks (*Oenanthe pleschanka, O.picata, O.oenanthe, O.finschii, O.isabellina*), desert lark *Ammomanes deserti*, sparrows, little owl *Athene noctua*, common kestrel *Falco tinnunculus*. On larger steep cliffs nest birds of prey such as the above-mentioned saker falcon, vulture, and golden eagle, as well as the long-legged buzzard and eagle-owl *Bubo bubo*. The Sarykamysh cliffs are rich in species as the water reservoir provides rich feeding grounds. Nesting places are associated with the water reservoir, such as the sheld duck *Tadorna ferruginea*, swifts (*Apus apus, A. melba*), brin-flies, bee-eater (Merops persicus, M. apiaster). The rarer species breeding in the area include the black vulture, lesser kestrel, roller *Coracias garrulus,* and horned lark *Eremophila alpestris*. In general, chinks are inextricably linked to other habitats, as foraging habitats for chink-nesting birds are the open spaces of the plateau or Lake Sarykamysh.

Birds associated with water bodies (waterfowl and water-related species)

As any arid zone wetland, Lake Sarykamysh plays an important role in the existence of most desert animal species and is characterised by the greatest diversity of fauna. Sarykamysh is also of great importance for migratory waterfowl and semi-aquatic birds. There are 91 species, including 22 rare ones, the most important of which are: common pochard, stiff-tailed duck, curly pelican, horned grebe (Table 1). Sarykamysh is also important for migratory birds. In 2012, its territory and the adjacent Ustyurt plateau with cliffs were included in the IBA international list (Ten *et al*. 2012) due to migratory accumulations on the water body.

In May and September 2017, both nesting and late migrating, flying non-breeding species were observed in the water body. Of the 56 species recorded that year, breeding stations were found only for *Charadriformes* nesting on the open shoals that abound on the Uzbek side of Sarykamysh. The proportion of *Charadriiformes* in May 2017 was 60.7 percent; however, nesting behaviour was observed only for Lesser *Charadrius dubious* and Sea *Ch. alexandrines* plovers, black-winged stilt *Himantopus himantopus*, peewit *Vanellochettusia leucura*, terns, gulls, and others. The presence of other species of this family indicates the importance of the water body as a summer staging area for non-breeding birds. Among anseriformes, only the sheld duck nesting on loess cliffs has nesting sites. In connection with suitable nesting sites in the southern part of Lake Sarykamysh (reed thickets, islands, etc.) in Turkmenistan, some nesting species of this family will likely appear in the northern part as well.

Migratory species

Ustyurt, located on the East Asia/East Africa Flyway (datazone.birdlife.org), is of great importance during the migration period. Rare migratory birds of prey include osprey, sea eagle, pale harrier, greater spotted eagle, steppe eagle, and шmperial eagle (Table 1). Large birds of prey follow this route through Ustyurt, from breeding grounds in Kazakhstan and Russian Federation to wintering grounds in West Asia and Africa.

As an extremely arid area, Ustyurt is most difficult for migrants in the autumn, especially during periods of drought. During this time, weak and young birds die. In the spring, rain-filled takers retain water until late May/early June, attracting migrating birds.

The steppe eagle is probably the most vulnerable species, as South Ustyurt lies on its mass migration route. In May 2017 alone, we saw 56 steppe eagles, and in September, we saw 85 (Figure 2). Of particular note is the accumulation of at least 50 steppe eagles at a waterhole located to the north-west of the depression. It is especially noteworthy that there was a concentration of less than 50 steppe eagles at a waterhole located north-west of the Dry Lake. According to data from a camera trap installed there, the birds rested for several days in May. In addition, we found 9 corpses of steppe eagles in 2017, of which 7 corpses of young birds were found in Shakhpakhty. It indicates a high mortality rate of young steppe eagles in Ustyurt.

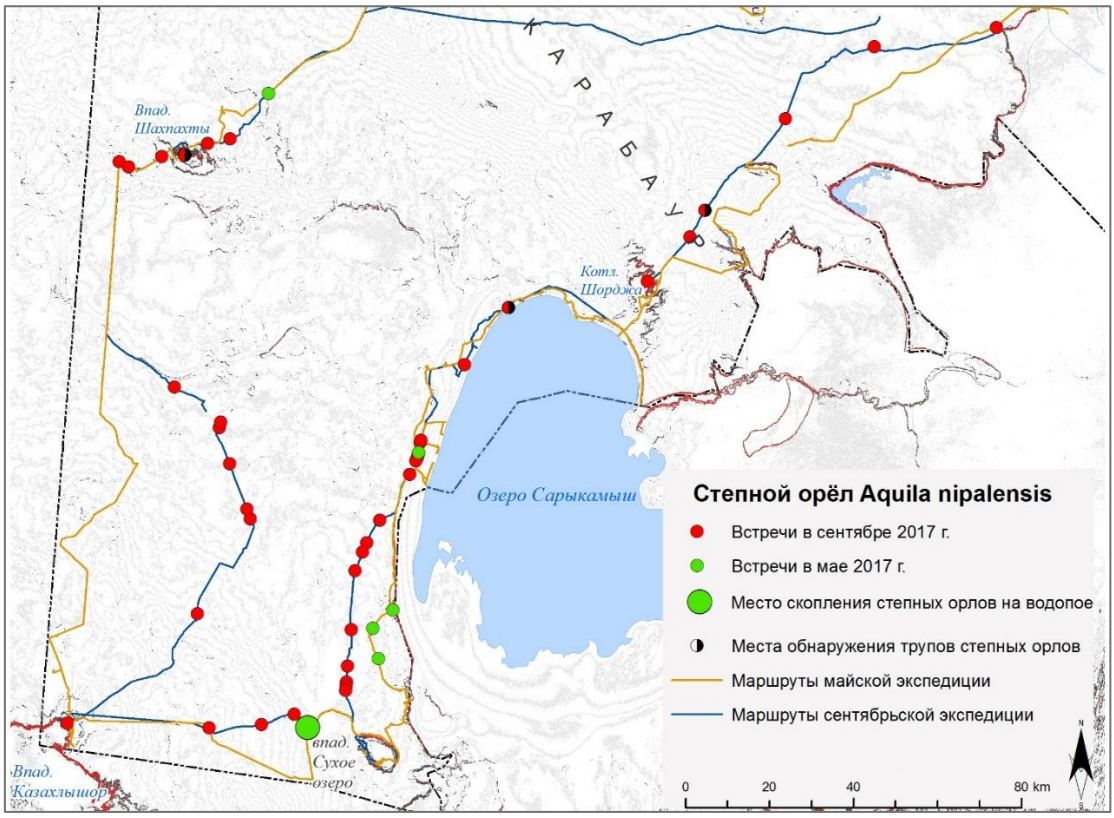

Figure 2 Steppe Eagle sightings in 2017.

Source: Ten, A., modified to comply with UN. World map (2022)

Discussion

Ustyurt landscapes represent a complex biogenetic complex, all elements of which are inextricably linked. The inhabitants of a cliff - the swifts, feed en masse on insects on Lake Sarykamysh. Eagle owl, foraging in the coastal strip and on the plateau, uses natural recesses of the the cliff as refuges and nesting places, etc. Studies of ornithological complexes of South Ustyurt are incomplete, it is important to expand them in other seasons (no winter period), as well as to study in more detail the relationship of birds with foraging sites, assess the importance of watering places, etc.

The list of species presented in this article is not definitive and will no doubt be expanded and supplemented by more observations in the area.

The most vulnerable nesting species in South Ustyurt can be identified as birds of prey nesting on cliffs, as the amount of nesting habitat is limited and increased disturbance from people (tourists, anglers) may lead to a reduction in nesting.

On the north-western part of Lake Sarykamysh there is a sandy area with sexual forest growing on it. Its condition needs to be monitored due to the possible influence of fishers constantly present on the water body (illegal logging control), as the sands are the nesting place of hornbills and sexual jays.

For migratory species, the most dangerous is insufficient watering, as demonstrated by observations of steppe eagles in 2017.

Based on the above, we believe that a monitoring programmer for key bird species and groups is required for the NNP, as well as measures to reduce threats: 1) establishment of watering points on the Ustyurt plateau in remote locations; 2) control of cutting of tree and shrub vegetation on the territory of Lake Sarykamysh.

Conclusions

The article provides information on the main ornithological complexes of Southern Ustyurt and lists avifauna (224 species) and rare birds (40 species).

Acknowledgements

We would like to thank the Michael Succow Foundation (Germany) for organising and supporting the expeditions.

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Annex 1. List of bird species of Southern Ustyurt

1 Alectoris chukar	51 Aegypius monachus	100 Calidris alba
2 Perdix perdix	52 Neophron percnopterus	101 Philomachus pugnax
3 Coturnix coturnix	53 Circaetus gallicus	102 Limicola falcinellus
4 Cygnus olor	54 Circus aeruginosus	103 Glareola pratincola
5 Cygnus cygnus	55 Circus cyaneus	104 Glareola nordmanni
6 Anser anser	56 Circus macrourus	105 Larus canus
7 Tadorna ferruginea	57 Accipiter nisus	106 Larus fuscus
8 Tadorna tadorna	58 Buteo buteo	107 Larus heuglini
9 Anas penelope	59 Buteo rufinus	108 Larus cachinnans
10 Anas strepera	60 Buteo lagopus	109 Larus ichthyaetus
11 Anas crecca	61 Aquila clanga	110 Larus ridibundus
12 Anas platyrhynchos	62 Aquila nipalensis	111 Larus genei
13 Anas acuta	63 Aquila heliacal	112 Larus minutus
14 Anas querquedula	64 Aquila chrysaetos	113 Gelochelidon nilotica
15 Anas clypeata	65 Porzana pusilla	114 Hydroprogne caspia
16 Netta rufina	66 Fulica atra	115 Sterna hirundo
17 Aythya ferina	67 Otis tarda	116 Sterna albifrons
18 Aythya nyroca	68 Chlamydotis macqueenii	117 Chlidonias hybrida
19 Aythya fuligula	69 Tetrax tetrax	118 Chlidonias leucopterus
20 Bucephala clangula	70 Burhinus oedicnemus	119 Chlidonias niger
21 Mergus merganser	71 Haematopus ostralegus	120 Pterocles alchata
22 Oxyura leucocephala	72 Himantopus himantopus	121 Pterocles orientalis
23 Pelecanus onocrotalus	73 Recurvirostra avosetta	122 Syrrhaptes paradoxus
24 Pelecanus crispus	74 Vanellus vanellus	123 Columba livia
25 Phalacrocorax pygmeus	75 Vanellochettusia leucura	124 Streptopelia decaocto
26 Phalacrocorax carbo	76 Pluvialis squatarola	125 Streptopelia senegalensis
27 Botaurus stellaris	77 Charadrius hiaticula	126 Cuculus canorus
28 Nycticorax nycticorax	78 Charadrius dubius	127 Bubo bubo
29 Ardeola ralloides	79 Charadrius alexandrinus	128 Athene noctua
30 Egretta garzetta	80 Charadrius leschenaultii	129 Caprimulgus europaeus
31 Casmerodius albus	81 Charadrius asiaticus	130 Caprimulgus aegyptius
32 Ardea cinerea	82 Lymnocryptes minimus	131 Apus melba
33 Ardea purpurea	83 Gallinago gallinago	132 Apus apus
34 Plegadis falcinellus	84 Limosa limosa	133 Coracias garrulus
35 Platalea leucorodia	85 Limosa lapponica	134 Merops persicus
36 Phoenicopterus roseus	86 Numenius arquata	135 Merops apiaster
37 Tachybaptus ruficollis	87 Tringa erythropus	136 Upupa epops
38 Podiceps grisegena	88 Tringa totanus	137 Ammomanes deserti
39 Podiceps cristatus	89 Tringa stagnatilis	138 Melanocorypha calandra
40 Podiceps nigricollis	90 Tringa nebularia	139 Melanocorypha bimaculata
41 Podiceps auritus	91 Tringa ochropus	140 Melanocorypha leucoptera
42 Falco naumanni	92 Tringa glareola	141 Melanocorypha yeltoniensis
43 Falco tinnunculus	93 Actitis hypoleucos	142 Calandrella brachydactyla
44 Falco columbarius	94 Xenus cinereus	143 Calandrella rufescens
45 Falco cherrug	95 Phalaropus lobatus	144 Eremophila alpestris
46 Pandion haliaetus	96 Arenaria interpres	145 Galerida cristata
47 Pernis apivorus	97 Calidris minuta	146 Alauda arvensis
48 Milvus migrans	98 Calidris ferruginea	147 Riparia riparia
49 Haliaeetus leucoryphus	99 Calidris alpina	

148 Hirundo rustica	187 Phylloscopus trochiloides
149 Anthus campestris	188 Sylvia curruca
150 Anthus pratensis	189 Sylvia nana
151 Anthus trivialis	190 Remiz pendulinus
152 Anthus cervinus	191 Parus bokharensis
153 Motacilla flava	192 Lanius phoenicuroides
154 Motacilla feldegg	193 Lanius collurio
155 Motacilla citreola	194 Lanius excubitor
156 Motacilla cinerea	195 Lanius pallidirostris
157 Motacilla alba	196 Oriolus oriolus
158 Motacilla personata	197 Podoces panderi
159 Prunella montanella	198 Corvus monedula
160 Turdus ruficollis	199 Corvus frugilegus
161 Turdus atrogularis	200 Corvus orientalis [corone]
162 Turdus philomelos	201 Corvus cornix
163 Phoenicurus ochruros	202 Corvus corax
164 Erythropygia galactotes	203 Acridotheres tristis
165 Erithacus rubecula	204 Pastor roseus
166 Luscinia luscinia	205 Sturnus vulgaris
167 Luscinia svecica	206 Passer ammodendri
168 Saxicola maurus	207 Passer domesticus
169 Saxicola caprata	208 Passer indicus
170 Oenanthe oenanthe	209 Passer hispaniolensis
171 Oenanthe pleschanka	210 Passer montanus
172 Oenanthe picata	211 Fringilla coelebs
173 Oenanthe finschii	212 Fringilla montifringilla
174 Oenanthe deserti	213 Chloris chloris
175 Oenanthe isabellina	214 Spinus spinus
176 Muscicapa striata	215 Bucanetes githagineus
177 Ficedula parva	216 Bucanetes mongolicus
178 Ficedula albicilla	217 Rhodospiza obsoleta
179 Scotocerca inquieta	218 Uragus sibiricus
180 Cettia cetti	219 Carpodacus erythrinus
181 Acrocephalus agricola	220 Miliaria calandra
182 Acrocephalus dumetorum	221 Emberiza leucocephalos
183 Iduna caligata	222 Granativora bruniceps
184 Iduna rama	223 Schoeniclus schoeniclus
185 Phylloscopus trochilus	224 Ocyris pusillus
186 Phylloscopus collybita	

Source: Author's own elaboration.

New data on invertebrates of the Gaplangyr State Nature Reserve

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Key words: Northern Karakum, invertebrates, scientific research, new species, endemics.

Introduction and key objectives

The Gaplangyr State Nature Reserve was established on August 16, 1979, to protect and restore the abundance of rare species of ungulates (Ustyurt urial, goitered gazelle and honey badger) and other representatives of fauna, as well as rare, endemic plant species and preserving the original hilly landscape. The territory of the reserve and its sanctuaries lies within the borders of Ustyurt and Sarykamysh physico-geographical regions and only in the southeast captures a small area of the Northern Karakum, called Zaunguz. The reserve is located on a clayey, sporadically undulating plain – the Kaplankyr plateau. Due to the peculiar natural conditions of the natural landscapes of the reserve, as well as in the whole of the Northern Karakum, various species of invertebrates have formed. Several-years-long research has shown that the fauna of invertebrates in Northern Turkmenistan totals about 1450 species [3;6]. The research has recommended including 21 rare and endemic species identified in a limited area of the northern part of the country in the Red Book of Turkmenistan [5]. Based on the analysis of published papers, a preliminary list of invertebrates of the Gaplangyr State Nature Reserve has been prepared for devising the fauna cadaster. Over 1253 species of arthropods belonging to 116 families and 21 orders were identified based on source reviews and following collections in the territory of the reserve. Hebrids (Coleoptera) have a special place among insects in terms of species diversity. Their species composition totals 677 species. Insects belonging to the orders Heteroptera, Diptera and Homoptera are also characterized by diversity of species. During our research conducted on the territory of the reserve and in adjacent areas in 2019-2021, the list of arthropods of the reserve has been supplemented by some species.

Methodology

According to the reserve's research work plan, field research is regularly conducted on the territory of the reserve and sanctuaries. In 2020, expeditions were organized under the CADI project to study the biodiversity of fauna of the reserve. Consequently, the Gulantakyr (Chyryshly) protected area and the territories of the Shasenem (Edikhovuz, Uzynshor), Sarygamysh (Mergenashan) sanctuaries, as well as the adjacent territories of Zengibaba and

Atabay shor lakes were explored. Different methods were used to collect the invertebrates [2]. The population of invertebrate desert biogeocenoses is divided into species that inhabit plant tissues, soil surface, soil and litter, and burrows of mammals. During the fieldwork, we also collected individuals using night light traps, conducted desk processing on the ground and in labouratory conditions, and created a photographic archive of insects.

Results

Spiders *(Aranei)* represent a large order in the Arachnida. Turkmenistan's fauna features 394 species and 401 species in the desert parts of Central Asia [4]. More than 60 species of spiders belonging to 18 families have been identified in the reserve. Two species from the family of orb-weaving spiders -*Araneidae* are indicated in the area of the Burchlyburun reserve [3]. *Argiope lobata Pallas,1172* (on July 1, 2019) and *Araneus pallasi (Thor), 1875* (on May 1, 2020) were observed on the territory of the Shasenem sanctuary and on the eastern part of the Uzynshor Lake.

Crab spiders - *Thomisidae* are found in a wide variety of habitats, from crowns and tree trunks to grasses and litter. *Thomisus onustus Walck,1805* was observed on saxaul in the territory of Shasenem sanctuary, Uzynshor and Atabayshor lakes on 02.05.2020. The species was previously noted in the protected area - Burchlyburun (Chronicles of Nature, 1984). On 05.02.2020, Mogrus sp. belonging to the jumping spider family Salticidae was found in the above-mentioned territories. Nine species of leaping spiders have been identified in the protected area [3]. *Oculicosa supermirabilis Zyuzin, 1993* from the *Lycosidae* family was found on a sagebrush formation on the Kaplankyr cliffs on 02.05.2020.

The Empusa *(Empusidae)* family and the *Empuza pennicornis (Pallas, 1771)* species were first recorded in the list of insects of the Northern Karakum desert, including in the reserve, on 03.05.2020 on the black saxaul of the Shasenem sanctuary. Empuza pennicornis is endemic of Central Asia. It is included in the Red Book of Turkmenistan (2011) and protected on the territory of the Kopetdag State Nature Reserve.

The Goby Winter Damsel *(Sympecma gobica Foerster, 1900)* of the *Lestidae* family is indicated for the first time in the list of insects of the reserve from the Odonata order. It was collected on 01.05.2020 at the Mashrykaji site in the territory of the Sarykamysh sanctuary. The species inhabits plains and mountains. It is observed at the height of 300 to 2500 m above sea level. *Orthetrum cansellatum (Linnaeus, 1758),* the Western Palearctic species of the family *Libellulidae,* was also observed in the the sanctuary.

The species belonging to 15 families of the Lepidoptera order were previously found in the territory of the reserve. On 10.04.2020, *Papilio machaon Lin, 1758* of the *Papilionidae* family was observed on the Zengibaba Lake in Jurushlyja. The swallowtail is a rare transpalaearctic

species. It was previously identified only in the Lower Amudarya reaches of the Northern Turkmenistan. The species is also observed in the Central Karakum Desert and on the territory of the Repetek State Biosphere Reserve. Following our collections, the species number of *Nymphalidae* also increased. The red admiral *(Vanessa atalanta (Linnaeus, 1758)* was observed in late autumn on 26.10.2019 on Uzynshor Lake on black saxaul forests. It is a Western Palearctic species. An adult insect winters. Caterpillars feed on nettles and grow high in mountainous areas. The butterfly flies over great distances.

On 18.07.2019, the Polyommatus icarus (Rott.) from the *Lycaenidae* family was observed on the camel's thorn at the Zengibaba site. The species is also found in the Central Karakum desert.

The winter moth - *Cheimoptena pennigera Danilewsky, 1969* was observed from the *Geometridae* family. It is a Turanian arid species. It is adapted to sandy deserts and has been identified for the first time in Northern Karakum, on the territory of the Gulantakyr Reserve, as well as on the Atabayshor Lake and Dashoguz branch of the main collector of Turkmenistan's Altyn Asyr Lake. It grows in one generation and was observed in the winter on 31.01.2021. The caterpillar grows on saxaul. In other parts of the Karakum desert, the species was found in Repetek [1]. In Kazakhstan, the species is listed in the Red Book. Its distribution area: Turkmenistan, Uzbekistan, and Kazakhstan.

Discussion

Arthropods are one of the important components of the biogeocenosis of the reserve. Based on many years of research and recent years' data, an inventory of arthropods of the reserve has been compiled. The biodiversity of arthropods in the reserve is represented by over 1253 species. The obtained data on the number of species does not exhaust the entire faunal composition of invertebrates (literature data analysis and field works continues). Further broader and more in-depth research is needed to study the faunal and zoogeographical composition, abundance, development dynamics and trophic relationships of arthropods in the territory of the reserve and its sanctuaries. It is important to organize joint research expeditions in the territory of the reserve involving scientists from the region and foreign countries.

Conclusion

The research provided new data on the biodiversity of arthropods of the reserve. The paper provides new information on 12 species belonging to different orders found in the territory of the reserve and adjacent areas. In addition, for the first time, the Empusa family and the Empusa pennicornis from the Mantodea order from the Red Book have been identified in the

territory of the reserve. A rare species of swallowtail *(Papilio machaon)* from the Papilionidae family has been observed in a new place of its distribution in the Northern Karakum Desert.

Acknowledgements

We express our gratitude to the CADI project for the assistance. In 2020, the fieldwork on the territory of the reserve was organized as part of the project. Yu. Marusik, S.N. Borisov, V.V. Dubatolov also helped in identifying the species composition of spiders, dragonflies and lepidopterans. We express our sincere gratitude to our fellow scientists for their assistance.

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Current state of ornithological fauna of the Gaplangyr State Nature Reserve

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Key words: Gaplangyr, Bird, Species, Eremophiles, Limnadophiles, Sinanthropes.

Introduction and key objectives

The Gaplangyr State Reserve is located on the south-eastern outskirts of the Ustyurt, in the contact zone of the Zauzboy folding region and the Zaunguz Karakum Desert, occupying the northwestern part of the Gaplangyr plateau (coordinates E57°11'11.134, N41°22'55.121") and borders with the Republic Uzbekistan in the northwest.

As per geobotanical zoning of the Palearctic, its territory is attributed to the southern desert district of the Turan lowland of the Turan province of the Asian desert area. As per forestry zoning of the USSR, the territory of the reserve is attributed to the ephemeral desert sub-zone located in the desert zone. The main territory of the Gaplangyr reserve and its wildlife sanctuaries is located in the Ustyurt and Sarygamysh physical-geographical areas of the northern desert subzone. Typical landscapes of the region are clay plain on the tertiary plateau with semi-shrub vegetation and sand flats, interspersed with dry-type playa plains with shrub and ephemeral vegetation.

Due to the variety of types of natural and anthropogenic landscapes, the reserve is the benchmark of nature in Northern Turkmenistan. The highest point is on the Gaplangyr cliff to the east of the Goklenguyi well and sits a302 metres above sea level, the minimum mark is in the Chyryshly - 45 metres. The reserve was established in 1979 to conserve and restore the mountain sheep, goitered gazelle, honey badger, as well as re-acclimatize the kulan and create conditions for wintering of migratory saiga [2]. Currently, the area of the reserve totals 275 735 hectares and administratively it is divided into two sections: Gulantakyr and Gaplangyr. Two wildlife sanctuaries – the Sarygamysh (established in 1980, the current area totals 541 466 hectares) and Shasenem (established in 1983, the current area totals 109 002 hectares) are adjacent to the reserve on the northern and northeastern sides and serve as a buffer zone. The Sarygamysh sanctuary is established to protect migratory waterfowl and other birds in the water area of the Sarygamysh reservoir and adjacent territories, protect and conduct biotechnical activities to improve the habitats of the goitered gazelle and saiga to rehabilitate them for further use and re-acclimatization of the kulan. The Shasenem

sanctuary is established to conserve and increase the abundance of rare ungulates (goitered gazelle, saiga) in their permanent habitats and migration areas.

The reserve has a peculiar fauna. The fish fauna of the Sarygamysh Lake, mainly formed by invaders from the water bodies of the accessary hydro-reclamation systems and the lower reaches of the Amu Darya, is very diverse, and totals 32 species. There are 25 species of reptiles and 45 species of mammals. In severe winters, saigas occasionally migrate from Kazakhstan and Uzbekistan to North-Western Turkmenistan, as well as to the territory of the reserve. There were 213 species of birds on the territory of the reserve and two sanctuaries (including the Sarygamysh Lake), of which 58 species nest in desert areas and by water, the rest are migratory, wintering, and vagrant [3-6, 8-10]. Twenty-five species are included in the Red Book of Turkmenistan (2011). In the last two-three years, during scientific research work and surveys within the CADI project in 2020-2021, the list of birds of the reserve was supplemented by two species: Griffon Vulture - *Gyps fulvus* and Grey Wagtail - *Motacilla cinerea* and now reached 215.

The key objectives of this research have been to study the current species composition, the nature of stay, nesting and distribution in the desert complexes of the reserve and adjacent territories.

Methodology

The data for this paper were collected during fieldwork between 2011 and 2021 in the Gaplangyr Nature Reserve and its sanctuaries, as well as adjacent territories.

Observations were conducted on specifically developed routes along the Gaplangyr cliff and on the remnant hills of Tarymgay, Gangagyr, Goyungyrlan, Zengibaba, Butendag (northeast of the Sarykamysh Lake) and the Burchliburun Cape (south-eastern part of the Ustyurt Plateau). The Zengibaba, Uzynshor, Atabaishor, Sarygamysh and Ak-yayla lakes (south of the "Altyn asyr" Turkmen lake) were also surveyed.

The censuses were conducted by route methods: on foot and by car, the length of each route was, respectively, within 1-10 and 5-50 km (determined visually, by car speedometre and by the "Garmin" GPS navigation system). Small birds were identified from 25 m on both sides, medium-sized birds from 100 m, and large birds from 500 m. Viking 10x42 and 16.5x20 binoculars, as well as a Canon camera and a bird identifier were used to identify the bird species [7].

Findings

From 2011 to 2021, the data were collected on 211 bird species in the Gaplangyr Nature Reserve and adjacent territories, the number of whose species varies from year to year. This paper analyses the distribution of the observed species by orders and the nature of their stay in the surveyed territories and the distribution of species within orders in the desert ecosystems. These data shall enable us to supplement the previously known data of the studied area.

Table 1

Distribution of ornithological fauna species of the Gaplangyr Reserve by orders and the nature of stay

No.	Order	Total number of species	Transient-nesting and wintering	Transient-nesting	Transient	Transient-nesting	Non-migratory	Transient –non breeding	Vagrant
1	Podicipediformes	5	1	-	2	2	-	-	-
2	Pelecaniformes	4	1	1	1	1	-	-	-
3	Ciconiiformes	10	1	-	7	1	-	1	-
4	Phoenicopteriformes	1	-	-	-	-	-	1	-
5	Anseriformes	22	2	3	7	10	-	-	-
6	Falconiformes	20	1	1	11	2	4	-	1
7	Galliformes	3	-	1	-	-	2	-	-
8	Gruiformes	6	1	3	2	-	-	-	-
9	Charadriiformes	48	1	9	33	4	-	-	1
10	Columbiiformes	7	-	1	3	-	3	-	-
11	Cuculiformes	1	-	1	-	-	-	-	-
12	Strigiformes	2	-	-	-	-	2	-	-
13	Caprimulgiformes	2	-	-	2	-	-	-	-
14	Apodiformes	2	-	1	1	-	-	-	-
15	Coraciiformes	5	-	3	1	-	1	-	-
16	Piciformes	1	-	-	-	-	1	-	-
17	Passeriformes	72	1	8	48	4	11	-	-
	Total	211	9	32	118	24	24	2	2

Source: Author's own elaboration.

As shown in Table 1, the avifauna core in the Gaplangyr Nature Reserve consists of transient species, whose number reaches 118, transient-nesting - 32 species, transient-wintering and

non-migratory - 24 species each, transient-nesting and wintering - nine species, transient-non breeding and vagrant - two species each.

Passerines are the most numerous order in the surveyed area with 72 species, including 48 transient species, 11 non-migratory, eight transient-nesting, four transient-wintering, and one transient-nesting and wintering species. Charadriiformes also have a high number of species - 48, including 33 transient, nine transient-nesting, four transient-wintering, one transient-nesting and wintering, and 1 vagrant species. Of the observed 22 species of Anseriformes, ten were transient-wintering species, seven were transient, three were transient-nesting, and two were transient-nesting and wintering species. Falconiformes are s represented by 20 species, including 11 transient-wintering species, four non-migratory, two transient-nesting species. Transient-nesting, transient-nesting and wintering and vagrant species are represented by one species each. Other orders are also rather fully presented - from one to ten species.

The distribution of species as per groups in desert ecosystems of the surveyed area is presented in Table 2. Eremophilic - typically desert, Limnophilic - water-tugay, and Synanthropic - anthropogenic complexes are highlighted as the most characteristic ones here. Interpenetration of individual species is possible at the border areas of these complexes, which can settle equally well in different conditions. However, most species are characterized by attachment to a certain type of territory, beyond which they can go only in certain seasons of the year - during migrations or wintering.

Table 2

Nature of species distribution in desert complexes

No	Order	Number of species by desert complexes					
		Eremophilic		Limnophilic		Synanthropic	
		Total	Nesting	Total	Nesting	Total	Nesting
1	Podicipediformes	-	-	5	1	-	-
2	Pelecaniformes	-	-	4	3	-	-
3	Ciconiiformes	-	-	10	1	-	-
4	Phoenicopteriformes	-	-	1	-	-	-
5	Anseriformes	-	-	22	5	-	-
6	Falconiformes	17	5	3	-	-	-

7	Galliformes	2	2	-	-	1	1
8	Gruiformes	2	1	4	3	-	-
9	Charadriiformes	2	1	46	9	-	-
10	Columbiiformes	4	1	-	-	3	3
11	Cuculiformes	-	-	1	1	-	-
12	Strigiformes	1	1	-	-	1	1
13	Caprimulgiformes	2	-	-	-	-	-
14	Apodiformes	1	-	-	-	1	1
15	Coraciiformes	-	-	1	1	4	3
16	Piciformes	1	1	-	-	-	-
17	Passeriformes	49	11	15	3	8	6
	Total	81	23	112	27	18	15

Source: Author's own elaboration.

As shown in Table 2, limnophilic birds are the most represented with 112 species, of which 27 are nesting birds. This confirms that there are several large and small natural and artificial reservoirs in the surveyed area - Sarygamysh, Zengibaba, Uzynshor, Atabayshor and Ak-yayla lakes [1]. Eremophilic birds have a large number of species - 81 (23 nesting species), whose core is made of passerines (49 species). Synanthropic birds with 18 species, of which 15 are nesting, round out the desert complex.

Discussions

The highlighted desert complexes feature diverse species and saturation, from which can conclude that the avifauna of the Reserve has been formed. The diverse nature makes the Reserve and its adjacent territory attractive for a large number of species of different groups of birds both during flyby and wintering and during nesting. It is worth noting that during 11 years of observations the composition and nature of stay of birds in the Reserve and adjacent territories were inconstant, which was caused by changes that took place in various ecosystems. The eremophilic complex remained the most constant, where the composition and abundance of eremophilic species varied mainly depending on weather conditions of the year. In the last decades, a network of wetlands has continued to develop in the north of Turkmenistan, and, in particular, the second largest lake after Sarygamysh - "Altyn Asyr" Turkmen Lake. Along the channels on the way to this lake, reservoirs of different

sizes have formed. Such a branched arrangement of channels with reservoirs in the desert has a positive effect on the migratory situation and the distribution of limnophilic birds. Actually, these reservoirs now represent th points of stopping, resting, feeding and nesting. As the network of wetlands developed and channels were extended to the center of the Karakum Desert, synanthropic species settled in. At present, the synanthropic complex is fully formed and only minor changes are possible in the coming years.

Conclusions

Thus, the avifauna of the Gaplangyr Reserve and its adjacent territories feature a large number of species and systemic diversity, which is achieved by the presence of various faunal complexes here, formed under various habitats.

During the 2011-2021 field research in the Gaplangyr State Nature Reserve and its adjacent territories, 211 bird species falling under 17 orders have been recorded. There are 65 species of nesting birds, including 23 species in the eremophilic complex, 27 in the limnophilic complex and 15 species in the synanthropic complex.

Naturally, this number of species doesn't represent the final figure; global climate change causing change in the residence of birds and the boundaries of their habitats results in the penetration of new species into the country, especially in the outskirts, which will be revealed as a result of further ornithological research.

Acknowledgements

The authors express their sincere gratitude to the management of the Central Asian Desert Initiative (CADI) project for organizing the field research in 2020-2021.

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New data on the theriofauna of South Ustyurt (Uzbekistan)

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Keywords: South Ustyurt, rare species, theriofauna

Introduction and key objectives

The Ustyurt Plateau extends to the territory of three countries - Kazakhstan, Turkmenistan and Uzbekistan, between Mangyshlak Peninsula, the Kara-Bogaz-Gol Bay, the Aral Sea and the Amudarya River delta. The total area is around 200 000 sq. km. Clayey and clay-stony deserts with vast takyrs, salt marshes and inner depressions prevail on the plateau; there are quite large sandy areas. The plateau is separated from the surrounding plains by high cliffs, often indented by large gorges. From the south, the plateau is adjoined by the Kazakhlyshor salt marsh and depression and the Sarykamysh depression with the namesake lake in it. The vegetation cover is formed by various combinations of communities belonging to 4 edaphotypes: gypsophilic, halophilic psammophilic, and tugai. The territory of Ustyurt belongs to the zone of "temperate deserts" *(cold winter deserts)*.

In 2017, two expeditions explored Southern Ustyurt in order to study terrestrial vertebrates. The research was conducted in collabouration with the Institute of Zoology of the Academy of Sciences of the Republic of Uzbekistan as part of the Central Asian Desert Initiative (CADI), which is implemented jointly by the University of Greifswald, the Michael Succow Foundation and the UN FAO Sub-Regional Office for Central Asia. CADI is part of the International Climate Initiative (IKI). The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMUB) supports this initiative pursuant to the decision of the German Bundestag.

Data and methods

Foot and vehicle-based recording were used to conduct mammal censuses. The total length of vehicle routes was about 1000 km (May) and 860 km (September). The average length of walking routes per day was about 5-7 km. The total length of walking routes was 82 779 m (May) and 25 800 m (September). Mammal locations were recorded using a GPS navigator. Two 10x42 Nikon Monarch binoculars, spyglass with a tripod (Nikon ProStaff, 48x60), smartphone (Xiaomi Redmi 5) with installed LocusPro software, Google Hybrid and Marshruty.ru maps were used for navigation and trace recording. Eleven Bushnell HD and Covert UV562HD camera traps were installed.

Trip dates were as follows: May 12-28, 2017, and September 22-27, 2017.

Results

The expeditions collected data on the distribution of seven rare mammal species included in the Red Book of the Republic of Uzbekistan (2019), of which three species have endangered status in the IUCN (IUCN red list), and 3 species are included in the Convention on the Conservation of Migratory Species (CMS). Below is the information on each of the species:

1. Brandt's Hedgehog *Hemiechinus hypomelas hypomelas*. The species was recorded on May 25, July 2, August 11 and 20 with a camera trap installed in the Shakhpakhty depression. On May 15, a skin (was found on the Karatash rocky ridge, located on the northern shore of the Sarikamysh Lake.

2. Corsac fox *Vulpes corsac turcmenicus*. One individual was observed 21 km north of the Sukhoe Ozero Depression. Traces were observed - in an inner depression 14 km west of Kerney Lake; in the cliff gorge on the Northeastern Sarykamysh; in the Shakhpakhty depression; 2 km northeast of this depression - on a takyr with a temporary watering point; 12 km northwest of Sukhoe Ozero depression- on a takyr with a temporary watering point and on a takyr located at the southern border of the Assake-Audan depression.

3. Honey badger *Mellivora capensis buechneri*. It was recorded twice by a camera trap on the cliff of the North-Western Sarykamysh - on May 25 at 6.08 am, descending from the plateau into the undercliff plain; on June 4 at 22.56, ascending to the plateau. On May 24, the honey badger was caught on a camera trap installed 12 km northwest of the Sukhoe ozero depression on the edge of the takyr with a temporary watering place. In addition, diggings and excrements were observed on the Kaplankyr cliff, under the cliff to the north-west of the Sarikamysh Lake. Fresh traces were observed on May 15 on the shore of the Sarykamysh Lake, opposite the Karatash rocky ridge.

4. Turkmenian caracal *Caracal caracal michaelis*. On May 18, excrements were recorded on the cliff of the North-Western Sarykamysh. A caracal was recorded by a camera trap on September 22, at 7:06 am, 2.7 km south of this place, on a cliff, descending from the plateau into the undercliff plain. On September 23, traces were recorded in the same area under the cliff. On September 25, excrements were observed in another part of Southern Ustyurt, on the edge of the Kaplankyr cliff.

5. Transcaspian urial *Ovis vignei arkal*. It was observed on the cliffs of the Northwestern Sarykamysh, Kaplankyr Reserve, and the Sukhoe ozero depression as it was the case in previous expeditions of 2012-2014 (Marmazinskaya *et al*., 2012, 2013, 2016; Gritsina *et al*., 2016). On May 18, 2017, fresh traces and excrements were observed on the edge of the Northwestern Sarykamysh cliff and at two locations located 2 km from each other. On September 22, the camera trap recorded at 9.15 am one individual ascending the plateau

at 400 m from one of the locations, on the descent. On May 19, a female with a lamb was observed on the cliff. These observations show that sheep in small numbers keep together on the cliffs of the North-Western Sarykamysh throughout the year. On May 20, a group of 7 individuals (3♀♀+4juv) was observed on the northeastern side of the Sukhoe Ozero depression. On May 22, a group of 8 urials (3 adult females + 5 lambs) rested on the outskirts of the Kazakhlyshor salt marsh, on a small ridge under a cliff. On May 23, the remains of a female eaten by wolves were found in one of the gorges. A camera trap installed on a plateau recorded 18 individuals on a low ridge two kilometres from the Kaplankyr cliff from May 22 to September 23. These were single females, groups of 2-3 females and young males, and one adult single male. On September 25, a male was observed resting in the Kazakhlyshor depression under a gypsum remnant. Fig. 1 shows the distribution of the Transcaspian urial based on research in 2012-2014. In 2017, the urials were observed in all of these locations. In addition, new sightings have been added to the map and highlighted in red. In May, traces of the Transcaspian urial were registered in new areas - in the cliff of the North-Eastern Sarykamysh, including, not far from the Turkmen border. Ungulate traces were observed on the sides of the Shorja depression, fresh traces of urials were found at the bottom of the depression, and one female was seen. The high sides, in some places, are indented by gorges and thus provide suitable habitat. In Shakhpakhty depression, three gorges were studied and two-five chains of traces were found in each, and excrements were found in one of them. Traces were also observed in the southwestern part of the Barsakelmes salt marsh near a stream with very salty water. The traces found on Barsakelmes confirm observations made in 2012 in the same area, when part of a horn was found, as well as a lamb, which an inexperienced member of the expedition could not identify but claimed that it was not a calf of goitered gazelle, which he saw in the "Jeyran" Ecocenter and knew well what they looked like. At that time, these findings were not given due importance. Horns and traces were found in the Akshaimak tract. These findings confirmed our 2012 assumptions about the presence of urials here, made only based on the presence of traces on the steep walls of the gorge. Also, traces of the urials were observed in the system of cliff gorges stretching south-west of the Sarykamysh Lake in the territory bordering Turkmenistan, starting from the Agynysh descent and continuing to the cliffs surrounding the Kara-Sazakly depression (Turkmenistan). In all of these habitats, the Transkaspian urial is quite rare. It is common only in the Kaplankyr/Kazakhlyshor and Sukhoe Ozero areas.

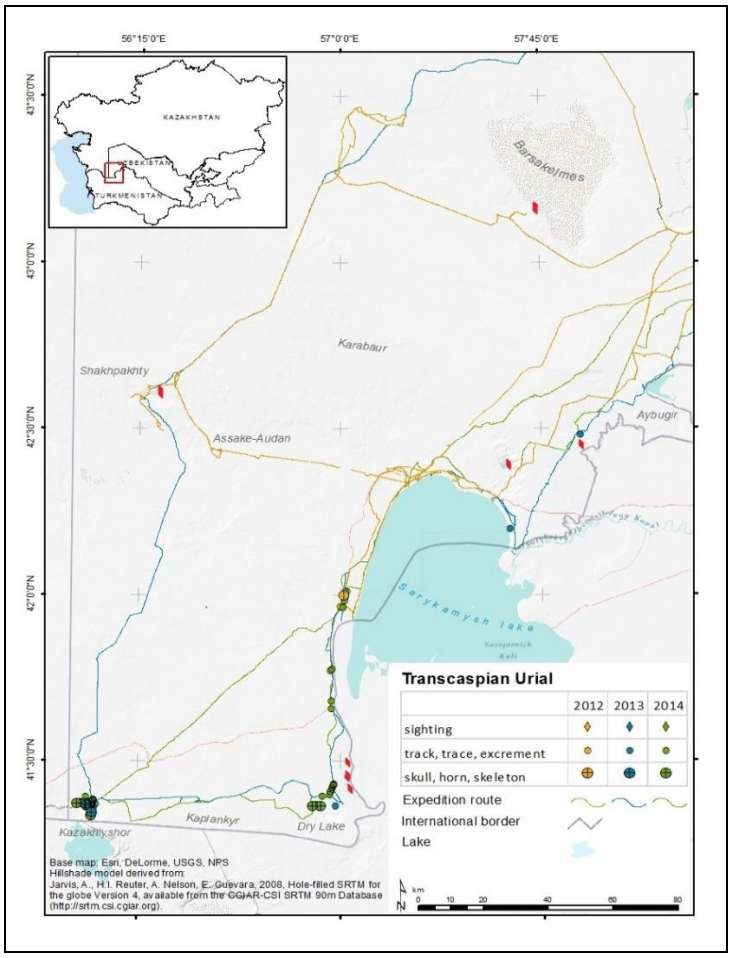

Fig. 1. Distribution of Transcaspian urial in Southern Ustyurt. New distribution locations found in 2017 are highlighted in red. Map Source: Ten, A., modified to comply with UN. World map (2022)

6. Goitered gazelle *Gazella subgutturosa subgutturosa*. As in previous expeditions of 2012-2014, the goitered gazelles and their traces were observed along the entire coast of the Sarykamysh Lake; on the areas of the plateau adjacent to the cliff surrounding the lake; in the area of the Sukhoe Ozero depression, the Kulantakyr tract; on the Kaplankyr plateau and in the Kazakhlyshor depression; in the Assake-Audan and Shakhpakhty depressions. A large number of traces, including trails, were observed near engineering and technical facilities on the border with Kazakhstan.

The camera traps recorded the goitered gazelles in the following areas: on July 5 at 6.57, ♂ad descended from the cliff to the Sarykamysh plain in North-Western Sarykamysh; on June 26 at 20.05, ♂ad and on July 9 at 6.12, ♀ad were recorded in the plain between the cliff and the Sarikamish Lake; on July 7 at 21.00, ♀ad was observed in the Shakhpakhty depression; on May 28 at 10.25, 2 ♀♀ (adult and one year old), and on July 4 at 5.34, ♂ad were observed in Shorja.

In May, four new habitats of goitered gazelle were found: the Akshaymak tract located 35 km northeast of the Sarikamysh Lake; the Shorja depression (11 km northeast of Sarykamysh Lake); sands and an adjacent clay area (4-9 km from the northern shore of the lake) and an area 8 km southwest of the Agynysh descent and 15 km southwest of the Sarikamysh Lake.

In September, 124 goitered gazelles were recorded during a 410 km long vehicle-based recording, of which 46 were observed grazing in the undercliff plain of the Northwestern Sarykamysh in the territory bordering Turkmenistan. The sex and age composition of goitered gazelles was as follows: ♂♂ - 26, ♀♀ - 29, juveniles - 35, individuals of undetermined sex - 34. Of all observed goitered gazelles, 20.9 percent were males, 23.4 percent - females, 28.3 percent - juveniles, and the sex of 27.4 percent of individuals was not determined. 34.8 percent of offspring consisted of twins; 65.2 percent had one calf each. It is possible that the number of twins was higher, but due to the death of one of the calves, the number of families with one calf was higher. Six females (20.7 percent) had no calves.

In May, 44 goitered gazelles (♂♂ - 15, ♀♀ - 11, juveniles - 4, of undetermined sex - 14) were observed during a 645 km long route. Of all goitered gazelles observed, 34.1 percent were males, 25 percent were females, 9.1 percent were juveniles, and 31.8 percent of individuals were of undetermined sex. Few calves were observed, probably because they were still in the hiding stage and did not follow females.

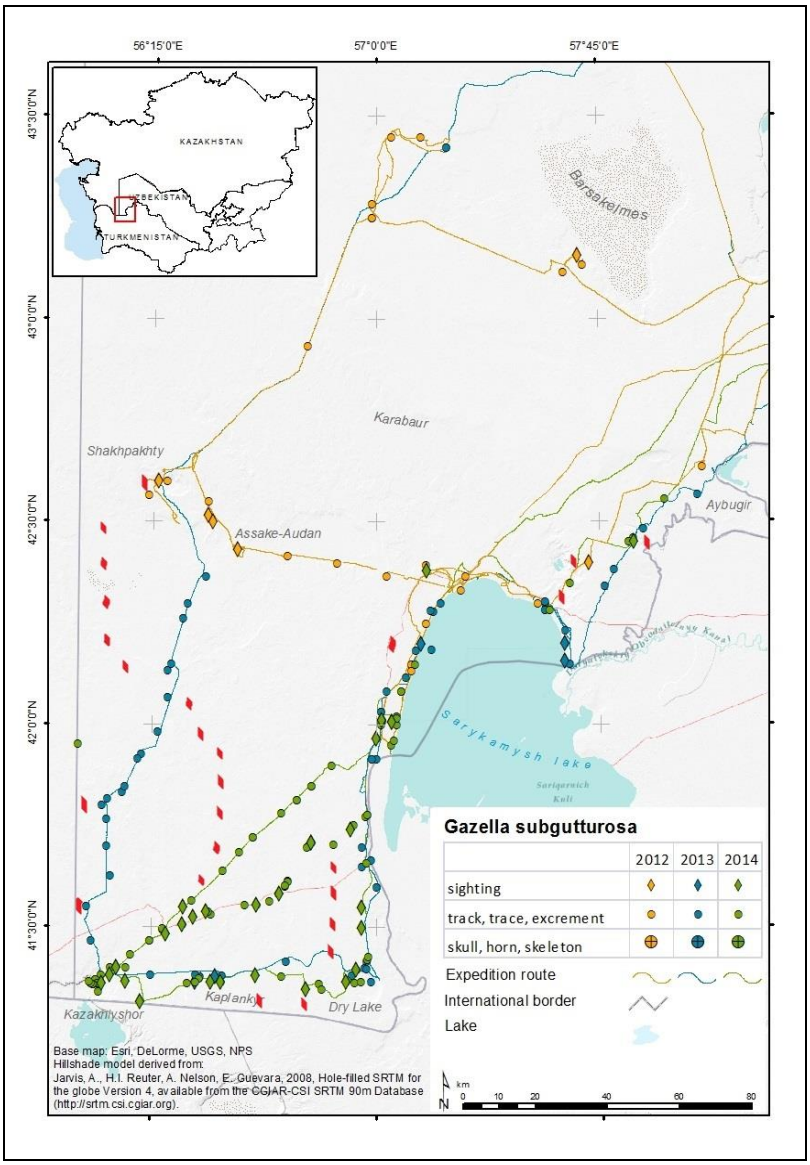

Fig. 2. Distribution of goitered gazelle in Southern Ustyurt. New distribution locations found in 2017 are highlighted in red. Map Source: Ten, A., modified to comply with UN. World map (2022)

Fig. 2 shows the distribution of the goitered gazelle based on research results in 2012-2014. In 2017, gazelles were observed in all of these locations. New sightings have been added to the map and highlighted in red.

Compared to the previous years of research, based on the number of traces of gazelles found and observed, the abundance of goitered gazelle in the vast areas between the Sukhoe Ozero and Kazakhlyshor depressions, Kaplankyr cliff and the southern borders of Assake-Audan, and in the Assake-Audan depression itself has increased.

7. Turkmenian kulan *Equus hemionus kulan*. As it was the case in previous expeditions of 2012-2014, traces were observed along the northern and northwestern shores and the undercliff plain of the Sarykamysh Lake, as well as in the areas of the adjacent plateau; on the plateau area adjacent to the cliff of the East Sarykamysh; in the area of the Sukhoe Ozero; in the Kulantakyr tract, including at the temporary watering place of the takyr; along the entire part of the plateau adjacent to the Kaplankyr cliff up to the engineering and technical facilities at the border with Kazakhstan.

On May 19, a group of 13 individuals was observed in the northwestern part of the Sarykamysh depression, on May 24, a female with a foal was observed on the Kaplankyr plateau near the border with Kazakhstan. On May 23 at 20.05, a kulan was captured by a camera trap installed 12 km northwest of the Sukhoe Ozero depression on a takyr with a temporary watering point. In May, traces were recorded in the area of the Agynysh descent. A kulan skull was found 11 and 8 km to the south-west of this descent, and a new habitat of kulans with a large number of fresh traces was found.

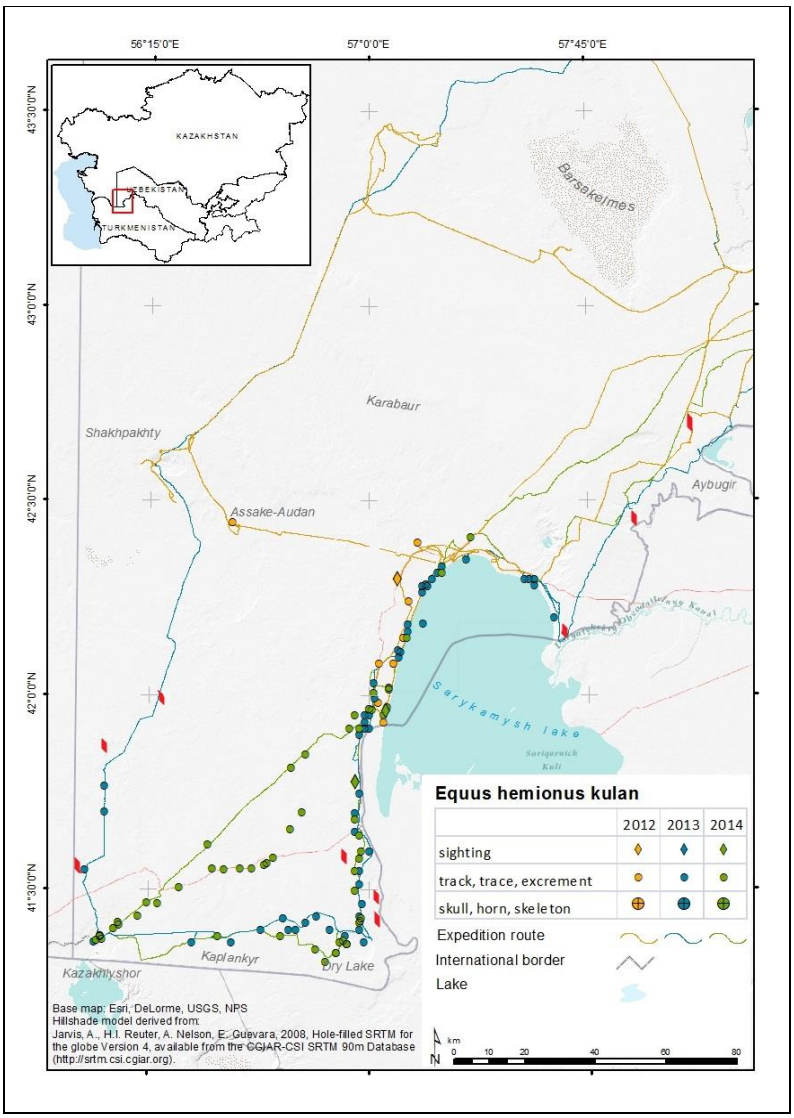

Fig. 3. Distribution of the kulan in the Southern Ustyurt. New distribution locations found in 2017 are highlighted in red. Map Source: Ten, A., modified to comply with UN. World map (2022)

In addition, the Akshaimak tract located 30 km northeast of the Sarikamysh Lake can be added to the new distribution locations of the kulan. On May 13, a fresh single trace of a young kulan was seen here. In May, single traces were observed on the only, more or less gentle descent from the Kaplankyr plateau to the Kazakhlyshor depression and in the depression itself. However, no traces were found leading to springs located in the gorges of the cliff. It is likely that the kulans have just begun to adapt to the Kazakhlyshor, as their presence in the depression was not previously observed. To the north of Kaplankyr, the last traces of their life activities were observed 23 km south of the Assake-Audan salt marsh.

On May 12, massing relatively fresh excrement of equids was found on a takyr located in the eastern part of South Ustyurt, 12 km north of the Kernei Lake (Turkmenistan) and 66 km

northeast of Sarykamysh Lake near a temporary watering point (water had already dried up). Traces were not imprinted on the solid ground. This could be kulans or feral horses coming from Turkmenistan. The situation in this area should be monitored.
Fig. 3 shows the distribution of the kulan based on research results in 2012-2014. In 2017, the kulans were observed in all of these locations. New sightings have been added to the map and highlighted in red.

Conclusions

Poaching is the main threat for animals in Southern Ustyurt and in the Sarykamysh depression. During our research south of the Assake-Audan depression, we found a poachers' camp with remains of killed gazelles, we found bones and pieces of goitered gazelle and kulan skins near fishing camps. Numerous motorcycle traces in some places are indirect evidence of poaching.

The establishment of the South Ustyurt National Nature Park in 2020 with an area of more than 1.4 million hectares will enable preservation of the unique biodiversity of a large area of the Northern deserts of Central Asia.

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Fig. 4. Honey badger, cliff of the NW Sarykamysh.

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Fig. 5. Caracal on the cliff of the NW Sarykamysh.

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Fig. 6. Female goitered gazelles in the Shorja depression.

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Fig. 7. Male goitered gazelle in Shakhpakhty

Acknowledgements

We express our sincere gratitude to the staff of the CADI project, the University of Greifswald, the Michael Succow Foundation and the UN FAO Sub-Regional Office for Central Asia, as well as to the Federal Ministry of Environmental Protection, Nature Conservation and Nuclear Safety (BMUB) for the opportunity to conduct this research.

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Status quo and vegetation dynamics in biogeocenoses of the southwestern Kyzylkum

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Key words: vegetation, productivity, grazing, degradation, state, dynamics.

Introduction and key objectives

Most of Uzbekistan's territory, i.e. over 70 percent is located in arid and semi-arid zones, which play a key role in the country's socioeconomic development.

Uzbekistan has enabling conditions for the development of animal husbandry and most of it, in particular, arid part is used for free range animal husbandry - mainly the Karakul sheep breeding. For centuries-long use of vegetation cover of arid pastures, there has been a mutually beneficial adaptation of vegetation to grazing of ungulates, which functions normally under optimal grazing conditions.

For many centuries, pastures in Uzbekistan have been used mainly for grazing the Karakul sheep. Grazing is recognized to be one of the main and powerful factors influencing the processes of landscape formation and formation of vegetation cover in arid areas. The state and fodder indicators of pastures, botanical composition of plant communities and ecological situation of ecosystems as a whole depend on conditions and nature of grazing.

Intensive use of plant resources of the arid zone led to disturbance of normal functioning of desert cenoses and transformation of ecosystems, species' impoverishment and decrease in the fodder suitability of vegetation in significant part of pastures in some areas.

In Uzbekistan, plants suitable for haying, fuel, and construction have been particularly damaged.

The availability of fodder resources does not mean that they can be fully utilized at any time of the year. The botanical composition of the vegetation is of great importance for the proper feeding of livestock. For example, it is most expedient to use cereal pastures as summer pastures, since cattle eat cereal grasses well in summer; ephemeral vegetation can only be used in spring. Saltwort is only eaten by livestock in the fall and winter. There are differences in the edibility of plants by different types of livestock.

Different botanical composition of vegetation, soil and climatic factors and water supply conditions determine the need for such a combination of different pasture massifs, which, subject to sequential integrated use, will provide all animals with sufficient fodder throughout the year and maintain normal pasture productivity.

These factors in pasture-based livestock farming create an urgent need to introduce pasture rotation. However, pasture rotation in the desert and semi-desert conditions of Central Asia requires strict consideration of the prevailing climatic conditions that determine the fodder yield and often water availability. Unsystematic grazing leads to a sharp decrease in pasture productivity, and sometimes to the exclusion of large areas from economic use for many years (Gaevskaya, 1971; Larin, 1960).

Methodology

Since the work was conducted on the territory of the Karakul district of Bukhara region, the research object was the vegetation cover of pastures in the Karakul district.

The research was conducted from mid-March 2019 to mid-August 2019.

Vegetation survey was conducted using the methods recommended at the Methodological Guidelines for the Geobotanical Survey of Natural Forage Lands of Uzbekistan (Tashkent, 1980).

Research results

2.1. Characteristics of geobotanical survey points

On the territory of the Karakul region, four sites were allocated for collecting field data to determine the status quo and capacity of the region's natural lands.

1) Surroundings of Durmon village (N39°34.931' E063°54.515')

The biotopes adjacent to the settlement are represented by areas of medium hilly sands with psammophilous vegetation. The dominant species and edificators are white saxaul (Haloxylon persicum), Calligonum microcarpum, jellyfish head (Calligonum caput-medusae), Richter's saltwort (Salsoa richteri), Russian boxthorn (Liceum ruthenicum). Perennial herbaceous species are represented by false camel thorn (Alhagi pseudoalhagi), Smirnowia turcestana. Good development of plants of the genus Suaeda, Salsola, Chenopodium and Euphorbia are characteristic of the in-between sloping hill depressions. The ephemeral synusia is characterized by cheatgrass (Bromis tectorum), Carex physodes, eremopyrums (Eremopyrum buonaparti, Eremopyrum cristatum), narrowleaf blue-eyed Mary (Coelpinia linearis), heliotropes (Heliotropium), etc.

Since the surveyed areas are located in close proximity to the settlement, one can observe significantly strong signs of anthropogenic impact - such as overgrazing and collecting the firewood for fuel.

2) Surroundings of the Kizil Rabot village (N 39°34.135' E063°58.254')

The biotopes in this area are represented by sandy-gravelly desert areas. Vegetation is represented by saxaul (Haloxylon aphyllum), calligonums (Calligonum microcarpum, Calligonum sp.), desert bindweed (Convolvulus hammada), Astragalus villosissimus, false camel thorn (Alhagi pseodoalhagi). The ephemera and ephemeroids are represented by Carex physodes, Strigasella, Eremopyrum, cheatgrass (Bromus tectorum), Remeria turcestanica, Ceratocephalus falcatus, heliotropes (Heliotropus), also there are bushes of peacock poppy (Papaver pavoninum) and others. As well as the previous one, this area is located near a village. In this regard, there is rather strong anthropogenic impact, thinning and reduction in the size of the tree and shrub vegetation.

3) Area near the Makhonkul Lake (N 39° 42. 131' E063°30.322')

The area represents medium hilly semi-fixed sands with psammophilous tree and shrub vegetation. The dominant plant species and edificators of plant associations in this area are black saxaul (Haloxylon aphyllum), Kashgar Tree (Tamarix hispida), Richter's saltwort (Salsola Richteri), calligonum (Calligonum caput-medusa, Calligonum microcarpum, C. sp.), bean caper (Zygophyllum sp.), desert bindweed (Convolvulus hammada), Astragalus villosissimus. The ephemera and ephemeroids are represented by maple-leaved goosefoot (Chenopodium sp.) in areas with a high degree of grazing pressure - in the territory of the sheep cot and adjacent areas. Euphorbia turczaninowii is often found in areas bordering with sheep cots. In areas with even grazing, ephemera and ephemeroids are represented by Carex physodes, cheatgrass (Bromus tectorum), Strigosella, eremopyrums (Eremopyrum christatum, E.buonaparti), Arabian schismus (Schismus arabicus), Ceratocephalus falcatus, narrowleaf blue-eyed Mary (Coelpinia linearis).

Cattle and small cattle graze in this area. In general, it is noteworthy (except for the near-sheep-cot area) that pastures in this area are in satisfactory condition: tree and shrub vegetation and ephemera are in satisfactory condition. It should be noted that sands move during strong winds. We have observed cases of significant filling of roads with sand in the summer period (sand-barking of unpaved roads in the territory of the massif itself).

4) Jigachi area (N39°31.345' E063°35.451')

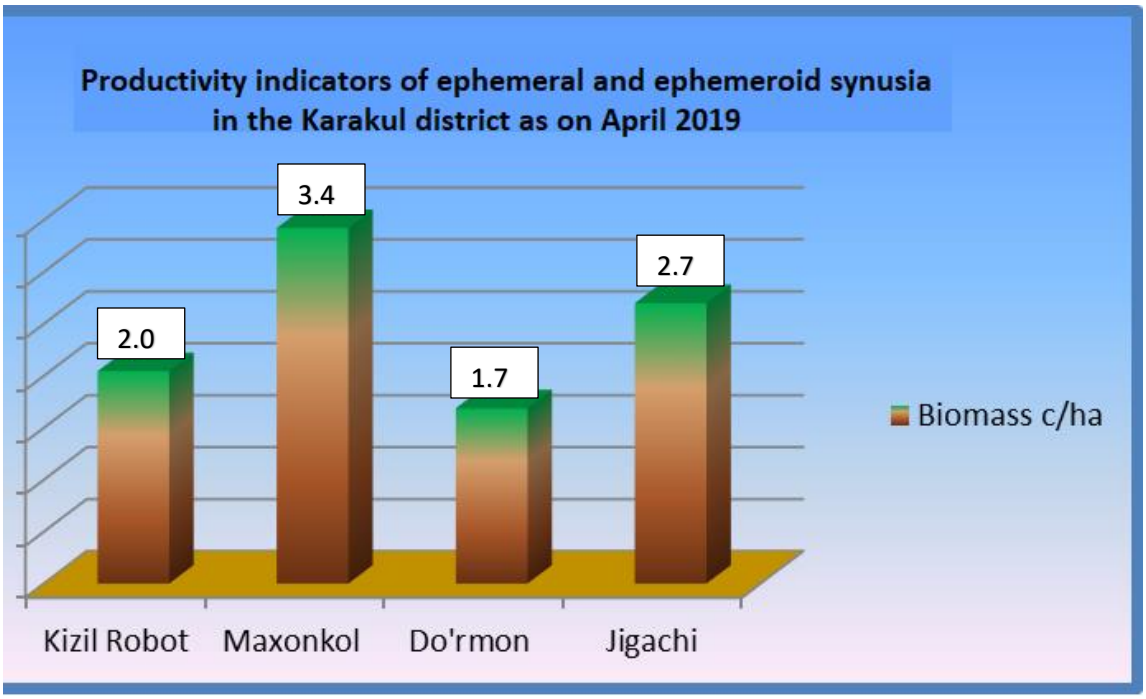
The area is located near the Jigachi village and is represented by medium-hilly sands fixed by vegetation. The dominants and edificators of vegetation cover are black saxaul (Haloxylon aphyllum) and white saxaul (Haloxylon persicum), tamarix (Tamarix hispida), calligonums, Astragalus villosissimus, false camel thorn (Alhagi pseudalhagi), desert bindweed (Convolvulus hammada), Acathophylum Bunge. Ephemera and ephemeroids are represented by Carex physodes, cheatgrass (Bromus tectorum), narrowleaf blue-eyed Mary (Coelpini alinearis), eremopyrums, Senecio subdentatus, etc.

2.2. Productivity indicators of the surveyed areas

In order to determine the biomass of the vegetation of ephemeral and ephemeroid synusia, cuttings were made using 50x10 cm frames and for areas with a heavy grazing pressure -

100x100 cm frames. Cuttings were made in fivefold replications for each area. In order to determine the productivity of tree and shrub vegetation, recording of plants per unit area was conducted and model bushes were sampled for each species and age category.

Figure 1 below shows the results obtained in determining the production of ephemera and ephemeroids.

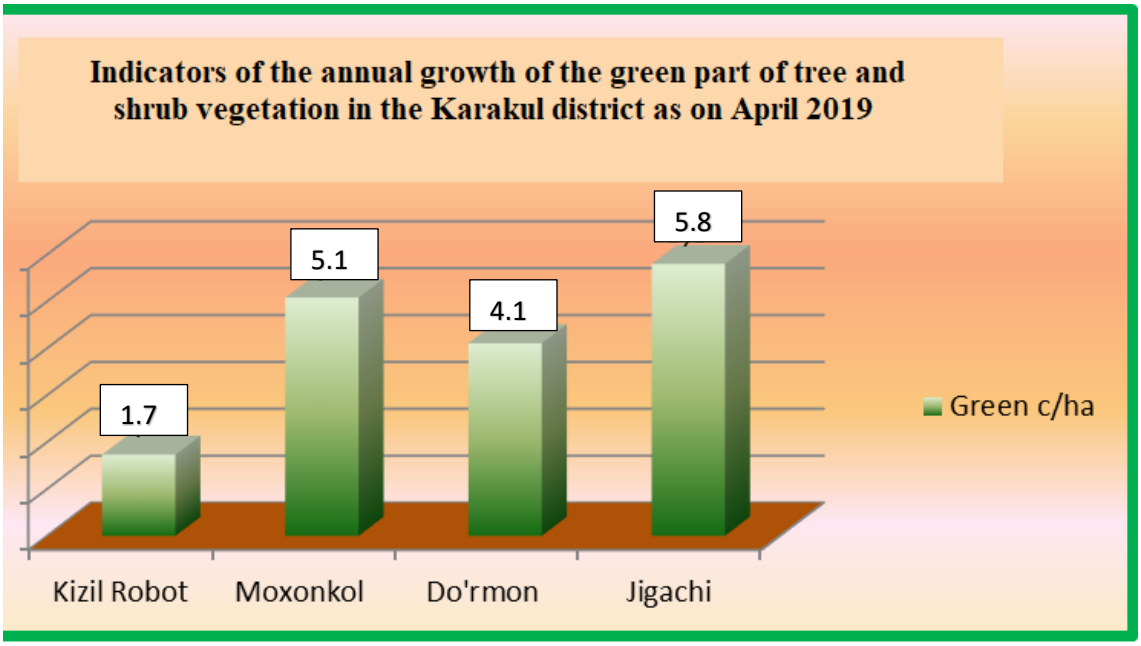


Source: Author's own elaboration.

Fig.1. Productivity indicators of ephemera and ephemeroids in different types of pastures in the Karakul district

As the Figure shows, the highest production rates of ephemera and ephemeroids are in the Makhonkul (3.4 cwt/ha) and Jigachi (2.7 cwt/ha) areas. The lowest are on the Durmon area (1.7 cwt/ha).

Figure 2 shows the indicators of the annual growth of the green part of tree and shrub vegetation.

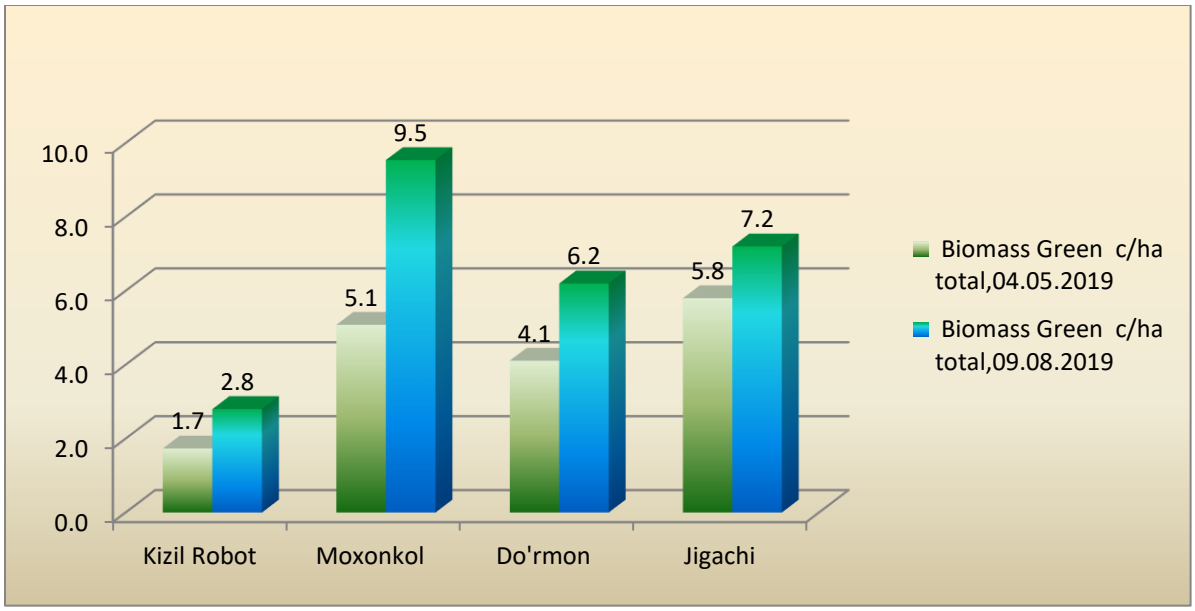


Source: Author's own elaboration.

Fig.2. Indicators of the annual growth of the green part of tree and shrub vegetation in the Karakul district as of April 2019

The data obtained to determine the productivity of the green part showed that in the spring, the biomass of the annual increase in tree and shrub vegetation ranged from 1.7 cwt/ha in the Kizil Rabot area, to 5.8 cwt/ha in the Jigachi area. (Fig.2).

Studies conducted in the summer, in August 2019, showed that by the end of summer there is an increase in the annual growth of vegetation. The results are shown in Fig. 3.



Source: Author's own elaboration.

Fig.3. Dynamics of annual growth of the green part of tree and shrub vegetation of pastures in the Karakul district for the period from April to August 2019

Based on calculations, on average, the growth of the green part of tree and shrub vegetation by August ranged from 24 percent at the Jigachi area to 87 percent at the Mahonkul area compared to April.

Conclusions

As our research has shown, the vegetation and soil cover are most affected in areas located near villages and sheep cots. This is due to high concentration of livestock in these areas and unsystematic grazing. Near the settlements, trees and shrubs are also most intensively harvested, as evidenced by the absence of large bushes of saxaul and calligonum. Radially, the impact of cattle at this level with the corresponding disturbance of the vegetation cover can extend from 3 to 5 kilometres.

In areas far from populated areas, the vegetation cover has insignificant changes and seems to be functioning normally. It should also be noted that the annual increase in tree and shrub vegetation during vegetation period is quite high - from 7.2 to 9.5 cwt/ha.

1. The highest rates of vegetation cover degradation were observed in the territory of sheep cots – 4th degree of degradation. Their size is up to one hectare. The areas adjacent to them can radially develop to a distance of 1 to 3 km and have 2nd to 3rd degrees of degradation. In the areas we studied, the radius of spread is up to 1 km.

2. Areas in the near-village territories of Durman and Kyzyl Rabot villages have signs of 1st and 2nd degree degradation. They are characterized by the absence of large saxaul *(Haloxylon aphyllum)* bushes, strong thinness and stratification of tree and shrub layer. Radial changes of this type were observed at a distance of 1-3 km from settlements.

3. Low rates of vegetation cover biomass and a high level of pasture disturbance in the Durmon and Kyzyl Rabot areas are due to the fact that these areas are located on the border areas with settlements. Accordingly, they are characterized by unsystematic grazing and high grazing pressure.

4. In the Makhonkul area, a partial mobility of sands was observed, which occurs with high wind activity. Presumably, this can be attributed to the initial stage of pasture degradation, if in the past, these sands were stable. The state of vegetation in this area is generally satisfactory.

5. There are no obvious signs of overgrazing in the Jigachi area, the pastures are more stable compared to other surveyed areas.

Acknowledgements

This work was completed within the framework of the Central Asian Desert Initiative (CADI), which is implemented jointly with the University of Greifswald, the Michael Succow Foundation and the UN FAO Sub-regional Office for Central Asia. CADI is part of the International Climate Initiative (IKI). The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMUB) supports this initiative pursuant to the decision of the German Bundestag.

We express our sincere gratitude to the staff of the project, the University of Greifswald, the Michael Succow Foundation, and the UN FAO Sub-Regional Office for Central Asia, as well as to the Federal Ministry of Environmental Protection, Nature Conservation and Nuclear Safety (BMUB) for the opportunity to conduct this research.

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Spatial dynamics of biodiversity and its monitoring in western temperate deserts (in the context of bird populations)

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Key words: biodiversity (BD), zoogeographic mapping, representativeness of territorial groups of birds, SPA.

Introduction and key objectives

The Old World's temperate deserts are common in Central Asia, by which the author understands the inner (continental) Asia, namely: its Western (*Parte Occidentali*), Middle (*Parte Mediani*) and Eastern (*Parte Orientali*) parts, respectively, spread from the Caspian Sea region to the Amudarya River inclusive, from the Amudarya River to Kashgaria and Dzungaria, and further east to the North China Plateau. Thus, starting from the deserts of the Iranian Plateau (Dashtekevir, Dashtelut, Dashtemargo and Registan) and the Turan Plain (Karakums, further - Ustyurt, the Caspian Narynkum and the Aral Karakum, Aralkum, Kyzylkum, Betpakdala, Moyunkum, Taukum and Saryishikotrau), the temperate zone extends through the Taklamakan and Tsaidam deserts to the Gobi Desert inclusively.

This does not contradict other territorial geographical classifications, in particular of M.P. Petrov (1973), and corresponds to the main principle for highlighting the temperate deserts - a very dry continental climate with hot summers and cold winters, with a sharp excess of evaporation processes over precipitation (Budyko, 1956; Dordrecht Geiger, 1961); and the entire vast territory of Central Asia has no runoff to the ocean (Mushketov, 1915), being characterized by closed basins. In the Russian-language geographical literature, the concepts of "northern" and "southern" deserts are distinguished, although they lie in the specified zone of temperate deserts. The "northern" deserts generally correspond to the Kazakhstan-Dzhungar sub-region, in contrast to the "southern" deserts, which are comparable to the Iranian-Turanian region (Petrov, 1973). The ecological and zoogeographical profile in the selected and studied region encompasses 2 more types of deserts, the so-called "transitional" and "foothill" deserts in addition to the "northern" and "southern".

In the temperate zone basins, rivers (Tedjen, Murgab, Amudarya, Syrdarya, Chu, Ili, etc.), whose feeding area lies in the mountainous parts of Central Asia, play the key role in water supply to deserts. We consider deserts and valleys of plain rivers (with macro-oasis) in the temperate zone, as an arena of BD existence, in their totality and interdependence with each other.

The research objectives have been: to map the bird habitats in the selected region, study the territorial groups of bird populations in the nesting period; conduct comparative

analysis of the IBAs network with the SPA network in terms of representativeness for BD conservation, including birds and other terrestrial vertebrates.

Methodology

The expeditions in 1976-2019 covered the entire designated region and surveyed the territory of 556.8 thousand km^2. The length of the entire region from the north (northern cliff of the Ustyurt) to the south (cliffs of the Badkhyz) in a straight line is 1 300 km, and from west to east in the northern half of the region - between the western and eastern cliffs of the Ustyurt - 400 km, in the southern half (between Chilmamedkum and the Obruchev steppe) – 1000 km. At the same time, in 1984-2019, a classification of the most important bird habitats for their preservation was conducted during the ongoing ornithological survey. Using a specific map of habitats (Rustamov, 1994) (which is not presented here due to the limited volume of the paper), the author conducted a comparative analysis of key bird areas with the current network of specially protected areas (SPA) represented, first, by reserves and sanctuaries.

As BD's integral component, the birds were selected as a convenient model to analyse the BD spatial dynamics. Two deserts of different origin and modern landscape structure – the Ustyurt and the Karakum with their adjacent peripheral desert territories (the Aral and the Caspian Sea regions, Chilmamedkum and Uchtagankum, Obruchev steppe) and, of course, the valleys of the Tedzhen, Murgab, Amudarya, Turkmendarya and Karakumdarya rivers (formerly Ilyalynsky and Karakumsky canals, respectively) served as the most suitable region in the zone of temperate deserts. In addition to these deserts, we also consider the Badkhyz and Karabil foothill semi-deserts.

The entire work and stages of our research on the spatial distribution and settling of birds have been based on the principles and methods of zoogeographic mapping (Cheltsov-Bebutov, 1973, 1976 *et al*; Rustamov, 1994 *et al*). The presented fundamental principles served as the basis for monitoring and systematic approach to the research of BD components and the subsequent practical use of findings.

Results

The region's PA network development was mapped during the work, indicating the areas of Important Bird Areas (IBAs) and the most important territorial groups of birds, and their representativeness against the habitats, especially intrazonal ones, such as water bodies, cliffs, and forest associations (tugai, black saxaul and pistachio woodlands).

Territories not covered by the PA network and/or the IBA network were identified during combined analysis and assessment of threats to territorial groups of bird populations and,

presumably, to BD hotspots. Therefore, the author proposed new additional territories and made recommendations for changing the status of existing PAs and IBAs (Fig. 1.).

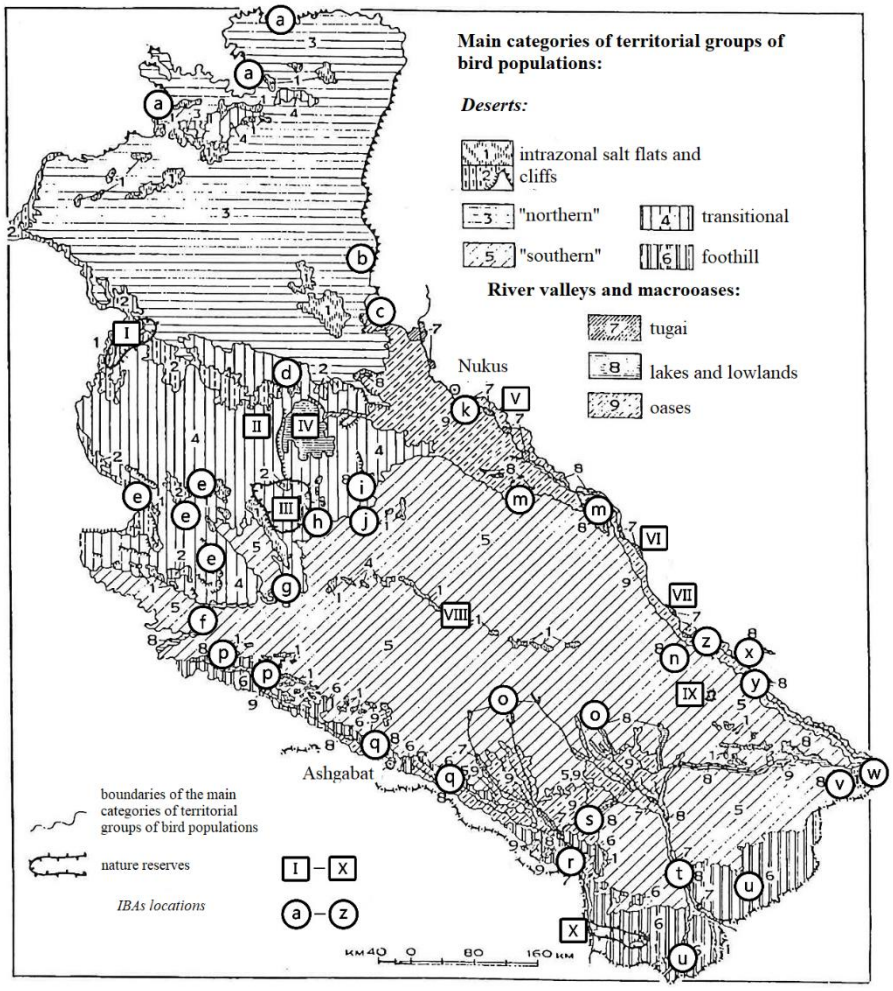

Fig. 1. Representativeness of the most important territorial groups of birds (designated in English capital letters) in the development of the PA network in the surveyed region (Roman numerals indicate strictly protected areas). Map Source: Rustamov, E., modified to comply with UN. World map (2022)

Index	Localization area (and coordinates)	Years			Status
		1984 -1990[4]	2004 - 2008[5]	2009 -2019[6]	
a	Cliffs of Northern Ustyurt: Donyztau (46°29'N,56°38'E), Western (44°52'N,53°46'E) and North-Western северо-западный (45°52"N,55°28E)	-	X	X	IBAs since 2008, not protected
I	Cliffs and the Kendirlisor Depression of Western Ustyurt (43°08′ N,54°37′ E)	XX	-	XX	Reserve since 1984, but without IBA status
b	Eastern Ustyurt, Saigachi Sanctuary (44°47'N,57°47'E)	-	X	X	Reserve since 1991, IBA since 2008.
c	Sudochye Lake (43°29'N,58°31'E)	X	XX	XX	Reserve since 1991, IBA since 2008, Ramsar status required
II	South-Eastern Ustyurt, Janubiy Ustyurt Nature Park (41°54'N,56°33'E)	XX	-	XX	Protected since 2020, a transboundary reserve is required
d	Assake-Audan depression (42°35'N,56°18'E)	-	X	?	IBA since 2008, protected since 2020 within the boundaries of the Nature Park
e	Depmechay (41°13′N,55°28'E) Ersarybaba-Akkyr (40°58′N,54°44′E), Tekejik-Biynekyr (40°11′N,55°35′E) and Koymat-Begarsan cliffs (40°21′N,55°55′E)	X	XX	XX	IBAs since 2009, not protected, organization of sanctuaries required
f	Cliffs and the bed of the Lower Uzboy (39°49′N,55°37′E)	X	X	X	IBA since 2009, not protected, organization of sanctuary required
g	Ak'yayla Lake (40°11'N, 57°02'E) – 1st stage of the Altyn Asyr Turkmen Lake	-	-	XX	Not protected, Ramsar status required
h	Lakes along the bed of the Upper Uzboy: Atabaishor (40°52'N,57°27E) and Uzynshor (41°09'N,57°37'E)	-	-	XX	

4 (Rustamov *et al.*, 199).

5 (Kashkarov *et al.*, 2008; Sklyarenko *et al.*, 2008; Rustamov *et al.*, 2009).

6 (Rustamov, unpublished data)

III	Karashor cliff (40°49′N,56°48′E)	X	X	X	IBA since 2009, northern part of the cliff within the Kaplankyr reserve
IV	Sarykamysh Lake (41°44′N,57°25′E)	XX	XX	XX	IBA since 2009 in the Sarykamysh sanctuary, northern part since 2020 in the Janubiy Ustyurt nature Park. Ramsar status of a transboundary area is required
i	Goyungyrlan cliff and lake (41°44′N,57°25′E)	X	XX	XX	IBA since 2009, not protected, needs to be expanded to cover Zengibaba and Tarimgay cliffs, and establish a sanctuary
j	Akchagay cliff and saline depression (41°04′N,58°15′E)	X	X	X	IBA since 2009, not protected
k	Muskinata Tugai (42°17′N,59°50′E)	X	X	?	IBA since 2009, not protected, status apparently lost
V	Baday-Tugay Tugai (42°00'N,60°22'E)	XX	XX	XX	Since 2013 within the Lower Amudarya Biosphere Reserve, without IBA status
m	Soltansanjar-Tuyamoyun (41°04′N,61°34′E) and Khorazmbalikchilari (41°16′N,60°33′E) wetlands	X	XX	XX	IBAs since 2009, not protected, Ramsar status of transboundary area required
VI	Tugai of the Kyzylkum Reserve (40°37'N, 62°06'E)	XX	XX	XX	Reserve since 1971, but without IBA status
VII	Gorelde (40°39′N,62°05′E) and Nargiz tugais (39°42′N,62°46′E) of the Amudarya Reserve	XX	XX	XX	Reserve since 1982, IBAs since 2009
VIII	Central Karakum, Bereketli Karakum Reserve (39°32'N,60°03'E)	X	-	-	Reserve since 2013, does not meet IBA criteria
IX	Black Saxaul woodlands of the Repetek Reserve (38°36′N,63°15′E)	XX	XX	X	Reserve since 1928, IBA since 2009
n	Ketteshor-Ramankel (39°06′N,62°55′E) and Eraji (38°46′N,62°21′E) lowlands in the Eastern Karakum Desert	-	XX	XX	IBAs since 2009, not protected
o	Dzharsay-Khangui (38°37′N,61°04′E), Airakly-Mollakurban (38°37′N,59°50′E) and Deryatakyr (38°21′N,58°52′E) lowlands in the Central Karakum	X	XX	XX	IBAs since 2009, not protected, for Deryatakyr status lost due to water diversion

p	Chokrak-Donuzaji (39°26'N,55°53'E) and Uzynshor (38°51'N,56°47'E) lowlands in the Western Karakums:	X	XX	XX	IBAs since 2009, not protected
q	Wetlands along the southern edge of the Central Karakum: Kopetdag reservoir (38°14′N, 57°52′E), Altynkol Lake (38°01′N, 58°22′E) and Mergen lowlands (37°55′N, 58°56′E)	XX	XX	XX	IBAs since 2009. Kopetdag reservoir is not protected. Lake Altynkol is on the Ramsar List since 2021, accreditation as a Ramsar urban wetland is required
r	Foothill semi-desert of the Eastern Kopetdag (36°44'N,60°58'E) and tugai of Tedzhen (36°53N,60°53')	XX	XX	XX	IBA since 2009, not protected
s	Khanhovuz wetlands (37°10′N,61°19′E)	XX	XX	XX	IBAs since 2009, not protected, Ramsar status required
t	Sariyazy wetlands (36°22′N,62°38′E)	XX	XX	XX	
X	Semi-desert (35°43′N,61°36′E), cliffs, saline depression and pistachio "savannah" (35°47′N,61°28′E) of Badkhyz reserve	XX	XX	X	Reserve since 1941, IBA since 2009.
u	Semi-desert of the foothills of Karabil (35°55′N,63°16′E) and pistachio woodlands (35°17′N,62°32′E)	XX	XX	X	IBA since 2009, not protected
v	Zeyit-Kelif wetlands (37°31′N,65°06′E)	XX	XX	XX	IBA since 2009, partially protected, Ramsar status required
w	The Tallymerdzhen agricultural massif between the reservoir of the same name (38°22'N,65°34'E) and the Jarguzer tugai (37°32'N,65°48'E) in the Amudarya valley	X	XX	XX	IBA since 2009, not protected, sanctuaries in the northern part and tugais of Jarguzer required
x	Dengizkul Lake (39°08′N,64°07′E)	?	XX	XX	Not protected, IBA since 2008, on the Ramsar List since 2001
y	Soltandag-Kyzylburun-Taylak lake system (38°47′N,64°11′E)	?	XX	XX	IBA since 2009, not protected, Ramsar status required
z	Samandepe Tugai (39°00'N,63°47')	?	?	XX	Not protected, IBA status required

Source: Author's own elaboration.

Given the region's intensive ongoing economic development, one should expect an increase in anthropogenic pressure on both developed and undeveloped areas (primarily, during hydrocarbon extraction), as well as the processes of changing the land ownership structure and land use. These threats will intensify due to the lack of integration with the objectives of BD conservation in the practice of planning and development of other sectors of the economy. Mapping the bird population groups, as BD's integral part, enables to identify problem areas

and bring them into the mainstream of the interests of other sectors for BD conservation. This requires an information map based on quantitative indicators and relevant criteria. Therefore, ornithographic monitoring and ornithographic (zoogeographic) maps indicating IBAs are an important tool for integrating BD conservation into planning and policies of countries (Kazakhstan, Turkmenistan, Uzbekistan) on the development of this temperate region of the western deserts of Central Asia.

Discussions

We analysed information on factors and threats to the conservation of bird populations, and to BD in general, in key hotspots, as well as the volume, geography, and directions of current trends in BD conservation. Besides, the author studied materials on IBA/BirdLife Important Bird Areas (Kashkarov *et al.*, 2008; Sklyarenko *et al.*, 2008; Rustamov *et al.*, 2009), results of the WWF ECONET project in Central Asia, IUCN Red Lists and national Red Books of Turkmenistan, Kazakhstan and Uzbekistan, available scientific literature and atlases regarding the deserts of the surveyed region, as well as other available sources of information.

The large-scale anthropogenic transformation, especially of the hydrographic network, for the last half century has been the most significant in the region, which affects the dynamics of zoogeographic and ecological structure of BD, including the population of birds, especially wetland birds.

Territorial groupings of bird populations, as BD indicators, are concentrated in remote desert areas at the junction of state borders between Turkmenistan, Kazakhstan and Uzbekistan. Therefore, some PAs and IBAs are divided into parts. This means that the best approach to their protection is bilateral or regional cooperation.

The analysis showed that the network of IBAs is not quite representative for BD conservation, birds in particular, and needs to be expanded and adjusted. One would hope that the proposed recommendations (see the legend table to Figure 1) on changing the status of protected areas will be used in determining future priorities that may take place in the countries of the region, such as national biodiversity conservation strategies and action plans (NBSAPs), strategies and plans for expanding protected areas, other national studies of BD.

Conclusions

- A comparative analysis of the IBAs network with the PA network showed that it is not quite representative for BD conservation, including birds, and needs to be expanded and adjusted.

- Given the ongoing intensive economic development of the region, one should expect an increase in anthropogenic pressure on both developed and undeveloped areas (primarily,

during hydrocarbon production), as well as the processes of changing the land ownership structure and land use.

- A further goal is to conduct ornithogeographic mapping of natural and transformed ecosystems for BD conservation and management.

- Monitoring and relevant ornithogeographic (zoogeographic) maps indicating IBAs are an important tool for integrating BD issues in planning and policies of the countries in the region.

Acknowledgements
In 2004-2008, expeditions and monitoring were carried out within the framework of the RSPB/ BL Program.

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Ecosystem assessment of sociable lapwing (CR) habitats on stopover in Uzbekistan

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Introduction and main objectives

In September 2022, it will be 10 years since Uzbekistan Society for the Protection of Birds (UzSPB) discovered congregations of Sociable Lapwing *Chettusia gregaria* (CR) on Talimarzhan water reservoir located in desert area of Kashkadarya region of Uzbekistan. The Talimarzhan water reservoir in Uzbekistan and desert area of Turkmenistan southeast of this reservoir is the only migratory stopover for up to 50 percent of the world population of globally threatened Sociable Lapwing on its autumn migration along the Eastern flyway from breeding grounds in northern Kazakhstan to wintering grounds in Pakistan and Oman.

In the period from 2012 to 2021, UzSPB recorded from 628 individuals (3.8 percent of the world population) to 4685 individuals (28 percent of the world population) of Sociable Lapwing on its autumn migratory stopover on Talimarzhan. This makes the priority Key Biodiversity Area (KBA) 'Talimarzhan Reservoir' in Uzbekistan one of the most important territories in the world for Sociable Lapwing protection (Donald, 2016).

In 2020, UzSPB started Sociable Lapwing Monitoring Programme under umbrella of BirdLife International, NABU and WWF-CEPF-Russia. The Monitoring Programme made it possible to monitor Sociable Lapwing's number, distribution, movement, disturbance factors and potential threats on a daily basis, throughout the entire autumn period of this species' stay at Talimarzhan stopover.

The Monitoring Programme showed that in 2020-2021, the grazing intensity on Talimarzhan reservoir increased significantly. In autumn 2020, more than 9000 heads of sheep and goats were grazing along the shoreline of the reservoir. During summer and autumn 2021, 15 000-10 000 heads of small ruminants were using coastal zone of the reservoir round the clock. Unregulated, absolutely spontaneous grazing and watering of sheep was recorded in places where Sociable Lapwings concentrate, rest, feed and spend the night every autumn.

The rapid increase in cattle number and a sharp depletion of the vegetation cover in places of Sociable Lapwing concentration at Talimarzhan were the main prerequisites for this study to determine the relationship between the intensity of grazing and condition of the Sociable Lapwing habitats on Talimarzhan autumn migratory stopover. Objectives of this study included monthly monitoring of the vegetation cover, insects and hydroregime in places of Sociable Lapwing concentration on Talimarzhan. The main purpose of this study was to determine the optimal and maximum allowed number of livestock on Talimarzhan in places of Sociable Lapwing concentration. The numbers were then planned to be included into the Species Action Plan for Sociable Lapwing for its further communication to administration of the Nishan district in the departmental subordination of which the territory of Talimarzhan is.

Methodology

In order to assess the condition of Sociable Lapwing habitats, in May-October 2021, the phytocenosis and entomological diversity were studied at the points where this species concentrate. When studying the phytocenosis, the Drude scale was used (Golub *et al.*, 2020). The phytomass of abundant plants in places of Sociable Lapwing concentration was weighed and compared by months.

Insects - feeding objects of Sociable Lapwing were collected by a net and car headlight in places of this species feeding, resting and spending the night. This research is scheduled for three-five years to compare seasonal condition of Sociable Lapwing habitats on Talimarzhan depending on grazing, hydro regime and climate.

Sociable Lapwing observations were carried out in the period from September 4 to October 21, 2020-2021. In the coastal area of the reservoir, point counts were carried out during the hours of the highest activity of this species: 05.40-08.00 and 11.30-17.30. To the east of the reservoir, route counts were carried out with a length of 33-55 km each. Sociable Lapwing counts in 2021 were carried out in partnership with Association for the Conservation of Biodiversity of Kazakhstan (ACBK) and Ornithological Society of the Middle East (OSME). Earlier in August these organizations tagged one Sociable Lapwing with satellite transmitter and shared data on terms and directions of its migration.

Binoculars Viking 10x50 and Viking AV-66 ED Spotting Scope were used for bird counts. Birds were photographed using Nikon D7500 camera and Sigma DG 50-500 mm telephoto lens. In 2021, observations were carried out continuously for 27 days.

Results

In April-October 2021, the condition of phytocenosis and the entomological diversity of Sociable Lapwing habitats on Talimarzhan were studied in 8 monitoring points with total area of 32.8 sq. km (2.8 sq. km in the coastal area of the reservoir, and 30 sq. km on the foothills (adyrs) southeast of the reservoir).

In the surveyed area, 20 plant species belonging to 11 families were recorded. Half of all recorded plants were annual, 25 percent of the total species composition of plants were represented by perennial grasses. The most abundant species of perennial grasses with a projective cover of more than 30-60 percent, growing in places of the highest Sociable Lapwing concentration in the coastal area of the reservoir were represented by the Common camel thorn *Alhagi pseudalhagi* (M. Bieb.) Fisch and Bermuda grass *Cynodon dactylon* (L.) Pers. The most abundant species of perennial grasses with a projective cover of more than 30-60 percent, in places of Sociable Lapwing concentration on adyrs, were Bulbous bluegrass *Poa bulbosa* L. and Sedge *Carex pachystilis* J. Gay.

Monitoring visits to Talimarzhan in April-June 2021 showed that due to the very dry spring and low precipitation, condition of the vegetation cover of the site was very poor. The premature end of the flowering period of many desert plants allowed us to assess the condition of vegetation of the monitoring points as unsatisfactory. The species composition and abundance of insects in the coastal area of the reservoir and on clay cliffs

were also very meager. Due to the active 24-hour grazing of over 15 000 heads of livestock, the phytomass did not increase; therefore, there was a decrease in insects.

Compared to the last year, in summer 2021, much fewer termites *Anacanthotermes turkestanicus* were recorded on adyrs. This happened due to the early end of Cousinia *Cousinia microcarpa* Boiss. vegetation, which is main food object of these insects. Termites are important food objects of Sociable Lapwing, the low abundance of these insects on clay hills (adyrs) in 2021 significantly affected Sociable Lapwing distribution on Talimarzhan.

For comparison, in June 2020 phytocenosis of this site was very diverse and the phytomass of the coastal area and hills were relatively satisfactory. Moreover, due to the active water intake for irrigation, the coastline of Talimarzhan reservoir moved away significantly, by about 2 km compared to the last year.

It should be noted that by July 2021, the end of vegetation and the death of all common and widespread plant species was recorded in the coastal area of the reservoir and on the adyrs. The premature end of the common plants' vegetation was due in large part to the weather conditions - an increase in air temperature to + 52 °C, as well as severe overgrazing.

When studying the entomofauna of the Talimarzhan reservoir, only 9 species of insects were found: mosquitoes, flies, ants, Asiatic locusts, termites, darkling beetles. Most of the insects collected at Talimarzhan reservoir are potential food items for Sociable Lapwing (del Hoyo *et al*., 1996). Participants of the study assessed the species diversity of insects in the coastal zone of Talimarzhan and in the adyrs to the east of the reservoir as scarce, and their numbers as very low. Since changes in the structure of vegetation affect the amount and distribution of Sociable Lapwing food items, excessive grazing should lead to a decrease in the number of insects that are main food objects of this species.

The extremely negative effect of uncontrolled grazing on the condition of the common abundant plant species can be confirmed by the fact that on July 15, in the coastal area of the reservoir, there was still a full bloom of extremely sparse plants in this area, such as Kashgar tamarisk *Tamarix hispida* Willd., Nipplewort *Lapsana communis* L. and Capers *Capparis herbacea* Willd. These species cover a very small part of the coastal area, were found only once during the survey and, probably, do not represent nutritional value for sheep, or were not noticed by them.

The ecological assessment of the vegetation cover condition carried out in August 2021 on the eve of Sociable Lapwing migration in places of this species annual concentration on Talimarzhan showed that there was no increase in phytomass due to uncontrolled grazing.

In August 2021, the dry phytomass of Bermuda grass *Cynodon dactylon* (L.) Pers. in the shoreline amounted to 10-14 grams of dry weight of the plant (1-1.4 centners per hectare). The phytomass Common camel thorn Alhagi pseudalhagi (M. Bieb.) Fisch was 20-30 grams of dry weight of the plant (2-3 centners per hectare). The decrease in phytomass was directly related to the increase in the number of grazing sheep to 15 thousand heads (more than 17 flocks).

The vegetation communities on adyrs in August 2021, by the beginning of Sociable Lapwing migration, consisted of the Bulbous bluegrass *Poa bulbosa* L. and Sedge *Carex pachystilis* J. Gay formations. However, plants of all these species were almost completely trampled by small ruminants. The vegetation on the adyrs was very sparse and scarce, its phytomass was 0.1-0.2 centners per hectare.

However, luckily for Sociable Lapwing, in September-October 2021, the restoration of the plant cover in the coastal area of Talimarzhan took place in places of this species autumn stopover. This was largely facilitated by the unstable hydro regime of the reservoir. In the period from April 22 to September 5, 2021, as a result of cotton irrigation, the water level in the reservoir was dropping constantly: during this period, the coastline moved 1,340 metres away. The sharpest drop in water was observed in August 2021. As a result, Common camel thorn *Alhagi pseudalhagi* (M. Bieb.) Fisch and Bermuda grass *Cynodon dactylon* (L.) Pers. bloomed again in the coastal area on the newly formed wet areas of the waterfront. Therefore, by the beginning of September 2021, in coastal areas used by Sociable Lapwing for feeding and resting, there was a significant restoration of the integrity of the vegetation cover.

Starting from the end of September 2021, the water level in the reservoir began to rise again. This enabled flooding of the coastal zone and re-vegetation of the most abundant plant species in places where Sociable Lapwing concentrate. By mid-October 2021, the coastline approached 300 metres, and in the places of Sociable Lapwing feeding, resting and overnight, formations of the camel thorn greened again.

However, due to the drought and the strongest overgrazing, the vegetation cover of Sociable Lapwing habitats on adyrs to the southeast of the reservoir, had not recovered by the beginning of the autumn migration. For this reason, in September-October 2021, Sociable Lapwings did not use usual stopovers on adyrs for feeding, rest and overnight.

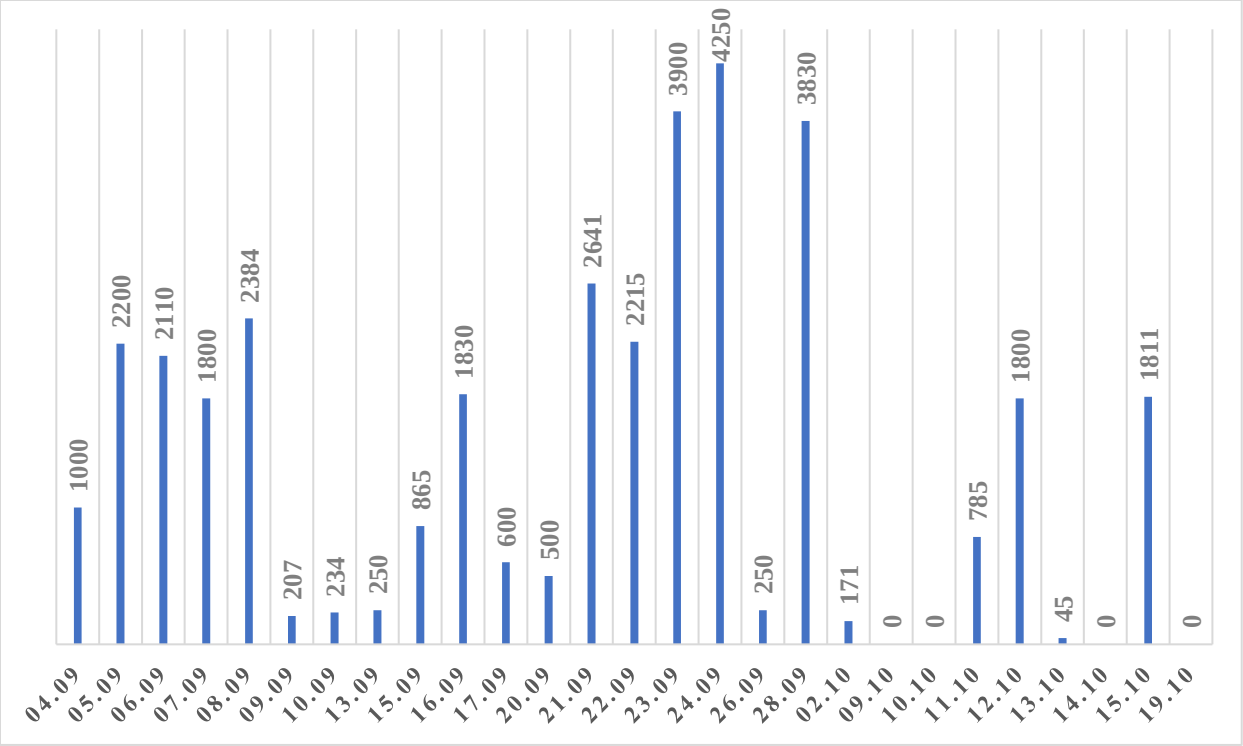

Figure 1. Sociable Lapwing number in shoreline in 2021

Source: Author's own elaboration.

Last year's places of Sociable Lapwing concentration on adyrs southeast of the reservoir were surveyed on 05.09.2021(10.30-14.00), 06.09.2021(08.30-10.50), and 23.09.2021(07.40-12.00). The length of each circular automobile route along the adyrs was 33 km. No Sociable Lapwings were found in places of last year's stopovers on adyrs. Trips to adyrs were held in the first half of the day, after Sociable Lapwings spending the night in the coastal zone, left it and flew away in a southeast direction. By the time of observations on adyrs, all Sociable Lapwings had already left the shoreline of the reservoir.

Another survey of last year's places of Sociable Lapwing concentration on adyrs, as well as possibly new places of this species stopover to the east of the reservoir, was carried out on 10.10.2021 (07.30-16.00). The length of the circular automobile route along the adyrs this time was 52.6 km. No Sociable Lapwings were found on adyrs either. The Sociable Lapwing marked by a satellite transmitter in Kazakhstan this year has not visited adyrs either.

Compared to 2020 observation results (Figure 2), when about 60 percent of Sociable Lapwings on Talimarzhan reservoir used adyrs for feeding, resting and overnight, and 40 percent of all Sociable Lapwings spent most of the time in the coastal zone, maximum number of all Sociable Lapwings in 2021 was concentrated in the shoreline only (Figure 1).

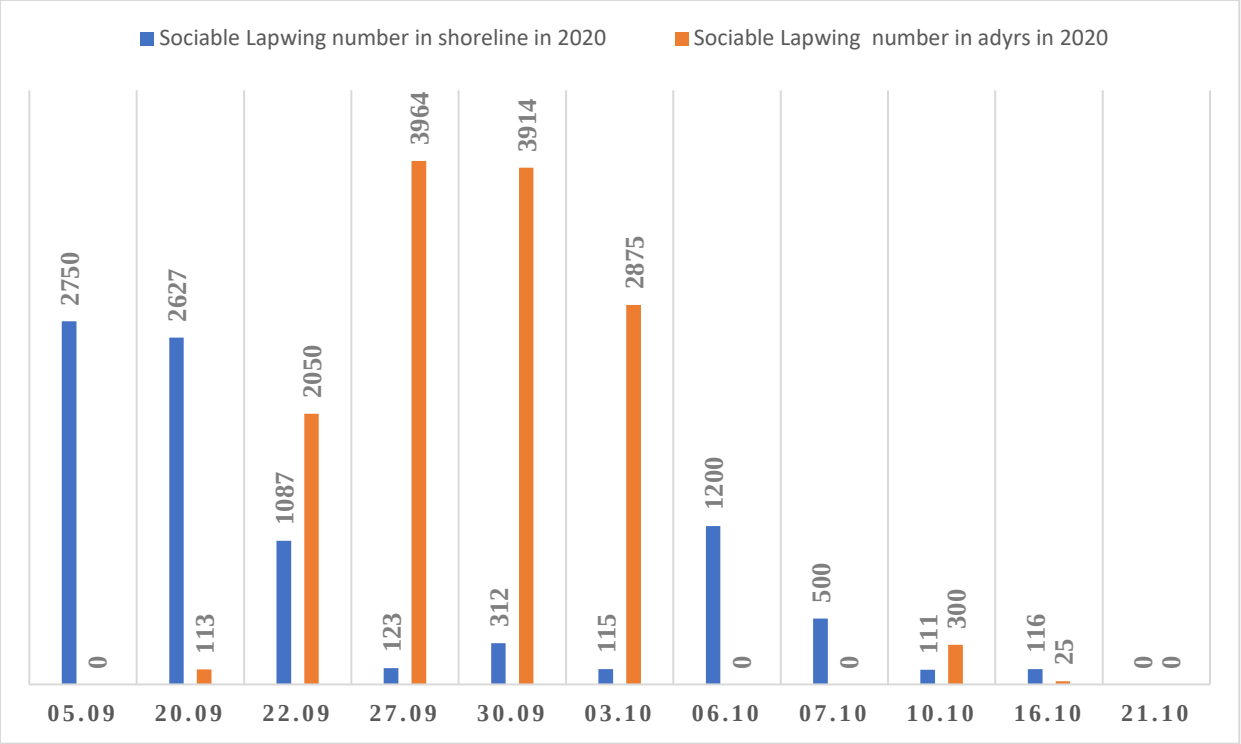

Figure 2. Sociable Lapwing number on Talimarzhan in 2020

Source: Author's own elaboration.

Discussion

As Ashoori *et al.* (2013) say, Sociable Lapwing threats on migratory stopovers are caused by agriculture development, unregulated grazing and degradation of desert ecosystems. In the classification of the Sociable Lapwing threats on the website of the International Union for Conservation of Nature (IUCN) (2021), grazing is classified as a threat that minimally affects this species but disturbs it and can be the reason of its habitat's degradation. It is known that in Sociable Lapwing breeding grounds in Central Kazakhstan, there is a positive correlation between the intensity of grazing and the density of Sociable Lapwing nest (Kamp *et al.*, 2009). However, the balanced grazing is needed in order to create favorable conditions for Sociable Lapwing on migratory stopovers. The overgrazing leads to deforestation of Sociable Lapwing habitats, and insufficient grazing leads to of the overgrown feeding and resting areas of this species (Donald *et al.*, 2017).

Results of Sociable Lapwing Monitoring Programme in 2020-2021 suggest that the sharp move of Sociable Lapwings from stopover habitats in the coastal zone of Talimarzhan to adyrs in autumn 2020 was associated with disturbance caused by the simultaneous presence of several thousand heads of small ruminants in the coastal zone of the water reservoir. By autumn 2021, unregulated grazing caused a change in the structure of the vegetation cover on adyrs southeast of the reservoir, that negatively affected the feed available for the species. Due to the dramatic changes in the structure and quality of the

vegetation cover on adyrs, all Sociable Lapwing, using Talimarzhan as a migratory stopover in September-October 2021 concentrated in the coastal zone of the reservoir.

Despite the fact that in the international classification of Sociable Lapwing threats the unstable hydro-regime is indicated as one of the negative factors, the unstable water level of Talimarzhan reservoir in 2021 had a favorable effect on the state of the vegetation cover in places of Sociable Lapwing autumn migratory stopover. The largest congregations of Sociable Lapwing on Talimarzhan reservoir, observed on 05-08.09.2021, 21-28.09.2021 and 12-15.10.2021, were formed precisely in the areas of the coastal zone modified by flooding and drainage.

Conclusion and recommendations

The Talimarzhan Reservoir in Kashkadarya region of Uzbekistan is the most important migratory stopover for up to 26 percent of Sociable Lapwing's world population on its autumn migration along the Eastern flyway from breeding grounds in northern Kazakhstan to wintering grounds in Pakistan and Oman. The main threat and disturbance factor for over 4250 Sociable Lapwings at Talimarzhan in September-October 2020-2021 was caused by mismanagement of livestock grazing and degradation of the species habitats in the coastal area and on adyrs. Grazing at the site remains uncontrolled, unregulated and often illegal that can seriously damage desert and wetland ecosystems of Talimarzhan in years with abnormal weather conditions.

Based on 2020-21 Sociable Lapwing Monitoring Programme results, UzSPB developed Species Action Plan for Sociable Lapwing at Talimarzhan. It was already communicated to the Head of Administration of the region where Talimarzhan is located. Activities recommended for Sociable Lapwing protection involve 10 governmental agencies and UzSPB site support groups. This plan is aiming to achieve four main results (Kashkarov *et al.*, 2021):

1. Reducing disturbance of Sociable Lapwing in the coastal zone of Talimarzhan reservoir.

1.1. Control over the livestock grazing and watering in the coastal zone of the reservoir in autumn. The maximum permissible number of livestock (sheep and goats) that from September 1 to October 25 can be grazed daily along the coastline of Talimarzhan reservoir without harm to Sociable Lapwing habitats should not exceed 2000 heads (4-5 herds).

1.2. Not to graze in the northeastern part of the coastal area during Sociable Lapwing feeding and resting hours from 11.00 to 17.00 in the period from September 1 to October 25. Instead, UzSPB recommends using the coastal zone in the northern and south-eastern parts of the reservoir for grazing from 11.00 to 17.00 in the period from September 1 to October 25.

1.3. Patrolling and raids to prevent Sociable Lapwings disturbance by livestock.

2. Improving conditions of Sociable Lapwing feeding and resting places in the coastal zone of Talimarzhan reservoir and on adyrs.

2.1. The maximum permissible number of livestock (sheep and goats) that from August 1 to October 25 can be grazed daily on adyrs southeast of the coastline of Talimarzhan

reservoir without harm to Sociable Lapwing habitats should not exceed 1000 heads (two-three herds).

2.2. Carrying out regular cleaning of the coastal zone from fishing nets and household waste.

3. Raising awareness of local people and rangers about importance of Talimarzhan reservoir for conservation of critically endangered bird species.

3.1. Raising awareness of local people of Nuristan, Talimarzhan cities and Djayron villages.

3.2. Trainings and meetings for rangers of Kashkadarya Regional Inspectorate and Nishan District Inspectorate for Control over Ecology and Environmental Protection in order to raise awareness of the value and uniqueness of Talimarzhan reservoir to maintain populations of globally threatened bird species.

4. Regular monitoring of Sociable Lapwing habitats condition and its number at Talimarzhan.

4.1. Providing comprehensive assistance to specialists of Karshi State University and Uzbekistan Society for the Protection of Birds in monitoring of the plant cover in the places of Sociable Lapwing concentration, in collecting information on the hydraulic regime and in Sociable Lapwing monitoring on Talimarzhan reservoir.

Acknowledgements

The current and future studies on Sociable Lapwing and this species habitats condition on the migratory stopover in Uzbekistan is being carried out by Uzbekistan Society for the Protection of Birds (UzSPB). This would not have been possible without dedicated support of the Nature and Biodiversity Conservation Union (NABU, Germany), BirdLife International (United Kingdom), WWF-CEPF-Russia (Russia and Kazakhstan), Ornithological Society of the Middle East (OSME, United Kingdom), Swiss Ornithological Society (Switzerland), Association for the Conservation of Biodiversity of Kazakhstan (ACBK, Kazakhstan), Karshi State University (Uzbekistan) and many others.

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Assessing the impact of border fences on goitered gazelle populations in Kazakhstan

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Keywords: Gazella subgutterosa, border fence, wildlife migration, Kazakhstan, Uzbekistan, Turkmenistan

Introduction, scope, and main objectives

The goitered gazelle (*Gazella subgutturosa* Güldenstädt, 1780) was widely distributed in Central Asia. In the former Soviet Union, the area of almost continuous distribution covered deserts and semi-deserts of Turkmenistan, Uzbekistan, Tajikistan, Kyrgyzstan, southern Kazakhstan and eastern Transcaucasia (Sludsky 1977). With its high numbers, the gazelle was an important indicator component of desert ecosystems.

The gazelle is listed in the Red Book of the Republic of Kazakhstan (2010) in Category III (declining species). Over the last 70-80 years, the gazelle's range in Kazakhstan has significantly decreased due to a shift of its northern border to the south; it is no longer continuous and fragmented into several relatively isolated parts. In Kazakhstan as a whole during this period the population size decreased by a factor of 13 (from 200 to 15 thousands), and in Ustyurt and Mangyshlak by a factor of 100 (from 100 to 1 thousand) (Blank 1991, Pestov *et al*. 2021).

The gazelle is listed on the IUCN Red List as VU (vulnerable) and is also listed on Appendix II of the Convention on the Conservation on Migratory Species of Wild Animals (CMS or Bonn Convention) and falls under the Central Asian Mammal Initiative (CAMI).

In the last decade a new anthropogenic factor negatively affecting the gazelle population has emerged: in accordance with the current legislation, border wire fences were installed along the entire length of the state border of Kazakhstan, which not only prevent the traditional seasonal cross-border migration of ungulates, but often cause their direct mortality.

Therefore, a zoological expedition along the southern state border of the Republic of Kazakhstan in the deserts stretching from the Caspian Sea to the Syrdarya River was

conducted in April-May 2021. The expedition was organized by the Association for the Conservation of Biodiversity of Kazakhstan (ACBK) within the project "Provision of access to key habitats for goitered gazelle in southern Kazakhstan" with funding from IUCN Save Our Species initiative. The objectives of the research were the following:

- A rapid assessment of the presence and condition of gazelle populations along the southern state border of Kazakhstan;

- Assessment of the presence and design features of border fences on different sections of the state border from Kazakhstan and its neighboring countries (Turkmenistan and Uzbekistan);

- Preparation of recommendations to minimize the negative impact of the border fence on goitered gazelle and other ungulates.

Methodology

During the expedition, whenever possible the vehicles moved along the state border within line of sight of the barbed wire fence. The observers in the first vehicle predominantly surveyed the terrain ahead and to the sides of the direction of travel in order to detect gazelles (and other animals) and traces of them up to 500 metres or more ("long-range observations"). Observers in the second vehicle mainly tracked a strip up to 10 m wide directly along the border fence in order to detect signs of gazelles ("near-sightings"), namely goitered gazelle hoofprints, trails, resting places, droppings, bones and other remains. When potential gazelle hoofprints were visually detected, the vehicle was stopped and observers walked through the area to confirm the presence of gazelle signs. In addition, random stops were made regularly (every 3-10 km), during which a 200-300 m section of the border fence was inspected on foot to look for gazelle signs that were not seen from a moving vehicle. Also, in situations where vehicle movement along the border fence was not possible within line of sight, vehicles were stopped every 3-10 km and observers walked to the border fence to search for goitered gazelle signs in sections of 200-300 m.

All sightings of gazelles (and other vertebrate species) and other traces of gazelles as well as design features of the border fence relevant for the ability of goitered gazelles and other ungulates to cross were recorded using a GPS (track and points). The GPS track was also used to continuously record the vehicles driven path.

The total length of the route along the border was around 1400 km. Thus, about 67 percent of the total length (around 2100 km) of the selected section of southern border of Kazakhstan have been investigated. About 450 localities with coordinates including 184 localities with information about sightings of gazelles themselves (40 individuals could be sighted at 19 localities) or traces of them, such as droppings, single tracks on the ground, trails full of gazelles or their bone remains (165 sites) were included in the database. In addition, over 90 locations were inspected where despite a thorough search no signs of migrating ungulates

(including gazelles) could be found. About 170 more locations were recorded in connection with sightings of other mammal, bird, reptile species as well as the presence of significant landscape elements and/or design features of the border fence.

We also visited border posts on the route and interviewed the border guards about gazelles (and a number of other rare vertebrate species). Of specific interest have been sightings, when gazelles were seriously injured or killed while trying to get through the fence.

Results

Speaking about gazelle populations along the southern border of Kazakhstan, certainly the strongholds of this species are in Mangystau and Kyzylorda provinces (Pestov *et al*. 2021). No signs of gazelles were found in the northern part of the Usyurt plateau both in Mangystau and Aktobe provinces between the village Beyneu and the former Aral Sea. In this area sporadically the saiga antelope (*Saiga tatarica tatarica)* is crossing the border through the many openings provided for the species there (Pestov et. al. 2021, Olson 2013). In the Turkestan province at the south-east end of the Kyzyl-Kum desert gazelles are rarely crossing the border, because numbers are very low. In this area a lot of animal husbandry is conducted, disturbing the gazelles and providing fodder competition (Pestov *et al*. 2021).

The investigations in spring 2021 did show relatively low numbers of gazelles and wild animals in general, because throughout south Kazakhstan a severe drought was giving wildlife a hard time.

Within Mangystau province Kazakhstan is bordering Turkmenistan and Uzbekistan. As investigated earlier, the situation with the border fence differs significantly within different sections (Pestov *et al.*, 2018). This was confirmed in May 2021 and the results of the investigations are shown in figure 1.

The total number of gazelles observed in Mangystau province in spring 2021 was 30 (five males, four females, 21 - sex not identified, no juveniles) on about 18 observation points. The vast majority of animals and other traces of gazelles was observed in the section 5-6 bordering to the newly established South Ustyurt National Park in Uzbekistan (20 specimens). Also, in the sections 4-5 north of Chink Kaplankyr (4 specimens) and in the section 1-4 in the west (six specimens) gazelles including droppings and hoofprints have been present. Most of the gazelles were observed on the territory of the planned protected area South Ustyurt in Kazakhstan (figure 1).

Regarding the fencing on the Turkmenistan border a chain-link fence with barbed wire on top is present. In the section 1-4 it is with 100- and 500-metre distance relatively close to the Kazakh border fence. Only in the section 4-5 at Chink Kaplankyr the two border fences are several kilometres away from each other (figures 1 and 3). The Uzbek border is not fortified with any border fence at all. On the Kazakh side throughout the province the standard model of the fence is about 150 cm high with 8 barbed wires fixed to poles 4 metres

apart. Only close to the border crossing Tazhen in section 7-8 near village Beyneu two lines of fences can be observed (figures 1 and 3). Partly one of the fences has a spiral barbed wire design which is 4 metres high.

In Kyzylorda province within the Kyzyl-Kum desert likely the largest fragments of gazelles' habitat in Kazakhstan are located (Pestov *et al*. 2021).

Within the Kyzylorda province only about half of the border fence could be inspected directly due to the very high dunes in some sections of the border (figure 2 and 4) and soft soil in the takyr on the former Aral Seabed. Possibly due to the severe drought only ten live animals (three males, three females, three unspecified sex and one juvenile) at seven locations have been observed. A new feature has emerged on this stretch of the border: many kilometres long trampled tracks/paths of goitered gazelle along the border fence could be observed. Different variations were encountered: tracks of footprints on both sides of the fence, either only on the Kazakhstani side or only on the Uzbek side. The animals obviously did walk long distances parallel to the fence during their seasonal migrations (figure 2). Only very few inspected places have been without any traces of gazelles, indicating the importance of the northern Kyzyl-Kum for the species.

The Kazak border fence within the Kyzylorda province has the same design as described above with few sections fortified by double fencing with the standard design or a single line of spiral barbed wire fencing (figure 2). The Uzbek border is also here not fortified with a fence.

As mentioned above the border fence in the Turkestan province has currently little relevance for the goitered gazelle migrations, as the animals do not migrate over the border in this area of the border. Only in the very north of the province at the border with Kyzylorda province we could observe some signs of gazelles (figure 2).

The border guards did report for Mangystau and Kyzylorda provinces cases of gazelles getting deadly injured during border crossing. For Mangystau province two deadly cases were observed in 2019 (Pestov et. al. 2020). In spring 2021 we once encountered the fresh remains of a dead gazelle and on one occasion observed the breaking through the wire fence of one gazelle, as a result of which antelope was seriously injured.

Discussion

The findings of the field work do lead to different recommendations how to mitigate the barrier the border fence is posing to goitered gazelle and other migrating animals. An overview on the recommendations is given in the maps in the figures 2 and 4 and discussed here in more detail.

For the Mangystau province different sections have been identified (figure 2). The section one to four requires joint action of Turkmenistan and Kazakhstan in the frame of the CMS,

which both countries are members of. Unilateral openings like the one in section two-three in Kazakhstan are actually contra productive in this section, as the animals are reportedly entering the narrow corridor between the two border fences and die regularly due to exhaustion or injury when fleeing from the border patrol vehicles. Until a mutual solution is found the currently open section two-three has to be closed in a way that the gazelles cannot enter the corridor. Entry to the corridor should be also closed at the place where the border fences start to move away from each other and provide a large area between them (at point four in figure 1 and 3). This is important, because a lot of goitered gazelles live in the large area between the border fences in section four-five below chink Kaplankyr. Both measures are only possible with a mutual effort between Kazakhstan and Turkmenistan in the frame of the CMS. Above the chink Kaplankyr in section four-five the border fence is without function, as vehicles are not able to cross the steep cliffs. It is recommended to completely removed it from this section. As most of the gazelles have been observed along the border with the South Ustyurt National Park in section five to six the below four-five wires should be taken out here along the whole stretch, also to allow kulan (*Equus hemionus*) to cross the border as was observed in 2019 already (Pestov et. al 2019). For the northern part of the province in section six-seven about 32 openings 8 metre wide and the lower three wires taken out are already existing. These openings are used by the gazelles, as could be observed. They should be provided along the whole stretch at least every 2-3 kilometres.

In the section seven to eight with double fencing no action is needed, as gazelles practically do not use this habitat at the moment.

The situation in the Kyzylorda province is again quite different as we could observe trampled tracks of goitered gazelle going parallel to the fence. Thus, a more detailed picture of the species movements hindered by the fence could be drawn. In the sand of the Kyzyl-Kum single footprints are not preserved for long, but frequently used tracks are formed and persist over longer periods. In comparison the clay soils in Mangystau province are not preserving the tracks so well and in summertime the dry soil is almost hard as rock. In Kyzylorda province tracks of gazelles parallel to the fence are found over 180 km along a surveyed stretch of 352 km which is more than half (51 percent) of the total surveyed border. About 46 km of this section is already in the northern part of the Turkestan province. Along the whole investigated stretch only two short sections (0.5 and 2 km) are opened for migratory animals with dismantled three to four lower wires (figure 4). These stretches can be used as an example for further openings. Specifically, we recommend for the sections with gazelle tracks along the fence to remove the lower three-four wires similar to the already existing openings. Along with spiral or double fence fortified sections no action is needed. As there have been virtually everywhere at least hoofprints or droppings present, also for the sections without distinctive gazelle tracks regular openings 4-8 metres wide and the lower three-four wires removed every 2-3 kilometres should be provided (figure 4).

Conclusions

As a conclusion of the investigations, we can confidently state that within the Mangystau and Kyzylorda provinces the goitered gazelle is depending on the desert habitat on both sides of the border fence. The fence is a serious obstacle for the species moving freely between the pastures and the barbed wire is also a direct risk to the health and live of the animals. The fence should therefore be opened on certain sections as discussed above. In addition, two protected areas are recommended to be established in Kazakhstan in order protect the species better. One is the already planned protected area South Ustyurt in the Mangystau province of Kazakhstan (figure 1 and 3). This protected area would form a continuous transboundary territory with the newly established South Ustyurt National Park in Uzbekistan and the Kaplankyr nature reserve in Turkmenistan. But only if the border fence is opened the goitered gazelle will be able to use the full potential of these transboundary protected areas. If waterholes are provided on the Kazakh side possibly also kulan still present in the Ustyurt National Park in Uzbekistan could return to the Mangystau province once again (Pestov *et al*. 2018). Another protected area should be considered to be set up in the Kyzyl-Kum desert within the Kyzylorda province. This part of the Kyzyl-Kum is without doubt one of the strongholds of the species. Without these measures and an effective anti-poaching approach, the species will have serious problems to survive in the deserts of Kazakhstan in the long run. The draft action plan for the protection of the goitered gazelle gives more details in this perspective (Pestov et. al. 2021).

Acknowledgements

We would like to thank: IUCN Save Our Species initiative for financial support of the research project, ACBK (Association for the Conservation of Biodiversity of Kazakhstan) for conducting the project, representatives of the Border Guard Service of the National Security Committee of the Republic of Kazakhstan for timely obtaining permission for the expedition to work directly along the state border of the Republic of Kazakhstan, director of Ustyurt State Nature Reserve - Mr. Serikov Zakon for his help in organizing the expedition and providing the UAZ vehicle with a driver, drivers transporting us safely though roughest terrain and hot weather Konys Zhaimukhanov and Bauyrzhan Utebaev.

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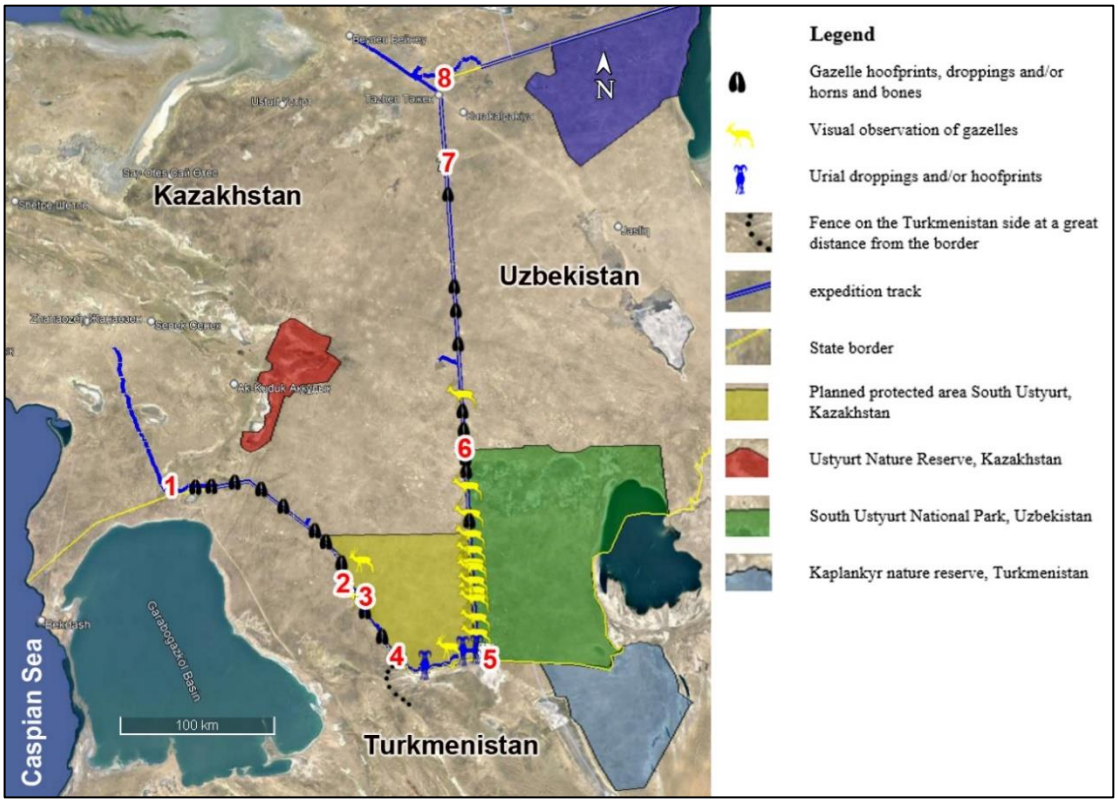

Figure 1.: Goitered gazelle and urial (*Ovis vignei arkal*) sightings and/or signs along the state border and (or) boundary wire fences in Mangystau province of Kazakhstan. Map Source: Google Earth, modified to comply with UN World map (2022).

Figure 2.: Localization of gazelles and/or signs of their presence at the border fence in the Kyzyl-Kum desert in Kyzylorda province of the Kazakhstan. Map Source: Google Earth, modified to comply with UN World map (2022).

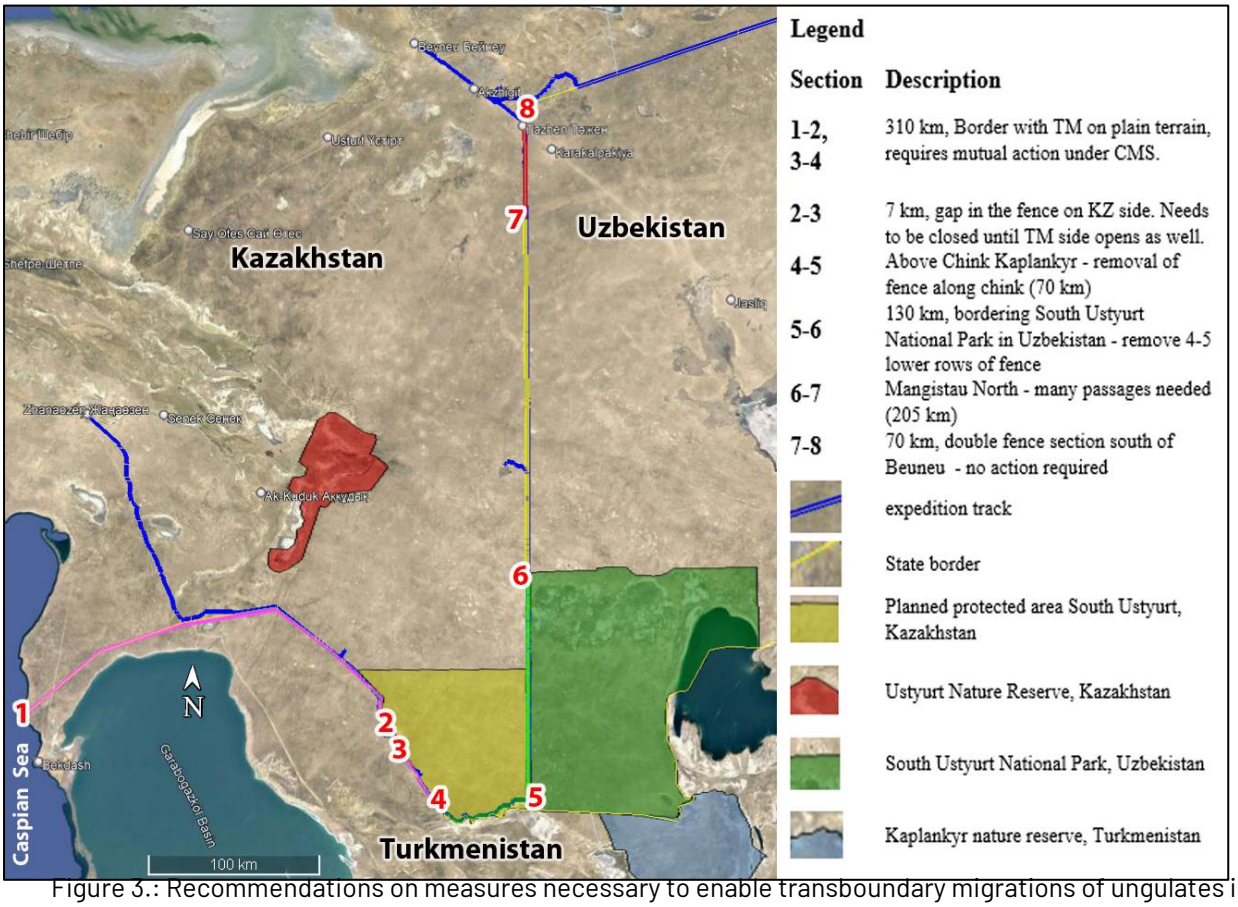

Figure 3.: Recommendations on measures necessary to enable transboundary migrations of ungulates in the territory of Mangystau province in the framework of the implementation of Kazakhstan's obligations under the CMS. Map Source: Google Earth, modified to comply with UN World map (2022).

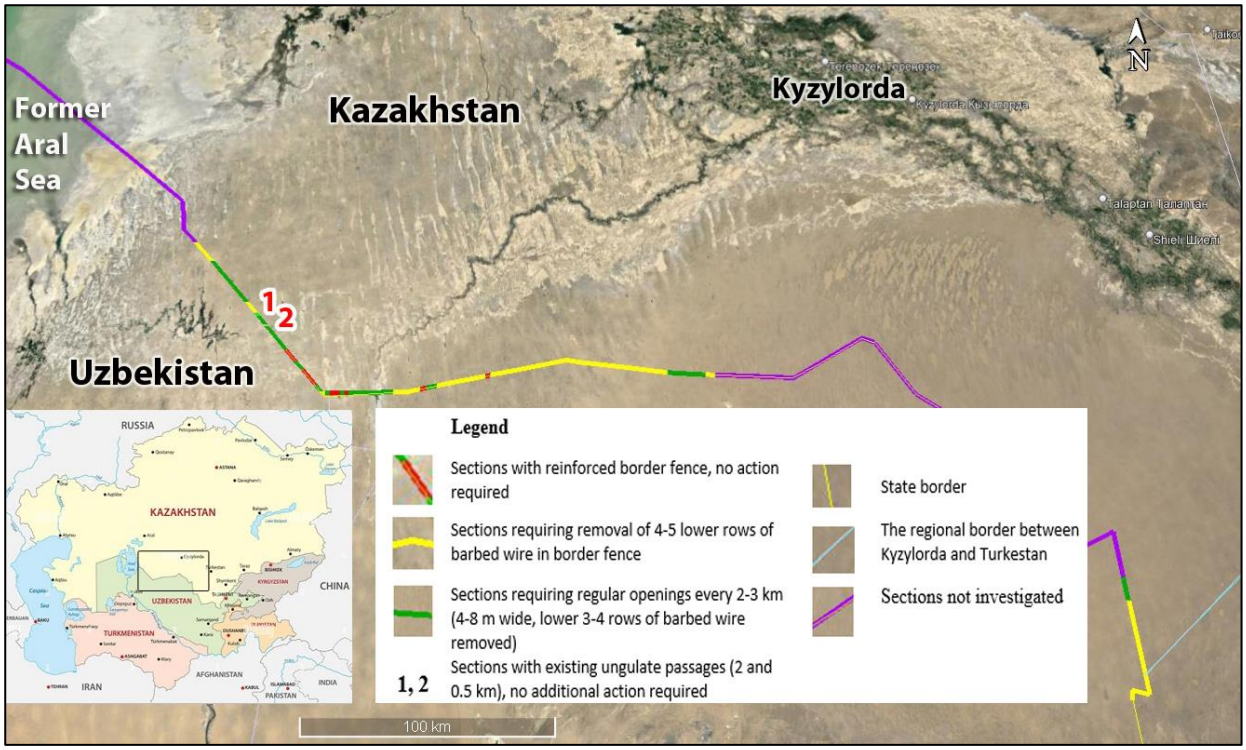

Figure 4.: Recommendations on measures necessary to enable transboundary migrations of ungulates in the territory of Kyzylorda province in the framework of the implementation of Kazakhstan's obligations under the CMS. Map Source: Google Earth, modified to comply with UN World map (2022).

Thematic session II

Sustainable land management

Cold winter deserts are continental deserts, whose aridity is explained by its distance to oceans or their position in the rain shadow of larger mountain ranges. They are characterized by a distinct seasonal climate, with strong, long-lasting frost in winter and extremely hot summer, in combination with very low annual precipitation of less than 100 mm. These extreme climatic conditions present a wide range of challenges to the local communities residing in the territories of cold winter deserts.

Sustainable land management (SLM) practices are implemented to harmonize the complimentary goals of providing environmental, economic, and social opportunities for the benefit of present and future generations, while maintaining and enhancing the quality of the land (soil, water and air) resources.

Based on regional case studies and scientific research, the following can be observed and facilitated for further promotion and awareness raising of best SLM practices:

- Poplar trees have great potential and suitability as a measure to serve as wind break and help in saving water resources in farm fields of Kyrgyzstan.

- Desert regions in Uzbekistan can be used for saxaul plantations that can be harvested as firewood and hence improve livelihoods in rural areas through additional income from afforestation interventions.

- Double cropping with a no-till system is possible with new crops introduced and tested in especially arid regions of Uzbekistan.

- Smallholders in remote rural areas benefit greatly from new wheat varieties that are locally developed in the country but do not usually reach household farms.

- Tracking livestock using Global Positioning System (GPS) collars in Kazakhstan study can assist in better pasture management through planning grazing events and seasons by conserving and rotation of allocated land within provided land holdings of farmers.

- Promising desert plant species are key for landscape restoration and several approaches are being monitored and studied in Uzbekistan conditions that allow developing suitable methods for landscape conservation or restoration.

- Findings from Turkmenistan studies show great promise of high-tech solutions for restoration of saline lands in desert ecosystem of temperate zone.

Impact of poplar tree wind break systems on water resources and farm income in Central Asia

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Keywords: fast growing trees, poplar cultivars, tree height, dbh, stem volume, yield, agroforestry

Introduction, scope, and main objectives

Central Asia is largely dominated by drylands so that agriculture depends on irrigation in most parts of the region, which results in large scale water withdrawal, mainly from rivers. This already results in widespread water scarcity. Climate change is expected to aggravate such water shortages as river runoffs are predicted to be substantially reduced latest during the second half of this century, which will put additional strain on irrigated agriculture (Reyer *et al.*, 2017). Tree wind breaks are one option to reduce water consumption in irrigated agriculture, add to farm income, and are therefore prioritized by government policies. Tree wind breaks reduce wind speed, which is the main driver that crop evapo-transpiration (crop water consumption) is reduced by tree wind breaks (Alimu, 2016). Today, the most dominant tree wind break type are single tree lines from poplars with an average planting distance of appr. 1 m.

Still, many farmers fear that tree wind breaks may compromise crop yields and income (Ruppert *et al.*, 2020). Against this background, the impact of tree wind breaks as they still exist on water consumption and farm income were investigated (Thevs *et al.*, 2019; Thevs and Aliev, 2021), as will be laid out below. In those tree wind breaks, poplar cultivars are used that have been developed more than 50 years ago, while recent international breeding developments have not penetrated that region yet. In order to potentially increase farm

income from tree wind break systems, the growth performance of 30 local and international poplar cultivars were tested across Central Asia (Thevs *et al.*, 2021a), as introduced below.

Methodology

The impact of tree wind breaks on crop water consumption was investigated by calculating the crop evapo-transpiration for relevant crops on fields with and without tree wind breaks. The crop evapo-transpiration of the different crops inside tree wind breaks and under open field conditions were calculated based on climate data that were measured on those different crop fields during the season 2017 (Thevs *et al.*, 2019). Thereby, climate data on the crop fields were measured in different distances from the tree wind breaks, in order to model the wind speed and other climatic factors depending on the distance from the tree wind break. Finally, the crop water consumption was calculated for crop fields between tree wind breaks of different distances. The water consumption of the trees of the tree wind breaks was measured, in order to obtain the water consumption of the whole tree wind break crop systems versus the crops without tree wind breaks. The tree water consumption was measured through sap flow measurements during the growing season 2017, as explained in Strenge *et al.* (2018).

The income from crops and trees were assessed through interviews with farm households and wood traders, also in 2017, in order to reveal the incomes from crops inside tree wind breaks versus crops without tree wind breaks (Thevs and Aliev, 2021). The farm households were interviewed with semi-structured questionnaires, which included questions on crop yields and revenues, costs for inputs and labour, and fixed costs. With regard to trees, revenues from tree harvest, tree size and age at harvest, and costs associated to tree planting and tree cultivation were queried during the interviews. The net present values accumulated over the time until tree harvest were calculated for the crop tree wind breaks system and the respective crops without tree wind breaks, as explained in Thevs and Aliev (2021).

These two datasets were collected in Ferghana Valley as a major breadbasket of Central Asia with its hot continental climate and in the Chui Valley to represent the areas north of the Tianshan Mountains with a slightly cooler climate than the Ferghana Valley. In the Ferghana Valley, the water consumption and agro-economy related data were collected in Bazarkorgon County. There, cotton, rice, and corn are the major crops. In Chui Valley, water consumption data were measured in Karasay Batyr, Kazakhstan, while agro-economic data were collected in Moskva County, Kyrgyzstan, with wheat, corn, potato, and barley being the main crops.

For testing recently developed poplar cultivars, in total 31 cultivars from different regions of the world were planted on testing plots in the Ferghana Valley and Chui Valley as explained in detail in Thevs *et al.* (2021a). This set of cultivars comprised *P. nigra*, *P. deltoides*, *P. trichocarpa* cultivars as well as *P. x canadensis*, *P. maximoviczii x trichocarpa*, and *P. nigra x maximoviczii* hybrids. The testing plots were located in Jalalabad and Osh, Ferghana Valley, and Bishkek, Chui Valley. Thereby, the plot in Bishkek was established in 2018, followed by the plot in Jalalabad in 2019 and Osh in 2020. On all three plots, 20 cm long cuttings were used as planting material.

Results

The water consumption of all crop tree wind break systems (including crop and tree water consumption) was lower than the water consumption of the corresponding crops without tree wind breaks. Thereby, systems with short distances between tree wind breaks saved more water than those with larger distances between tree rows (Tab. 1).

Tab. 1: Water consumption – evapotranspiration (ET) of crops without tree wind breaks (ETc) and with tree wind breaks of different distances between tree wind breaks, tree height 14 m (Thevs *et al.*, 2019)

Place and crops inside tree wind breaks	No tree wind break	Distance between tree wind breaks [m]			
		100	200	500	1000
Bazarkorgon					
corn	838	718	728	766	791
cotton	904	761	777	823	852
rice	812	702	708	743	767
Karasay Batyr					
barley	611	497	496	515	529
corn	1035	754	787	844	882
potato	699	549	556	582	602
wheat	753	582	594	625	648

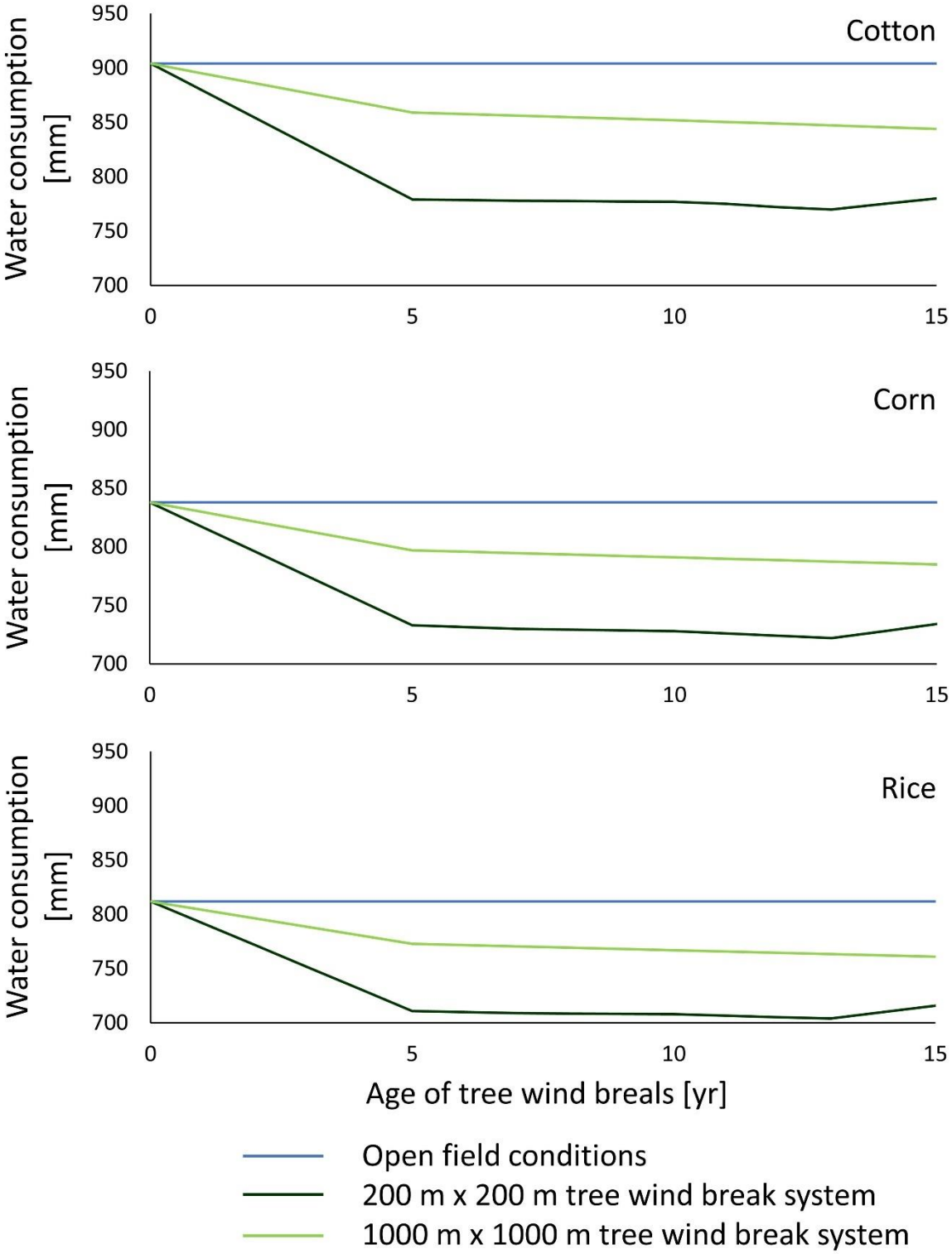
Source: Author's own elaboration.

Along with the increment in tree height (Tab. 2), the difference in water consumption becomes larger between the tree wind break systems and crops without tree wind breaks, as shown below in Fig. 1.

Tab. 2: Tree age and corresponding tree height of the cultivar Mirza Terek

Tree age (after planting)	5	7		13	15
Tree height [m]	9.6	12.5	14	17.8	19

Source: Author's own elaboration.



Source: Author's own elaboration.

Fig. 1: Water consumption (ET) of cotton, corn, and rice under open field conditions and corresponding tree wind break systems over the course of tree age (Thevs *et al*. 2021b)

In Ferghana Valley, trees from tree wind breaks were harvested at an age of 12 to 15 years. Therefore, these two tree ages were considered for further calculations and as rotation times. The tree age of 12 years corresponded with the diametre class 15 – 22 cm, which was sold for an average selling price of 1250 KGS. The next two trading classes, 22 – 27 cm and 27 – 35 cm were associated to a tree age of 15 years and the average selling price was 2425 KGS. Trees in Chui Valley had an average age of 16 years at harvest, which corresponded to diametres of 15 – 35 cm and a selling price of 1250 KGS per tree, as poplar tree trading was less common here compared to Ferghana Valley. The agro-economic data of the crops are given in Thevs and Aliev (2021).

Under these time spans of 15 and 16 years, respectively, until tree harvest and a discount rate of 17.5 percent, the tree wind break systems listed in Tab. 1 resulted in slightly higher accumulated NPVs than the respective crops without tree wind breaks. Though, this result only prevailed, as long as a crop yield increase of 10 percent was assumed for the crops inside the tree wind break systems. If the calculations were more conservative and no crop yield increase was assumed, the wind break systems did not yield any higher NPVs (Thevs and Aliev, 2021).

On all test plots, the modern poplar hybrids P. x canadensis (PDN) grew faster than the locally dominant cultivar Mirza Terek, as shown for the example Jalalabad at the end of their first growing season in Tab. 3. In Osh, though, there was no significant difference between those cultivars.

Tab. 3: Tree height as indicator of growth performance of tested poplar cultivars at the end of their first growing season in Bishkek, Jalalabad, and Osh. Averages ± standard deviation. Source: Thevs *et al.* (2021a)

Cultivar	Species	Bishkek	Jalalabad	Osh
Mirza Terek	*P. nigra*		143 ± 40	112 ± 43
Samsun	*P. deltoides*		231 ± 88	
89M060	*P. deltoides*		121 ± 57	
Oudenberg	*P. x canadensis*	300 ± 58	179 ± 101	84 ± 10
Orion	*P. x canadensis*	346 ± 52		101 ± 39
H-8	*P. x canadensis*			144 ± 83
H-11	*P. x canadensis*		164 ± 64	
H-33	*P. x canadensis*	311 ± 98	223 ± 74	102 ± 43
Tiepolo	*P. x canadensis*		202 ± 4	
Veronese	*P. x canadensis*		259 ± 63	
H-275	*P. maximoviczii x trichocarpa*	187 ± 77	81 ± 27	94 ± 38

Matrix-11	*P. maximoviczii x trichocarpa*	207 ± 81	71 ± 56	85 ± 25
Max-3	*P. nigra x maximoviczii*	265 ± 99	168 ± 43	71 ± 33
Trichobel	*P. trichocarpa*	248 ± 78	184 ± 62	

Source: Author's own elaboration.

In Bishkek, tree growth rates were higher across cultivars compared to Jalalabad and Osh. The cultivar H-33 reached a tree height within four years (Tab. 4), which corresponded to seven-year-old Mirza Terek trees in Ferghana Valley (Tab. 2) and reaches the lower diametre boundary of the trade class of a selling price of 1250 KGS. Orion, Oudenberg, and Vesten reached tree heights, which correspond to five–seven-year-old Mirza Terek trees in Ferghana Valley (Tab. 2 and 4).

Tab. 4: Means ± standard deviations of tree heights [m], and DBH [cm] and stem volumes [dm^3] at the end of the growing season 2021 for the plot in Bishkek. From all cultivars three trees were measured.

Cultivar	Species	Tree height [m]	DBH [cm]	Stem volume [dm^3]
Oudenberg	*P. x canadensis*	10.6±0	7.3±0.8	22±7
Orion	*P. x canadensis*	11.5±0	10.4±0.9	44±5
H-33	*P. x canadensis*	13.7±0.2	13.8±1.3	97±19
H-17	*P. x canadensis*	10.7±1	9.1±1	37±13
Vesten	*P. x canadensis*	10.9±0.2	6.6±0.3	18±2
Max-3	*P. nigra x maximoviczii*	8.5±0.8	5.8±0.5	14±5
Max-4	*P. nigra x maximoviczii*	9.3±0.5	7.4±0.9	21±4
Matrix-11	*P. maximoviczii x trichocarpa*	7.1±0.7	4.8±0.9	8±3
Fritzi-Pauley	*P. trichocarpa*	7.3±0.5	3.7±0.7	6±2

Source: Author's own elaboration.

Under warm climate conditions, i.e. low elevations, *P. x canadensis* hybrids attained highest stem volumes, followed by *P. nigra x maximoviczii* hybrids.

When the calculations of the accumulated NPVs were repeated with the assumption of a tree age of eight years at harvest, due to deployment of faster growing cultivars, selling price per tree of 1250 KGS, a discount rate of 17.5 percent, and no yield increases due to tree wind breaks, then all crop tree wind breaks systems, except rice, attained higher NPVs than the corresponding crops (Tab. 5).

Tab. 5: Accumulated NPV [1000 KGS] of different tree wind break systems after 8 years until harvest.

Place and crops inside tree wind breaks	No tree wind break	Distance between tree wind breaks [m]			
		100	200	500	1000
Bazarkorgon					
corn	-4.6	34.8	14.9	3.2	-0.8
cotton	180	204	192	185	183
rice	341	342	341	341	341
Karasay Batyr					
barley	17	72	44	28	22
corn	110	151	130	118	114
wheat	35	88	62	46	40

Source: Author's own elaboration.

Discussion

The tree wind break systems with higher tree density (i.e. shorter distance between tree rows) saved more water than those with larger distances between tree rows, because the former reduced the wind speed over all parts of the crop fields between the tree rows. At larger distances, parts of the crop fields experience the high wind speed as under open field conditions, which increases crop water consumption.

Under conditions of rather high discount rates, or unclear future, time is a major driver that reduces the revenues from trees. Therefore, the shorter time spans until harvest that P. x canadensis hybrids can achieve result in substantially higher economic benefits from tree wind break systems established with such faster growing cultivars. In addition, the faster growth increases the efficiency of those tree wind breaks over time with regard to reduce wind speed and crop water consumption. The water consumption of those faster growing cultivars was not found to be higher than the currently dominant poplar cultivars (Thevs *et al.*, 2021c).

Poplar wood is often seen as inferior to other wood species. But technological innovations in the field of engineered wood products of recent years opened new applications based on poplar wood, as listed in Isebrandt and Richardson (2014).

Conclusions

Single row tree wind breaks from poplar trees reduce overall agricultural water consumption and have the potential to improve farm income over a wide range of crops and spatial arrangements. Tree wind breaks also offer wood resources, which potentially reduce the pressure on natural woodlands and forests adjacent to farmland. The potential to increase farm income can be unlocked through the use of modern poplar cultivars, in particular P. x canadensis.

Acknowledgements

This work received financial support from the German Federal Ministry for Economic Cooperation and Development (BMZ) commissioned and administered through the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) Fund for International Agricultural Research (FIA), grant number: 81236142. Niels Thevs' position as an integrated expert at World Agroforestry was co-funded by BMZ as part of the Center for International Migration and Development (CIM) program. The sites in Khorog and Osh were funded by internal funds from World Agroforestry's genebank program.

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Establishment of seed isles as a sustainable option for rangeland rehabilitation in Qashqadarya province

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Keywords: Seed isles, plant, Atriplex, Kochia and Salsola

Introduction

All year-round grazing for many years was the main reason for pasture degradation and deflation in the farm. Pasture planning, monitoring, and management is therefore poorly practiced in the farm. Sustainable management systems are not yet in place. Ecological welfare of the rural population can be achieved only with the proper use of the pasture (Rabbimov and Mukimov, 2016). Therefore, research approach to develop improved system of the pasture management an important issue. The pastureland is the national wealth and is the main source of very cheap forage for livestock.

Natural pastures are forage base for livestock production. Therefore, research approach to develop improved system of the pasture management an important issue. It is necessary to preserve existing pastures, to increase the productivity of pasture plants, and to ensure the rational and efficient use of pastures in general. Introduce pasture plant's seed production management principles to prevent pasture degradation as this is the major sinks of greenhouse gases all over the world. Reseeding forage plants in degraded rangelands is difficult and is costly as there are a lot of field activities should be carried out (Fund *et al.*, 2019; International Center for Agricultural Research in the Dry Areas (ICARDA) report, 2013; Dobb and Burton 2013; Melissa *et al.*, 2021). There is a need to organize seed production of forage plants in the degraded rangeland and to increase capacity of rangelands users. The main objective of this research is to rehabilitate pastures through establishment of seed isles.

Material and methods

The experiment is introduced a method used in nature protection to initially increase the quantity of a plant species in an area, where it is nearly instinct: to build fenced seed isles at a windy place within nature.

This study was conducted at Oltinboyev Yeri farm in Qamashi district of Qashqadaryo province. Data on rainfall and temperature were recorded at the plot site whereas data on relative humidity were obtained from the meteorological office near the study site.

The seed isles were established and protected by iron fence. Atriplex, Kochia and Salsola species were planted in the seed isles. The seed isles were arranged in windy direction in order to reach wide area for distribution. In the experiment there were four fenced area with

45 m^2 area each. All four isles surrounded with wire to exclude grazing by animals during the plant growing season. Seed isles were seeded with perennial, drought-tolerant, productive native forage plants such as Kochia, Atriplex and Salsola. The control treatment was an overgrazed open rangeland. Plant vegetation composition is mainly Carex, poa, hulthemia and astragalus plants. The Carex and poa are dominated plant in this rangeland.

Field data was collected every month from the start of germination until the end of the growing season and was as follows:

- Seed Germination rate
- Determine plant density (number of plants/unit area)
- Plant height
- Determine percent plant cover (visually and digitally using platform photography)
- Determine the biomass production

Plants were cut leaving 5 cm stubble whenever they reached 26–28 cm. Data on biomass and dry mass production were collected at the end of the growing season i.e. in the beginning of May through end of May. Data analysis was performed using GenStat 18th edition.

Results

The year 2020, in contrast with 2021 was characterized by favorable weather conditions for the development of range plants. In general, winter 2020 was warmer than usual and almost without snow (Figure 1). Spring 2020 was characterized by surpass rainfall that promoted wide growth and development of range vegetation. Plant vegetation in the rangelands was observed by the end of May-beginning of June and favorable weather conditions in spring promoted good development of many range species that was not observed for the last 19-20 years.

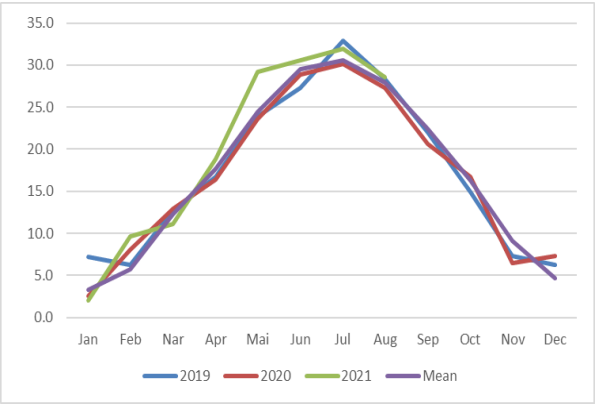


Figure 1: Average air temperature in Guzor district.

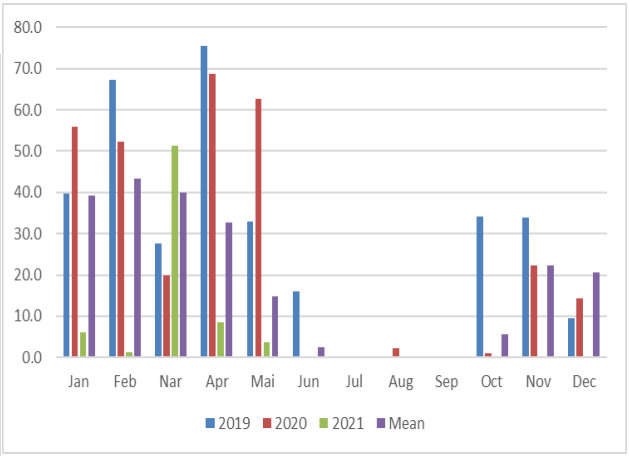


Figure 2: Mean annual precipitation, Average air temperature in Guzor district

Source: Author's own elaboration.

Field germination. As stated above climatic conditions of the 2020 positively affected the plant growth and development. Seedlings of the plants per square metre fluctuated between 28-345 units (Figure 3). Natural rangeland with no grazing had (283 plants/ha-1) the highest number of seedlings per square metre while the lowest had the treatment where Kochia planted (28 germinated plants per square metre).

Number of plants per square metre**.** Number of plants per square metre was calculated at the end of May month when the plant vegetation reached the final growth stage. The number of plant per square metre was not differ from treatment to treatment the highest was recorded with seed isles – Kochia (308) in 2020 while lowest was recorded also with Kochia in 2019 (Figure 4).

We observed across all treatments regardless of implementation year—was a distinct increase in plant density between control treatment and seed isles with Kochia, Atriplex and Salsola (see Figure 4).

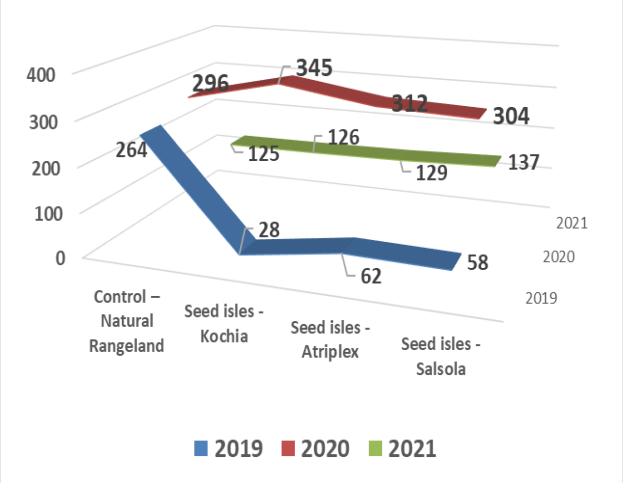


Figure 3: Field germination in control treatment and seed isles with Kochia, Atriplex and Salsola

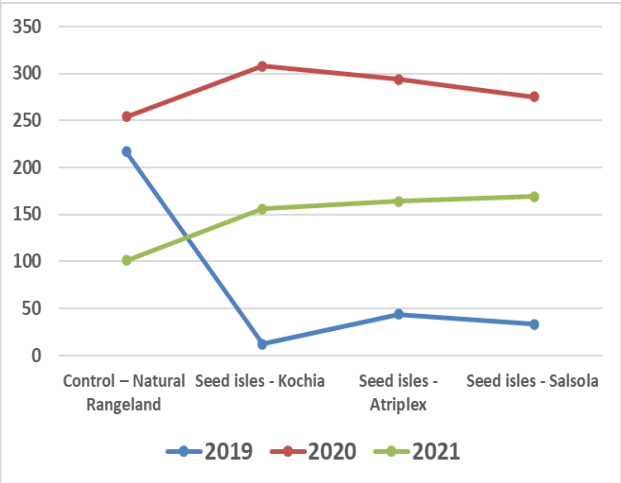


Figure 4: Number of plants per square metre

Source: Author's own elaboration.

Plant height. There was not significant difference on plant height among all four treatments of the experiment. Plant height of control treatment (natural rangeland) was 45, 58 and 15 cm in 2019, 2020 and 2021 respectively. Plant height of Natural Rangeland seed isles with Atriplex was 12.3, 71.3 and 39.1 in 2019, 2020 and 2021 respectively. The treatment seed isles with Salsola had the highest plant height 81.4 in 2020 among all treatments and years (Figure 5).

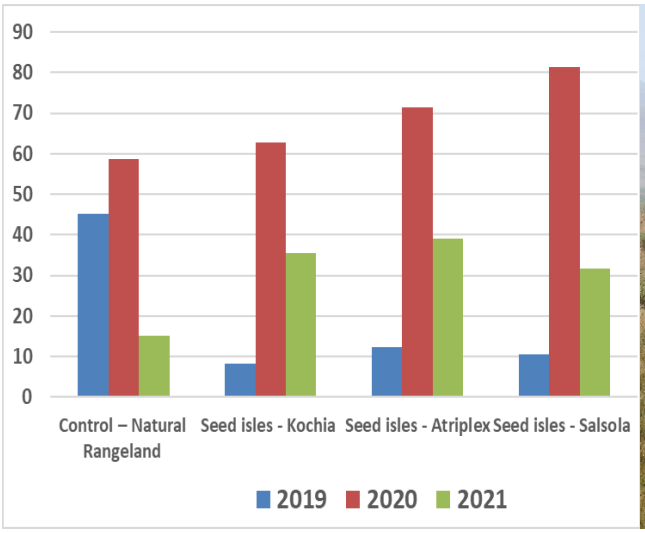
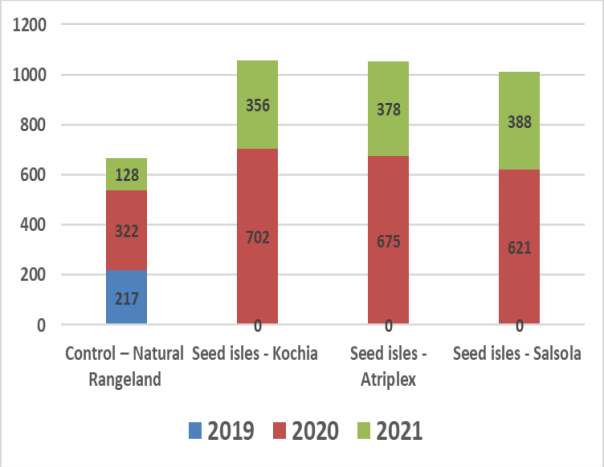


Figure 5: Plant height of natural rangeland and seed isles with Kochia, Atriplex and Salsola

Figure 6: Established seed isles in spring (2020)

Source: Author's own elaboration.

Biomass and dry matter production. Figure 6 and 7 shows the biomass and dry matter production influenced by grazing management and seed isles. There was significant difference on biomass production. It should be mentioned here that no data was collected on seed isles with Kochia, Atriplex and Salsola because all plants were was seeded in 2019. That is why we could not determine yield data. Analysis of the different grazing management has shown that the highest biomass production was recorded in the natural rangeland without grazing (373 g/m2) in 2019 while starting from 2020-year biomass and dry matter production started increasing in seed isles with Kochia, Atriplex and Salsola (Figures 7 and 8). This strong response was not observed in the 2021, nor was it observed in 2019.



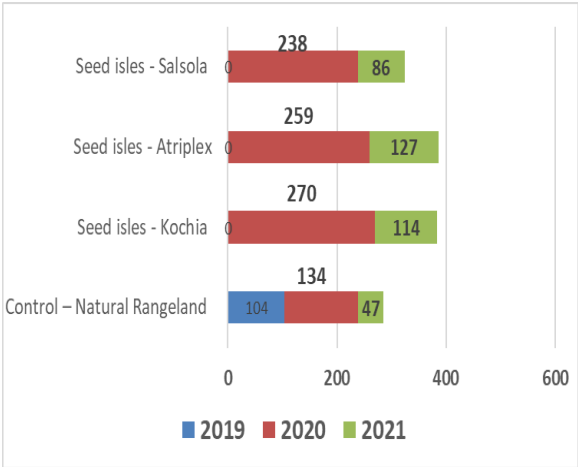


Figure 7: Biomass production natural rangeland and seed isles with Kochia, Atriplex and Salsola

Figure 8: Biomass production natural rangeland and seed isles with Kochia, Atriplex and Salsola

Source: Author's own elaboration.

Discussion

Three years results show that productivity of Kochia, Atriplex and Salsola are increased almost two times than natural rangeland. Also, this study shows that forage productivity can be achieved about tonne per hectare with long-term management. Beside higher biomass and dry matter productivity the seed isles are also should be concentrated in creating self-sustaining populations of reproducing rangeland plants. The seed isles at various plots on the fenced areas will increase number of different perennial rangeland species and shall assure that seeding can take place even in years with overgrazing. The fenced seed isles on the rangelands itself will also prevent loss of forage species.

Conclusions

Seed isles with Kochia treatment more than double the biomass productivity in 2020 year of the study, despite drought year in 2021 the biomass productivity of seed isles with Kochia, Atriplex and Salsola was higher than natural rangeland.

There was significant difference in plant height among all four treatments of the experiment. Plant height of control treatment natural rangeland with grazing was fluctuated between 15.2, 45.1 and 58.6 cm in 2019, 2020 and 2021, while plant height of seed isles with Kochia, Atriplex and Salsola was higher in 2020 and 2021 years.

Analysis of the different seed isles has shown that the highest biomass production was recorded in the seed isles with Kochia (702 g/m^2).

On the basis of primary findings of this research it can be concluded that the seed isles is one of the factor that has been implicated as critical in determining biomass productivity of the pastures in Qamashi district. In long term the seed isles will increase number of plant species and will decrease pasture degradation.

Acknowledgement

The study was done under "Integrated natural resources management in drought-prone and salt-affected agricultural production landscapes in Central Asia and Türkiye" CACILM-2 project. The project is funded by the Global Environmental Facility (GEF) and implemented by FAO. We thank Sherzod Oltiboyev for providing support to conduct the study in his farm.

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Study of natural rangelands in the South-Eastern part of Almaty oblast as an example of Kurtinsky district

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Keywords: natural pastures, ecosystems, desertification, overgrazing, degradation

Introduction, scope, and main objectives

Desertification is a key process of land degradation in arid and semi-arid regions of the world, directly affecting over 1 billion people and covering 40 percent of the land surface [1]. In particular, desertification processes are active in Kazakhstan, the largest landlocked country in the world, where 80 per cent of the land is made up of dry steppes, deserts and semi-deserts.

In order to analyse the main factors of desertification, we studied ecosystems of natural pastures in the South-East of Kazakhstan, located in the Balkhash-Alakol depression. These are sands and grey soils of Taukum, Sary-Taukum, Moyinkum and Saryesik-Atyrau deserts. The climate is sharply continental, with cold winters, little snow cover, hot summers, scarce precipitation, and a poorly developed hydrographic network. The rate of desertification processes in the region increased markedly from the 1970s to 1994–1995, against the background of overgrazing and significant regional climate warming [2].

The region under study is mainly an area of pastoralism and only partly of irrigated agriculture. The unfavourable weather conditions characteristic of the region are very detrimental to agriculture and, in particular, reduce the fodder capacity of natural pastures, making grazing more difficult. These phenomena include late spring and early autumn frosts, strong winds, dust storms, hail, dry winds, low air temperatures, blizzards in winter, especially against the background of low snow cover and occasional ice.

The main limiting factor for the area's vegetation cover is insufficient moisture (K. Thornthwaite coefficient - 0.25). With an average annual rainfall of 251.4 mm over the period 1998–2017, the years 2000, 2001, 2007, 2008 and 2012 averaged 154.4 mm of rainfall and the remaining 15 years had an average annual rainfall of 283.7 mm or 83.7 percent more than the 5 dry years. The drought duration in our surveyed district can be as long as 130-200 days.

Unstable precipitation has already been affecting the vegetation for many years. In wet years, the role of ephemerals increases markedly; in dry years, grasses and ephemerals develop poorly, and wormwood begins to dominate the herbage.

Material and methods

The geobotanical research method. The geobotanical surveys were carried out in two phases: a field survey and a desk survey.

During the preparatory period, available stock, literary and cartographic materials characterizing the study of natural pasture conditions in the study area of Kurtinsky district were collected.

Data on the structure and dynamics of the phytocenosis of the surveyed natural pastures were obtained because of field observations in key plots located in the semi-desert zone of the Kurtinsky district of the Almaty region. The number of surveyed plots was 20. Simultaneously with delineation and description of vegetation plots, forage yields were determined using the method of slopes of four sites of 1 m^2 each, and observation sites of 25×25m were laid with coordinate referencing. The geobotanical description forms were filled in with data on the total projective cover of the soil by plants, their height and phonological condition. Herbaceous plants were cut to a height of 1-3 cm, large grasses to 4-6 cm, and current-year growth was cut or cut off in semi-shrubs (Figure 1).

Figure 1. *Comparison of rafts from the surveyed region from one observation site:*

A - spring period; b - end of the summer period.

In determining the yield, the gross mass (with non-eating plants) and forage mass (eaten by at least one livestock species) were calculated in quintals per hectare of dry matter. In addition, a shrinkage factor was determined to convert raw photomaps to dry matter. For this purpose, once a decade for each community type, cuttings were sorted by species or species group and weighed raw.

The cut plants were spread out to dry out until air-dry (brittle) and weighed to determine the dry weight yield.

All raw and dried yields of individual plants and plant groups were recorded on the vegetation description forms, from which yields in quintals per hectare were calculated [3, 4].

GPS tracking methods for farm animals. To study the motion activity of grazing animals in the surveyed natural pastures, we used TranSystem 747-PRO-S GPS-loggers designed to track farm animals (goats, sheep, cattle, camels, and horses) during grazing. GPS loggers allow recording the coordinates of the tracked animal, taking into account time, speed of movement, altitude with an accuracy of up to 3 metres with signal interval every 10 seconds for 28 hours.

The data were sorted and processed in GPS-tagger software to be converted into a standard vector file (Shapefile polyline) and georeferenced.

GPS tracking material was collected: on camels, cattle and small ruminants from seven nearby farms.

Results

The peculiarity of the vegetation cover of the surveyed territory is the dominance of annuals in the composition of plant communities. Vast areas of the plateau are occupied by ephemeral and complex saltwort-ephemeral formations of numerous cruciferous, ephemeral cereals, small legumes and Ceratocarpus. Characteristic for the desert zone perennial components: sagebrush and semi-shrub saltwort have practically lost their dominant significance. Small fragments of communities containing them are distributed among ephemeral and ephemeral-saline vegetation. Such a ratio of components in the composition of plant communities is a consequence of long-term unsystematic use of pastures without real accounting of their fodder capacity and pasture load, which leads to large-scale overgrazing, degradation of pasture vegetation and desertification. Pasture digression reduces the fodder capacity of lands due to loss of perennial species of indigenous vegetation and their replacement by secondary (modification) groupings, mainly of annual badly eaten and weed plants. Secondary communities are polydominant in their botanical composition, often without a well-defined edificatory. They are formed from numerous species of early spring ephemera and annual saltwort.

Discussion

The number of grazing livestock must not exceed the feeding capacity of natural rangelands. The herd structure should be optimal in terms of the ratio of different animal species (sheep, goats, cattle, horses, camels); the ratio of species should be determined based on the species composition of the plant communities on certain farms in the area.

Pasture rotation schemes need to be designed for specific grazing areas based on current climatic conditions, forage types and herd structure. The grazing range will regulate the grazing regime and maximize the use of plant fodder by alternating periods of intense grass shedding with periods of grass re-growth.

To better use the plant resources and increase the carrying capacity of the pastures, an adequate number of accessible watering points should be available during the summer. In this case, the animals can use both dry plants and halophytes.

In order to maintain vegetation productivity in the steppe, semi-desert and desert zones, no more than 60-67 percent of the above-ground vegetation mass should be cut down.

In order to restore degraded phytocenoses, a reserve fund of fallow land should be formed. It is desirable to carry out phytomelioration works with the sowing of seeds of fodder plant species corresponding to the final stages of successional processes (agropyron fragile, eurotia or calligonum leafless). Stockpiles with perennial plants can be used in a grazing rotation system.

Conclusions

The formation of the vegetation cover of the study area is influenced by unfavourable desert climatic conditions and human activities. The main factor of anthropogenic impact on the vegetation is grazing, which has long been practised in the area.

A feature of the vegetation cover of this area is its secondary character and almost complete absence of indigenous plant communities formed by typical desert perennials: wormwood and semi-shrub saltwort. The vegetation cover is dominated throughout the entire area by annuals: ephemeral grasses, numerous species of grasses from the cruciferous and legumes, Ceratocarpus and other saltworts. The development of these plants is unstable from year to year, depending closely on the current year's conditions. In wet spring years, ephemerals develop lushly; in favourable summer and autumn precipitation, they are replaced by annual saltwort so that the synusias of ephemerals and Ceratocarpus alternate with each other over time. In dry years, annuals do not reach full development, and many of them may not develop at all, remaining in the soil as diasporas for a long time.

Acknowledgements

The author would like to thank the Michael Succow Foundation for providing the CADI scholarship programme for this research.

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High-tech methods of saline land reclamation in the cold winter deserts of Turkmenistan

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Keywords: desertification, spectroradiometre, hyperspectral analysis, X-ray phase analysis, phytomelioration, phreatophyte, transpiration.

Desertification, drought and soil salinization are high on the list of current global problems of humankind that pose an obstacle to sustainable economic development. These phenomena occur as a result of unsustainable use of natural resources and due to various factors, including climate change and human activities. The Central Asian (CA) states (Uzbekistan, Kyrgyzstan, Tajikistan, Turkmenistan, Kazakhstan) are very interested in economic, social and ecological stability of their states and give special importance to solve these problems.

In recent years, climatic conditions have changed greatly due to the shrinking of glacier areas in most of the mountain systems of the Tien Shan, Pamir and Altai, along with the drying up of the Aral Sea. In this regard, the shortage of water for irrigation and watering is already being felt. The natural vegetation cover is degrading, the processes of erosion and salinization are growing, and the productive capacity of irrigated lands is decreasing. A serious problem before mankind is to preserve the available natural-landscape resources while improving and multiplying its specific species and developing methods of combating desertification and soil salinization.

Current situation poses a challenge to protect the environment, specifically:

- it is necessary to control the processes of soil salinization and quality (mineralization) of irrigation water;
- use phytomeliorants to desalinize and improve soil fertility;
- take radical measures to eliminate the factors causing desertification.

In order to carry out remote control and to manage soil salinization and desertification processes in the future, high-tech methods are being used. We present a method of satellite diagnostics of the soil cover condition and the degree of soil salinity. This method is based on the reflective spectral capacity of the soil surface free of vegetation, and the results obtained will help to address these problems.

Below we present the actual results of our studies in this region.

The location of the saline soil on the space image was determined by the use of a spectral library for saline soils free of vegetation, the spectra of which were measured by FieldSpec 4 spectroradiometre in the optical range from 350 - 2400 nm (Fig. 1), and the hyperspectral analysis method (Fig. 2). The mineralogical composition of a field sample of saline soil was

determined by X-ray diffraction analysis and identified with the spectral reflectance of the saline soil sample surface (Table 1).

Fig.1.

Spectrum of reflected solar radiation from the surface of a sample of saline soil free of vegetation

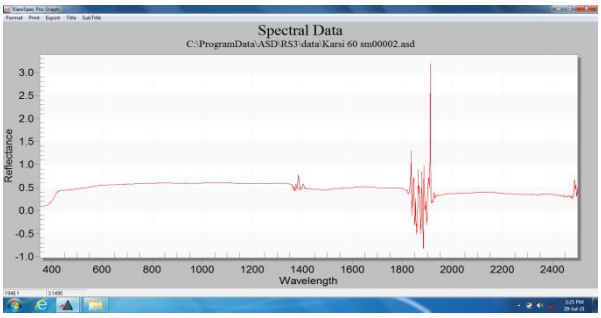


Fig.2

Location on the satellite image of the saline soil with the mineral composition shown in Table 1

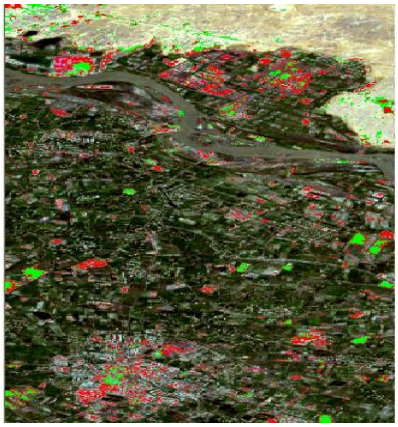


Table 1

Results of X-ray phase analysis of the mineralogical composition of the soil sample *

Name of mineral	Value in percent
Quartz (SiO_2)	22/3 percent
Albite ($NaALSi_3O_8$)	27.8 percent
Microcline ($KAlSi_3O_8$)	-
Orthoclase ($KAlSi_3O_8$)	18.1 percent
Calcite ($CaCO_3$)	22.4 percent
Dolomite $CaMg(CO_3)_2$	3.3 percent
Aragonite ($CaCO_3$)	2.6 percent
Lime (CaO)	1.1 percent
Halite (NaCl)	2.4 percent
Amphiphol	-
Hydromica	-
$(K<1Al_2[OH]_2\{AlSi_3O_{10}\}*nH_2O)$	-
Total :	100 percent

Source: Author's own elaboration.

*The results of X-ray phase analysis were obtained using a D-2 Phaser X-ray diffractometre.

The degree of soil salinity, with their subsequent classification, is determined using calculated narrow-band spectral indices of soil salinity.

SI-1 = ALI9/ALI10; SI-2 = (ALI6 – ALI9)/(ALI6+ALI9);

SI-3 = (ALI9 – ALI10)/(ALI9 + ALI10);

SSSI-1 = (ALI9 – ALI10); SSSI-2 = (ALI9xALI10 – ALI10xALI10)/ALI9;

ALI1- ALI10 –ALI spectral sensor channels. Satellite EO-1 [2].

Table 2

Calculated soil salinity indexes

Soil sample	ALI6 775nm-805nm	ALI9 1550nm-1750nm	ALI10 2080nm -2350nm	SI-1	SI-2	SI-3	SSSI-1	SSSI-2
Topsoil layer 0-30 cm	0.6005	0.5258	0.3943	1.333502	0.066323	0.142919	0.1315	0.098612
Tillage layer 30-60 cm	0.6378	0.5263	0.3676	1.431719	0.095782	0.177537	0.1587	0.110846

Classification of soil salinity [3]

Zero salinity <0.1	Low salinity 0.1 – 0.3	Moderate salinity 0.3– 0.6	Strong salinity 0.6-1.5	Very strong salinity >1.5

Source: Author's own elaboration.

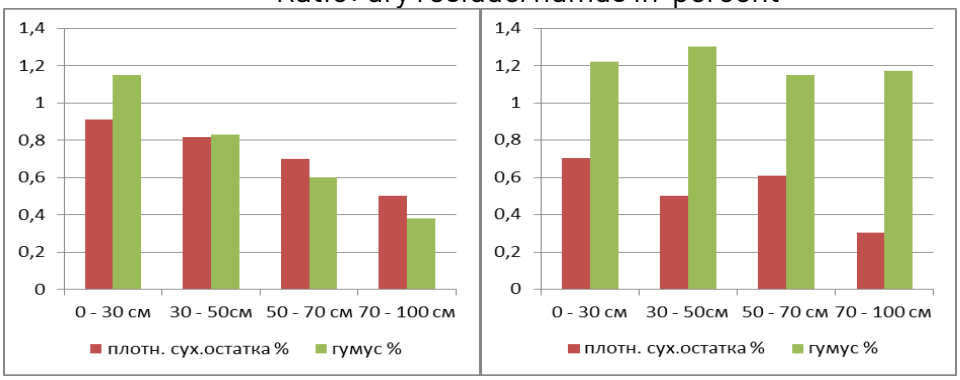
There are various methods of reducing and controlling the level of soil salinity (agrotechnical, hydromeliorative, and engineering). All of them are rather labour-consuming and expensive. Therefore, nowadays phytoreclamation is one of the most effective and environmentally safe methods, which is being used increasingly more often.

Phytoreclamation is a method which forms bioecological equilibrium in agrosystem, the most convenient in use and cheapest way to reduce soil salinity [1, 4, 5]. In our case we consider the possibility of restoration of saline lands using licorice plant (*Glycyrrhiza glabra L.*), of legume plant group. Below, in Fig. 3, there is a comparative analysis of the soil characteristics before (a) and after (c) four-five years of growing licorice. As can be seen, during this period, the content of humus increases and dry residue decreases, indicating soil desalinization.

Fig. 3

Medium saline soil, comparative analysis.

Ratio: dry residue/humus in percent



Legend, translated:

Dry matter density percent	
Humus	
см	cm

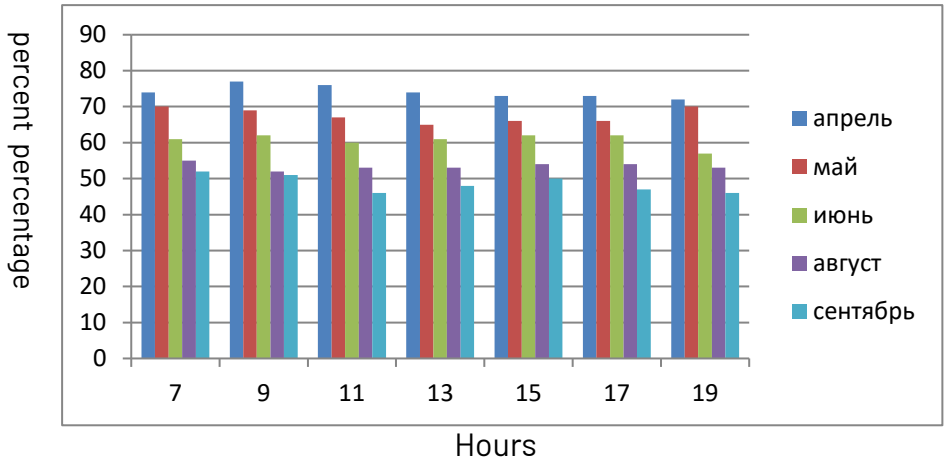
a - Before planting of licorice b - after 4-5 years of licorice vegetation

Source: Author's own elaboration.

There is also a decline of ground water level in the licorice's natural growing conditions. Licorice by the water consumption type belongs to phreatophytes and more often grows intensively in areas with shallow groundwater. Forming a continuous cover and well shaded soil, it actively reduces evaporation from its surface and prevents the rise of salts in the upper soil horizons. The lowering of the water table is also due to transpiration of the plant leaves. Licorice roots penetrate deep into the soil, reach groundwater, and subsequently use them in their water metabolism. Due to water consumption mainly for transpiration, seasonal accumulation of water-soluble salts on the soil surface stops. Seasonal and hourly water saturation of surface part of licorice plants can be seen in the figures below (Fig.4,5).

Fig. 4

Dynamics of licorice leaf water content in Prioasis sands in percent



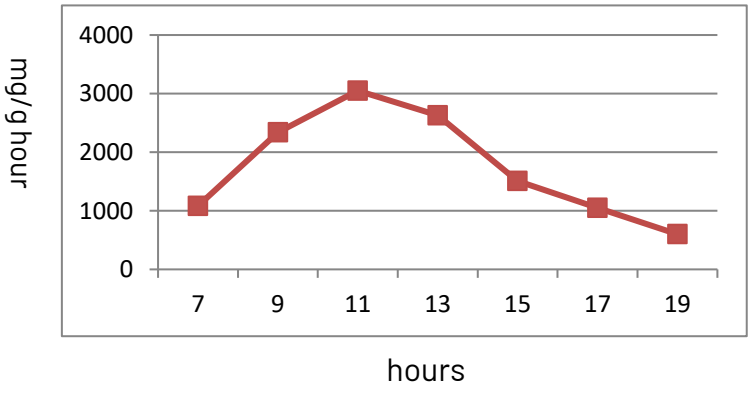
Legend, translated:

April	
May	
June	
August	
September	

Source: Author's own elaboration.

Fig. 5

Transpiration intensity of licorice during daytime (June)



Source: Author's own elaboration.

As can be seen from the graph in summer during the daytime (from 11 am to 5 pm), transpiration of licorice decreases, despite the fact that air temperature continues to rise (≥400 C). This indicates the regulative activity of the plants, thus, licorice avoids excessive water loss that could disturb its water regime. At this level, the intensity of transpiration is actually maintained during the entire spring and summer period, and only in the autumn some decrease is observed. Active process of transpiration in morning and midday hours of

spring and summer contributes to lowering of subsurface water. At high air temperatures, leaf stomata become closed and transpiration slows down.

Based on the above mentioned we can conclude that cultivation of licorice in saline soils improves physical properties of soil, reduces salinity degree by lowering groundwater level, most likely contributes to aeration and infiltration, as well as increases fertility of reclaimed soils. And the crop itself, selected as a reclamation agent, belongs to the most highly valued raw plants, which are in great demand on the world market.

Introduction of the land coordinate farming system in Turkmenistan will contribute to monitoring of soil inventory and condition.

The following conclusions were made as a result of our research:

- it is necessary to create a spectral library of soil salinity level and vegetation cover in the cold deserts of Turkmenistan with the help of high-tech methods;

- cultivation of licorice in conditions of saline soils increases their fertility and reduces the degree of salinity by lowering the groundwater table;

- it is recommended to use other advanced salt-tolerant plants contributing to soil desalinization as a phytomeliorative crop rotation.

Acknowledgments

The authors of the article, employees of the National Institute of Deserts, Flora and Fauna of the Ministry of Agriculture and Environmental Protection of Turkmenistan, thank the organizing committee of the Regional Secretariat of CADI, as well as the coordinators of the UN Regional Project (FAO) and the Global Environment Facility (GEF) project on "Integrated Natural Resource Management in Drought-prone and Saline Agricultural Production Landscapes in Central Asia and Türkiye (CACILM - 2)" for providing opportunity to participate in the workshop.

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Current state of pastures in the Navoi and Bukhara provinces of Uzbekistan and ways of rational use

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Abstract: The article presents materials on the Bukhara and Navoi regions' current state and presents the vegetation types of various pasture ecosystems and yields.

Keywords: Desert, pastures, degradation, yield, vegetation, digression

Introduction and objectives

Natural pastures account for about 23 million hectares and are the main source of livelihood and well-being of the population living here. The pasture fund is 8 759.9 thousand ha in Navoi and 2 576.2 thousand ha in Bukhara oblasts. In 2009-2011, because of the development of degradation processes, the area of pastures decreased by 26.2 thousand ha, of which 21.0 thousand ha are in Bukhara oblast.

Pastures of deserts and semi-deserts are characterised by relatively low productivity (2.5-3.2 dt/ha) and are ecologically fragile ecosystems. Due to unsystematic, irrational use of pasture ecosystems, degradation of vegetation cover is currently observed in more than 40 percent of the used territories. A high density of animals is observed, especially in the zone of foothill pastures, which have long been devoid of shrub vegetation, due to which they are narrowly seasonal. Animals are mostly provided with purchased fodder, the profitability of livestock farms is very low; at the same time, there is a trend of constant growth in the number of livestock in dehkan farms.

In contrast to the sandy desert, the number of grazing animals in the adyr and gypsum desert areas is high, with only about one hectare of pasture per one conditional head. All this amounts to a load three-four times higher than the norm, which leads to intensifying degradation processes and reducing and impoverishing vegetation biodiversity. This unsatisfactory condition is caused by irrational and unsystematic use of pastures, cutting down bushes, and overloading pastures. In contrast to the foothill zone, the main reason for degradation is the irrational use of pastures and lack of water sources. [1]

Degraded pasture area, mln ha

Regions	Degraded pasture area, mln ha	percent
Bukhara	1.2	37.6
Navoi	4.1	43.8

Source: Author's own elaboration.

Desert pastures are affected to a different extent by various factors. Among them are overgrazing (48 percent), destruction of vegetation for fuel (25 percent), disturbance of vegetation cover during construction of roads, power - industrial complex lines, mines (1.0 percent), ploughing of lands for cultivation (1 percent), reduction of water sources (15 percent), the advance of mobile sands (10 percent). Under the influence of these factors, the following consequences are observed: exposure of land surface, degradation of near-settlement and near-settlement, as well as some pasture areas, the appearance of mobile sands, industrial waste heaps (dumps). As a result, the biological productivity of pastures and their fodder capacity decreases, which should be considered the beginning of the development of the desertification process.

The main reasons for this unfavourable situation are:

- 85 percent of non-irrigated land use is in the desert and semi-desert natural-climatic zone of the country, which is more prone to land degradation. Global climate change, reduced precipitation and more frequent droughts have negatively affected the efficiency of rained farming, pasture and forestry land use;

- The reform of economic and land relations in rain-fed land use requires further deepening (lease land relations, legal and economic mechanism for organisation and management of production in breeding farms, etc.);

- massive unauthorised cutting of trees and shrubs by the local population for household purposes due to the lack of other energy sources;

- The continued use of degraded pastures as part of the SFF without proper reclamation, the absence of a production unit in the SFD for planning the use and reproduction of pasture productivity, which constitutes 30 percent of all its land;

- no permanent use or lease rights to pasture on private farms;

- farms are unprofitable and in need of state support;

- the long absence of land inventories in breeding farms and forest farms, forestry and land management materials, pasture rotation, regulated grazing;

- uneven distribution of livestock and rangeland across the regions of the country, with unacceptable grazing pressure in many regions;

- poor implementation of market principles in non-irrigated arid land use;

- inadequate land legislation on providing and managing rangeland, rain-fed cropland and forestry land.

The current situation in non-irrigated arid land use cannot be considered normal; it does not meet the requirements of agricultural and forestry development and economy at the present stage of society development. To ensure effective non-irrigated land use, it is necessary to reform economic and land relations further, create sustainable land use, provide prevention of land degradation and high ecological and economic efficiency of land resources use.

The main way to ensure stable development of cattle breeding and environmental protection in this zone, in our opinion, is the introduction of effective technologies of pastures improvement, allowing to increase their productivity by three-four times, development and introduction of the system of rational use of artificial and natural forage lands, intensification of forage production by creating seeded hayfields, use of alternative sources of income for the local population. It is necessary to comply with a load of pastures with normal capacity. In order to maintain high productivity and preserve sheep herds on farms, it is necessary to create fodder stocks, use them rationally, and apply efficient technological elements in the overall production system.

Methodology

- the geobotanical surveys were carried out according to a common rangeland monitoring methodology [2];
- routine field surveys with a traditional method of describing sample plots and field interpretation of satellite images;
- identification of pasture types and determination of fodder yields on sample plots by season;
- assessment of the degree of vegetation degradation in the sample areas;
- comparison of modern and historical geobotanical maps and vegetation descriptions.

Results

Within the framework of the PPG Project in Uzbekistan GCP /UZB/003/GFF "Sustainable Forest and Grassland Management in Arid Ecosystems of Uzbekistan (PPG)" an analysis and survey of grasslands in Bukhara and Navoi oblasts, which are mainly divided into 4 management types, was conducted:

1. suffritencent-grassy type
2. ephemerous-ephemeroid type
3. shrubby-grassy type
4. halophytic type

Desert pastures of Bukhara and Navoi oblasts are characterised by low productivity of 2-3 dt/ha in good years, with yields varying from year to year and from season to season. In bad years, the sheep flock of Bukhara oblast is driven to the pastures of Navoi oblast. In 2015-2016, there was an extremely unfavourable climatic situation for the growth and development of semi-shrub vegetation in Kyzylkum desert conditions. Semi shrubby vegetation did not vegetate for two years, and yield was 0.3-0.5 dt/ha due to some vegetation of herbaceous and shrub vegetation.

Under favourable conditions in 2017, all pasture areas in the area have fully recovered and are well-vegetated, with yields in the spring season of around 4.0-4.5 dt/ha. Sheep capacity averages 0.5 head per hectare of pasture area; good areas can support more than 0.7 head per hectare.

The main vegetation in the pastures: Artemisia diffusa (Artemisia diffusa), singren-Astrragalus oblongatae (Astragalus villosissimus Bunge), Heliotrope (Heliotropium argusioides), Cousinia (Cousinia resinosa), Amberia (Alhagi pseudalhagi), Gamadae creeper (Convolvulus hamadae), sedge (Carex pachystylis) and Bulbosa bluegrass (Poa bulbosa). Projective cover of plants 55 - 75 percent

©FAO Photo 1 and 2. State of the Artemisia in Bukhara and Navoi oblasts in 2015 and 2016


©FAO Photo 3 and 4. State of the Artemisia in Bukhara oblast in 2017

©FAO Photo 5 and 6. Status of pastures in Bukhara oblast in 2020

Under 2020 conditions in the pastures of Bukhara oblast, the average yield of fodder mass by seasons of the year was 2.7-3.5 dt/ha on the salt rangeland type of pastures. Sheep

carrying capacity averaged 0.33 head per 1 ha of pasture area; it is possible to keep more than 0.43 head per 1 ha in good areas.

These pastures are recommended for use in spring, summer and autumn [2]. Vegetation Climacoptera lanata (Climacoptera lanata), ambergrass (Alhagi pseudalhagi), annual saltwort (Salsola sclerantha), saxaul (Haloxylon persicum), syngrain Astragalus villosissimus Bunge), early saltwort - Salsola praecox, creeper vine Convolvulus hamadae. Plant height 25-35 cm, Saxaul 1.5-2.5 m.

The average fodder yield by season was 2.0-2.1 dt/ha on the White Saxaul pasture type. Pastures of year-round use [1]. Vegetation is saxaul (Haloxylon persicum), rarely cherkez (Salsola Richteri), Climacoptera (Climacoptera lanata).

On the White Saxaul type of pasture, the yield of fodder mass by seasons is 2.0-2.1 dt/ha. Sheep capacity averages 0.26 head per 1 ha of pasture area.

The pastures are of year-round use. Vegetation is saxaul (Haloxylon persicum), rarely cherkez (Salsola richteri), Climacoptera (Climacoptera lanata).

The pastures of Alat, Romitan, Shafran, Gijduvan districts and the southern part of Bukhara and Navoi oblasts are similar in types, and there are 3 most common plant associations.

1. Shrubby-ephemeral-ephemeroid is the most widespread throughout Bukhara oblast and is located mainly on hilly and ridgy sands. Yields are 3.5-4.0 dt/ha, and the degradation percentage is 50-60 percent. The pastures are of circular use. Sheep capacity averages 0.5 head per hectare of pasture.

2. The suffritencent plant community is located mainly on gypsum soils in the district's south. Yields are 2.5-3.0 dt/ha. Sheep yields an average of 0.37 head per 1 ha of pasture.

3. Plant community on saline land

Yields 4.5-6.5 dt/ha, percentage of degradation 30-40 percent. Pastures of autumn-winter use. Sheep capacity averages 0.56 head per hectare of pasture area; it is possible to keep more than 0.81 head per hectare in good areas.

©FAO Photo 7 and 8. Status of the swampy areas in Navoi oblast in 2017 along the Navoi - Uchkuduk road (Kanimekh district)

Under 2020 conditions in the pastures of Navoi oblast, the average yield of fodder mass by seasons of the year was 2.9 -3.3 dt/ha. Sheep carrying capacity averages 0.36 head per 1 ha of pasture area; in good areas, it is possible to keep more than 0.41 head per 1 ha.

©FAO Photo 9 and 10. State of pastures in Navoi oblast in 2020

The pastures in Navoi oblast are characterised by good productivity of 3.5-4.5 dt/ha and are used all year round. The average percentage of degradation is 45-55 percent.

Good forage lands in Tamdyn (Yamankum Massiv) and Uchkuduk districts (Altintau Massiv), these pastures have wide biodiversity of well-eaten fodder plant species. The annual yield is 5.5 dt/ha, sheep capacity of the pastures is 0.68 ha per one head.

Discussion

Low fodder productivity of natural pastures (about 105-300 kg/ha of hay in average weather conditions) creates certain difficulties in the optimal development of cattle breeding in this

natural zone. As the long-term experience of scientific research in desert-pasture cattle breeding shows, this problem can be solved by their improvement. In particular, in relation to degraded rangelands, the creation of protective plantations and pasture agrophytocenoses from different plant life forms and oasis fodder production based on groundwater use provide a good effect. [3]

The goal of pasture management is to make the most productive use of pasture forage and to increase pasture capacity and productivity. Pastures should only be grazed in a planned manner, according to a system that provides for both the change of seasons and the number of years of grazing in the same season. Pasture rotation and a planned grazing system are important tools to maintain high pasture productivity in the desert. With these measures, it is possible to distribute the pasture areas correctly between farms and to ensure an even consumption of pastures.

The main prerequisite for a rational pasture management system in the desert zone is a full water supply to the pastures.

All livestock farms show inadequate animal feeding, especially in autumn and winter, low levels of livestock development (cattle), irrational use of fodder resources (pastures, irrigated land).

On livestock farms, very large amounts of coarse fodder are procured annually for the winter and throughout the year (about 30-40 percent) and purchased from the market, which significantly reduces the efficiency of livestock production. Also, in practice, fodder is used very poorly and inefficiently. In summer, the animals are kept on arable land for two-three months after harvesting the spike crops; these lands are also used for a fee.

Conclusions

There are two main overgrazing factors in the area: [3]

- excessive concentration of livestock per unit area;

- inefficient livestock husbandry practices.

Negative trends in pasture development in the area:

- an increase in the abundance and area of non-edible and weed species - burgee, garmache, heliotrope, etc., which proves harmful to the pasture, while the number and yield of the main fodder species - sedge, bluegrass - decreases;
- at present, vegetation cover in the vicinity of settlements and farms is overgrazed (up to 100 percent), and more remote pastures are underused due to the remoteness of the lack of water wells
- intensive (100 percent) grazing of Artemisia-ephemera pastures near human settlements, especially in mid-spring, leads to a decrease in the number of the main fodder plants, sedge and wormwood;

- in the remote plain wormwood-ephemera pastures, the wormwood is ageing, and there are many dead wormwood bushes and stems, which are not well eaten by livestock.

Each region has forestry organisations with tree crop propagation nurseries. According to the Plan, these organisations rehabilitate degraded pasture areas annually but do not have sufficient funds and machinery to carry out the work on a larger scale.

Acknowledgements

The study would not have been possible without the support of the Government of Uzbekistan and local authorities under very difficult circumstances. The entire team contributed to the study, and, in addition, the FAO office in Uzbekistan and the FAO Statistics Division provided invaluable advice. Special thanks are due to the national numbering team, who were at the forefront of the COVID-19 pandemic and successfully completed the commissioned survey.

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Improving degraded pastures in Uzbekistan's desert zone by introducing best practices

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Abstract
The paper presents the best practices on restoration of degraded pastures in the sandy zone of the Karakul district of the Bukhara region implemented by UNDP project. Measures on restoration of pasture biodiversity, preservation of landscape-ecological systems were taken on degraded lands. Land reclamation measures have been implemented to fix moving dunes, create (restore) protective forest belts on pastures, reproduce pasture productivity through artificial reseeding in degraded areas, restore pasture infrastructure, and repair inactive wells. Consistent improvement of pasture productivity by reseeding plants, introduction of technologies to improve pasture productivity ensure the long-term sustainability of protective forest belts.

Keywords: sandy desert, Kyzylkum, degradation, drought-resistant forage plants, seeds, seedlings, technology, grazing

Introduction
Uzbekistan's Karakul pastures, occupying an area of around 23.5 million hectares, are the main source of forage for Karakul sheep, goats, and camels. These pastures are located in different soil and climatic conditions: gypsum, solonchak, sandy, etc. These pastures are suitable for use throughout almost the entire year and are characterized by a variety of pasture forage, its relatively high nutritive value, and provide the cheapest forage [1]. Characteristic climatic features are the small amount of precipitation - from 80 to 250 mm per year, high temperatures in summer (38-45^{0}C and above), and low temperatures in winter (minus - 10-15^{0}C and below).

The vegetation cover is sparse and consists of ephemeral and semi-shrub vegetation adapted to hot and dry climate. Pasture protection belts represent an efficient method for improving natural pastures in the desert zone by creating more favorable conditions for the growth and development of native vegetation (soften the microclimate, contribute to the accumulation of soil moisture, reduce the wind speed, and protect the soil from deflation). Land degradation and desertification are becoming one of the major environmental problems threatening natural ecosystems and socioeconomic development of the Republic of Uzbekistan.

Research methods

The project activities focused on degraded agro-landscapes and low-productive sandy pastures in the Karakul district of the Bukhara region. [2]

In order to improve the productivity of degraded lands, best practices of sustainable land management were applied, along the following areas:

- restoration and conservation of pasture biodiversity;
- restoration of pasture productivity and their production infrastructure to prevent pasture degradation, restoration and preservation of landscape and ecological systems, improving environmental quality in the area;
- implementation of land reclamation measures to stabilize sand movement and creation (restoration) of protective forest belts on pastures;
- reproduction of pasture productivity through artificial reseeding on degraded areas;
- restoration of pasture infrastructure, repairing inactive wells, sheep barns, road network and bridges, technical anti-erosion structures.

Findings

Pasture enrichment activities in the Karakul district were carried out under the UNDP Project "Reducing pressure on natural resources from competing land use in non-irrigated arid mountain, semi-desert and desert landscapes of Uzbekistan". Monitoring of plant condition showed that seedlings and germinated seeds vegetate well.

Table 1.

Yield and age of life of forage crops:

Forage crop	Yield, cwt/ha	Life-form	Age of life, years
Black Saxaul	2.4-4.0	Perennial	60-80
White saxaul	2.4-4.0	Perennial	40-60
Salsola richteri	1.4-1.6	Perennial	40-60
Calligonum	2-3	Perennial	25-30

Source: Author's own elaboration.

Planting of seedlings and overseeding of black saxaul was conducted on the territory of Karakul LLC on a degraded pasture area. The area lacks shrub vegetation, and the project consultants and representatives decided to restore this pasture area. The main vegetation in this area is keireuk *(Salsola orientalis)*, Russian thistle *(Salsola arbuscula)*, singren *(Astragulus vilosissima)*, annual saltworts (*Salsola sp.)*. Planting of seedlings and seeding were carried out on an area of 30 hectares, at 9 metres inter-strip space. The total area to be restored is 300 hectares, and the area configuration is 5000 metres x 600 metres = 300 hectares. Saxaul seedlings were planted in 1-metre-wide furrows; black saxaul seeds were additionally sown in the same furrows to obtain guaranteed seedlings.

Planting of seedlings and overseeding of black saxaul *(Haloxylon aphyllum)*, salsola *(Salsola paletzkiana)* and calligonum *(Calligonum caput-medesae)* was conducted in the following forestry enterprises of the Karakul district: on 130 hectares of the area one and on 170 hectares of the area two of the "Navoi" forestry enterprise and on 1000 hectares of the "Karakul" forestry enterprise. The crop coordinates in areas of "Gugurtli" and "Kandym" forestry enterprises are given in Table 2. The strips are distributed perpendicular to the direction of the prevailing wind.

Table 2

Crop coordinates of the specialized state forestry enterprise "Navoi" of the Karakul district

Area 1 Gugurtli area			
Point	N	E	Altitude
1	40 23 018	62 23 185	157
2	40 22 572	62 23 029	150
3	40 21 509	62 23 180	167
4	40 21 468	62 23 492	166
Area 2 Gugurtli area			
Point	N	E	Altitude
1	40 20 437	62 23 517	161
2	40 20 351	62 24 315	166
3	40 19 186	62 23 560	160
4	40 19 158	62 24 295	160

Source: Author's own elaboration.

Table 3.

Crop coordinates in Kandym area of the "Karakul" forestry enterprise in the Karakul district. Crop configuration 4 km by 2.5 km = 1000 ha

Point	N	E	Altitude
1	39 32 570	63 24 002	184
2	39 33 289	63 21 144	180
3	39 32 244	63 20 111	184
4	39 31 298	63 22 520	184

Source: Author's own elaboration.

Natural pastures are left between strips. In such an arrangement, there are 10.0 - 12.5 hectares of protective strips for every 100 hectares of pastures. The seeding rate for saxaul is five, salsola - 10-12, calligonum 6-7 kg/ha. The technology brings benefits after three-four years, and is used for 40-60 years, while farmers can distribute seeds and expand crop areas at no additional cost. All activities for land preparation, sowing and crop care are traditional.

Seeding rates

In creating pasture agrophytocenoses, it is necessary to account for the optimal seeding rate of every life form (Table 4).

Table 4.

Seeding rates of desert forage plants:

No.	Plant species	kg/ha	Million pcs/ha
1	Saxaul	5-8	0.13
2	Salsola	10-12	0.68-0.80
3	Calligonum	5-6	0.06

Source: Author's own elaboration.

The figures in Table 4 are subject to 100 percent economic suitability, however usually the quality of the sown seeds of desert forage plants is very low. The quality of sown seeds depends on its purity and germination capacity.

Usually, the purity of seeds is 17-75 percent for saxaul, 30-67 percent for salsola, and 20-30 percent for calligonum. To this end, the seeding rates for every species is determined while accounting for the quality of the seeds sown.
Black saxaul, halophytic or leafless - Haloxylon aphyllum (Minkw) Iljin is characterized by high and stable forage yield, long productive age of life (25-35 years). In multicomponent agrocenoses, it significantly reduces wind speed, retains snow, increases the relative air humidity, thereby creating a special microclimate that favorably affects the growth and development of plants of the lower tiers. The yield of air-dry forage mass in different years is 13.4-12.6 cwt/ha, the seed yield is 0.5-1.3 cwt/ha. One hundred kg of air-dry mass contains 45.5 forage units. [3]

In the Karakul district, seedling planting and seeding was carried out on an area of 300 hectares, at 9-metre inter-strip space. Saxaul seedlings were planted in 1-metre-wide furrows, and black saxaul seeds were additionally sown in the same furrows to obtain guaranteed sprouts. Pasture protection strips are laid 10-25 metre-wide from large shrubs (saxaul, salsola and calligonum) with a density of 600-1200 pcs/ha. On flat areas, strips are placed perpendicular to the direction of prevailing winds; on adyrs - across slopes and ridges. Natural pastures are left between strips. In such arrangement, there are 10.0-12.5 hectares of protective strips for every 100 ha of pastures. The seeding rate for saxaul is 5 kg/ha, for salsola - 10-12 kg/ha, chogon - 8-10 kg/g, calligounm - 6-7 kg/ha. The technology brings benefits after three-four years, and farmers can distribute seeds and expand crop areas at no additional cost.

White saxaul – Haloxylon persicum Bge.
White saxaul is a shrub from the Chenopodiacea family, 3-4 metres high, with a thick, gnarled, gray-brown trunk. It develops a powerful and deep-penetrating root system that uses moisture at a depth of 3-20 m. White saxaul is a valuable desert plant that provides forage for sheep and camels.

It has an important reclamation value as an excellent sand-binding plant. Sheep eagerly consume it in autumn and winter, reluctantly - in spring and summer. Camels eat it well all year round. The edible parts are assimilation shoots and fruits. The fruits of white saxaul represent a fattening feed for Karakul sheep. The edible shoots contain 2.7-9.8 percent protein, 12.6-26.3 percent fiber, 24.6-40.5 percent nitrogen-free extracts (NFE). The nutritive value is 52 forage units per 100 kg of dry weight. The digestibility coefficient of protein is 52, of fiber - 47, of fat -29, and of organic matter - 56 percent.

Under natural conditions, white saxaul grows slowly, and its forage yield is low - 2-4 cwt/ha of air-dry forage. Under cultivation, it grows relatively quickly; its height in the first year of life is 35-40, in the second or third years - 60-150 cm. The dry forage yield under cultivation is 3-5 cwt/ha. [3].

White saxaul is a promising plant for creating pasture agrophytocenoses in sandy deserts.

Salsola paletzkiana Litv.
Salsola are arbuscles from the Chenopodiacea family, 3-5 m high, are typical psammophytes, distributed in nature mainly in sandy desert conditions, and are often landscape species.

Forage properties of Salsola paletzkiana and Salsola Richteri have been studied quite well. The air-dry forage contains 19-20.3 protein, 2.8-2.9 percent fat, 14-17 percent ash, 42-47 percent NFE, and 15-17 percent fiber. One hundred kg of air-dry forage contains from 33 to 45 forage units depending on the season. Salsola forage contains 0.55 forage units, while in alfalfa hay this figure is 0.43. Thus, the introduction of Salsola paletzkiana into the cultivation in the conditions of a gypsum desert not only increases the productivity of pastures, but also significantly improves the quality of pasture forage.

In the first year, the height of individual plants reaches 80-100 cm. The root system of Salsola is of a universal type. It develops differently depending on soil conditions. There is evidence that in sandy desert conditions, where groundwater is deep enough, the Salsola roots evolve mainly in the horizontal direction. In hilly sands with groundwater at a depth of 8-10 m, the Salsola roots evolve vertically, reaching moist horizons. Excavation of the root systems of four-year-old individuals of the Salsola paletzkiana showed that the main root penetrates the soil up to 6 metres deep; the lateral roots go 1.5-2.5 metres away from the main one. A specific type of root system development of the Salsola species in different soil conditions indicates its high adaptive potential.

Under cultivation conditions, the height of Salsola paletzkiana at the age of four reached up to 2.3 metres, forming many shoots of the second and third orders. Crown width is 1.7 x 2.0 metres.

The forage productivity of Salsola species under different conditions varies in different ranges. The forage yield of Salsola under cultivation conditions is directly dependent on the density of its standing. The individual forage productivity of Salsola paletzkiana in the fourth year of life ranges from 3.5 to 6.2 per bush, and in the structure of the forage yield, a high proportion (up to 72 percent) belongs to the seed fraction.

The potential forage productivity of the Salsola paletzkiana is high enough and directly depends on the density of its standing on one hectare.

©FAO Pic 1. Black saxaul

©FAO Pic 2. Salsola paletzkiana

©FAO Pic 3. Plowing

©FAO Pic 4. Planting seedlings

©FAO Pic 5. Root systems of seedlings

©FAO Pic 6. Inter-strip spaces

The main challenges addressed by the technology are degradation of land resources, including soil, water, plant and animal resources, wind erosion and biological degradation. Created agrophytocenoses with the use of shrub and semi-shrub vegetation reduce the wind speed, retain snow and protect the soil from deflation, create a milder microclimate in the cenosis itself and in the adjacent pasture areas. This, in turn, creates more favorable environmental conditions for the growth and formation of a relatively large yield of pasture forage and the development of other plant species. Application of these methods enables increasing the biodiversity and, accordingly, the pasture forage supply by 2-3 times.

©FAO Pic. 7. Seeding with a harrow

©FAO Pic. 8. Plant sprouts

Measures to maintain vegetation cover ensure the sustainability of forest belts for 40-60 years; no additional investment is required to maintain the technology. The technology is

low-cost, so the result obtained in comparison with investment is positive already in the short term. All measures for land preparation, sowing and crop care are traditional. [3,4]
Well rehabilitation. Due to uneven distribution of wells in the territory of the Karakul region, 8000 ha of pasture area around 44 watering sources of the farm completely lack vegetation. To reduce the load and evenly distribute flocks, one well is needed for about 2-3 thousand hectares of pastures. Watering sources consist of shaft wells of different depths (20-25 m and deeper), and part of which (40 percent) is in need of repair. Signs of pasture degradation are expressed around watering wells and flocks; the area adjacent to the well within the radius of 100-200 m to 500-600 m is completely devoid of vegetation. Restoration of one well enables restore and use 5-6 thousand hectares of pasture area and provide water to 600-700 heads of animals. It reduces the load on other wells and pasture areas, enabling systemic and moderate grazing, which prevents degradation of vegetation cover, and facilitates conservation and restoration of biodiversity. [5]

Conclusions

Rational use of desert pastures, conservation of biodiversity, consistent improvement of pasture productivity by replanting, implementation of technologies to improve pasture productivity ensure the long-term sustainability of forest belts.

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The influence of geo-morphological landscape patterns on vegetation characteristics in Central Asia grasslands

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Key words: Grassland improvement, plant cover, slope direction, evapo-transpiation, wilting point, pasture productivity

Introduction

Grassland ecosystems are affected by a combination of physical and environmental factors, as well as by grazing and anthropogenic activity (Vetter 2009). Topographic conditions, such as aspect and slope, affect pasture diversity and can have a crucial influence on its structure in terms of vegetation patterns and plant distribution (Walton *et al.* 2005). Moreover, aspect may have distinct effects on species richness and productivity, as well as on nutrient dynamics (Gong *et al.* 2008). In fact, aspect affects the amount and daily cycle of solar radiation received at different times of the year (Desta *et al.* 2004). In addition, the net radiation is fundamental to drive the processes of evaporation, air and soil heating, as well as other smaller-energy consuming processes such as photosynthesis. Therefore, the relationship between aspect and solar radiation contributes to predicting plant distributions (Desta *et al.* 2004). The primary objective of this study was to examine the influence of season and aspect on vegetation characteristics and plant community dynamics in Tajik rangelands.

Methods

Description of study areas

The study was conducted in Tajikistan where two sites were selected, the first site (site 1) is located in Southern Tajikistan where the climate is continental, moderately warm, with a short warm winter and hot, dry and long summer. The average annual precipitation is 251 mm. Average yearly temperature is 15.8˚C. The second study area (site 2) is located in Central Tajikistan. The climate is medium continental with average annual rainfall of 652 mm. The average yearly temperature is 14.30˚C.

Vegetation sampling

Herbaceous biomass: Twelve quadrates of 1m x 1m were randomly distributed across the landscape representing a particular aspect to estimate biomass production. Aerial biomass was harvested by manual clipping 2.5 cm above soil surface within each quadrat. All vegetation material was oven dried (48 hr, 70˚C), and weighed. The percent of total standing biomass of the above ground parts was determined for all species present.

Vegetation cover using line-intercept method: The line intercept sampling technique was used to determine the herbaceous cover. Cover was calculated as the percent of transect line covered by each species.

Statistical analyses

Analysis of variance (ANOVA) using replicated trials in incomplete block designs was used to study the relationship between aspect and vegetation characteristics and aspect. Treatment included location (site), season (spring and autumn), and aspects (north versus south). All statistical analyses were performed with SAS software for windows (SAS 2009).

Results

Slope aspect effect

Based on the results of the mean value of vegetation parametres including the biomass, plants, bareground, rocks and litter, slope aspect has a strong impact on the vegetation characteristics parametres. In fact, north-oriented slopes had significantly and nearly 3 times higher biomass productivity than south-oriented slopes (Figure 1). Moreover, percent cover was almost 9 times higher at the north aspect compared to that at the south aspect while bare ground was much more dominant at the southern slopes. Rocks and litter were completely absent in the northern slopes (Figure 2).

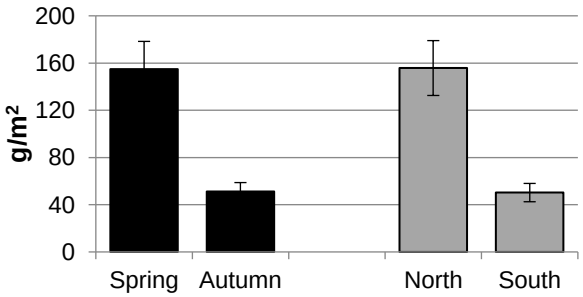

Figure 1. Impact of season (spring, fall) and aspect (north, south) on biomass productivity (g/m^2) in Tajikistan
Source: Author's own elaboration.

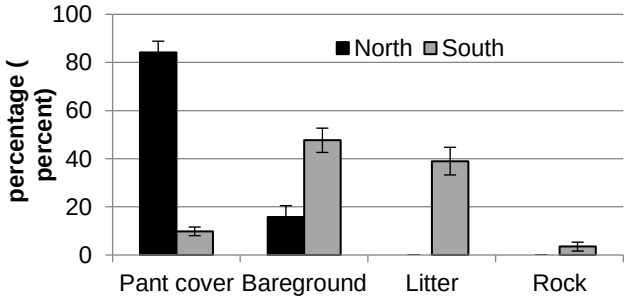

Figure 2. Impact of aspect on percentage of plant cover, bare ground, litter, and rock in Tajikistan.

As site also proved significant, the impact of slope direction on biomass productivity and vegetation characteristics was confirmed by the analysis of these vegetation parametres for each site separately. In both sites north oriented slopes had significantly higher biomass productivity than south oriented slopes. The difference was about three and four times for site two and site one respectively (Figure 3). For site one, plants of the northern slopes were almost five times higher than that of southern slopes, while bare ground was by 50 percent greater at the southern slope compared to that at the northern slope. Rocks and litter were completely absent in the northern slopes (Figure 4). Plant cover for site two was almost 18 times greater at northern than at southern slopes. However, south facing slopes had six times higher bare ground than north facing slopes and litter was completely absent at north aspect (Figure 5).

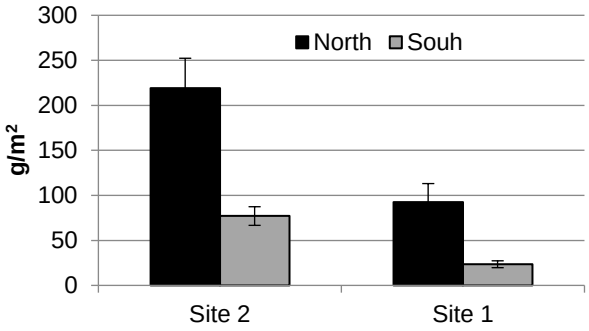

Figure 3. Impact of slope direction (north and south) on biomass productivity (g/m^2).

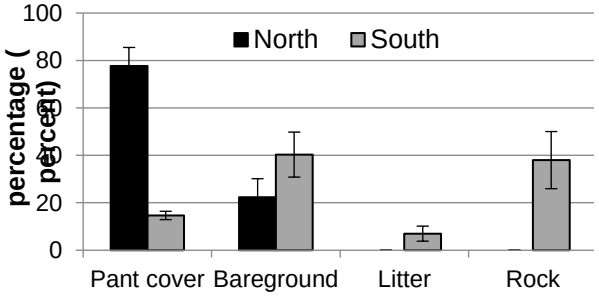

Figure 4. Impact of aspect on percentage of plant cover, bare ground, litter, and rock at site 1.

Source: Author's own elaboration.

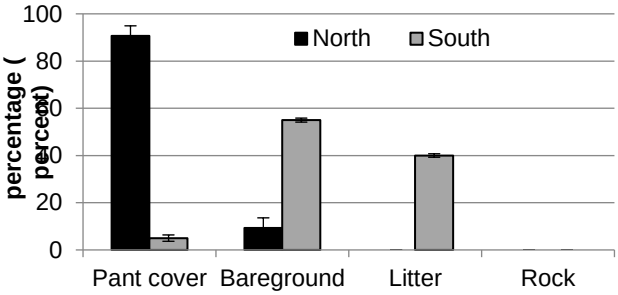

Figure 5. Impact of aspect on percentage of plant cover, bare ground, litter and rock at site 2.

Season effect

Biomass production of the spring season was almost three times higher than that of the fall season (Figure 1). Plant cover and litter were abundant during the spring season while the bare ground and rocks were dominant in the fall season (Figure 6). The effect of season on vegetation characteristics was then examined for each site separately. Biomass productivity was two to three times greater in the spring season compared to the autumn season for site one and site two respectively (Figure 7).

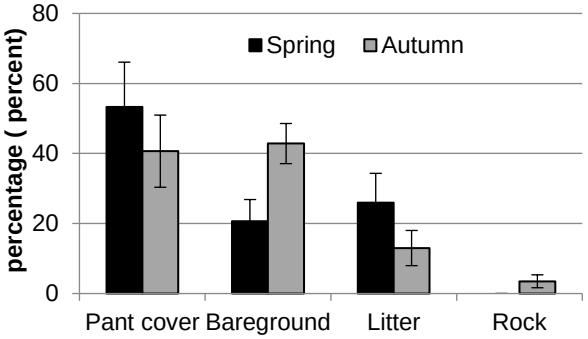

Figure 6. Impact of season on percentage of plant cover, bareground, litter and rock in Tajikistan.

Source: Author's own elaboration.

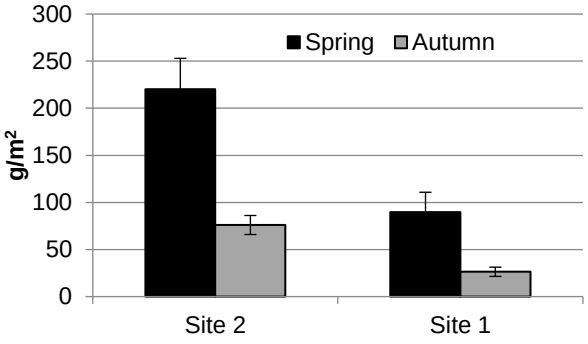

Figure 7. Impact of season (spring and autumn) on biomass productivity (g/m^2) of site 1 and site 2.

Percentage of plants and litter for site 1were more abundant in spring in comparison with autumn season while bareground and rocks were scarce and almost absent during the spring (Figure 8). For site two, plant cover was significantly superior during the spring while

the bareground was abundant in fall season. No significant difference between rocks and litter in spring and fall was observed (Figure 9).

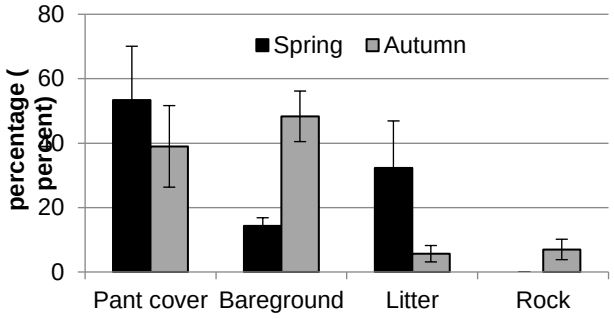

Figure 8. Impact of season on percentage of plant cover, bareground, litter and rock in site 1.

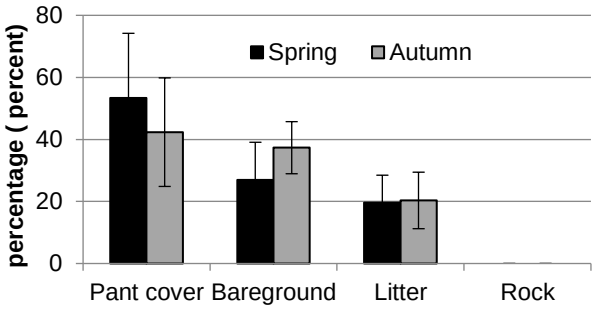

Figure 9. Impact of season on percentage of plant cover, bareground, litter and rock in site 2.

Source: Author's own elaboration.

Discussion

The differences in vegetation parametres, indicate a strong effect of slope aspect and season on site productivity. Biomass and plant productivity of north oriented slopes was higher than that of south-oriented slopes. and biomass was higher during the spring compared to the autumn season. Consequently, this indicates that the slope direction and the season of the year are important parametres affecting soil water availability which leads to the observed variations in site productivity. These results are in accordance with previous studies saying that on south facing slopes soil water availability primarily limits plant growth as the soil dried more quickly compared to north-facing slopes, reaching the wilting point faster after rainfall events (Gong *et al.* 2008).

Conclusion

Better vegetation growth occurs at north facing slopes where shade is more predominant that sun and thus the north side show less evapo-transpiration. This environmental factor has been ignored in the past and needs to be taken into account when considering options for rehabilitation and restoration measures of degraded grasslands. Proper grassland improvement and management strategies integrating both local communities in the decision-making and biophysical features will set up a strong basis for sustained grassland management.

Acknowledgements

This work was supported by the International Fund for Agricultural Development (IFAD) and the Center for Agricultural Research in the Dry Areas (ICARDA).

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Changes in the floristic composition of Karnabchul desert rangelands as a result of grazing

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Keywords: desert, pasture, grazing, species composition, degradation, forage productivity

Introduction

Karnabchul - covering an area of more than 500 thousand hectares - is a major breeding region for Karakul sheep breed in the Samarkand region of the Republic of Uzbekistan. The climate of the Karnabchul Desert is sharply continental, with an average annual air temperature of 17.1 °C, an absolute minimum of -27.30 °C and an absolute maximum of +47.20 °C. The average annual precipitation is 160 mm, varying from 81.9 to 297.4 mm in different years. Precipitation mainly occurs in the autumn and spring periods of the year. The Karnabchul soils are light grey soils; the top layer is practically non-saline, with a gypsum layer 25-30 cm thick at a depth of 35-40 cm. In the arable soil layer, the content of humus varies between 1.1-1.7 percent, and its content gradually decreases with depth. Based on the soil and climatic characteristics of the region, a peculiar vegetation cover has formed here - Artemisia ephemera associations, the main edificator of which is Artemisia diffusa Krasch. The most common ephemeroids are bulbous bluegrass Poa bulbosa L. and desert sedge Carex pachystilis Gay. Ephemeral vegetation is represented by such species as Bromus tectorum L., Bromus danthoniae Trin., Papaver pavoninum Schrenk, Astragalus filicautis F. etM., Ziziphora tenuior L., Alyssum desertorum Steph, and others. Among coarse-stemmed plants such species as Sogdian Iris songarica Bge., Camel's thorn - Alhagi pseudoalhagi (M.B.) Desf., Sprawling Loosestrife-Convolvulus hamadae L., Cousinia decurrens Rgl., stinking ferula - Ferula assa-foetida L. and others are widely spread. In the seventies of the last century, more precisely in 1970-1975, more than 250 species of flowering plants were recorded in the flora of the Karnabchul desert (Mavlyanov, 1973). The species diversity of plant cover ensured the high nutritive value of pasture forage and good fodder productivity. However, due to excessive, continuous haphazard, almost year-round grazing, a significant change in the vegetation cover of the Karnabchul Desert has now taken place. In order to assess the current state of the pastures, the floristic composition of the pasture varieties and their fodder productivity were investigated.

Research methods

Geobotanical surveys were conducted according to the generally accepted methodology for pasture monitoring (Methodological instructions on a geobotanical survey of natural forage lands in Uzbekistan, Tashkent, 1980; Granitov I.I., 1967). Herbarium materials were collected in the spring periods of 2019, 2020 and 2021. Forage productivity of pasture differences was determined by transect and area methods.

Results

Research in recent years shows that the number of plant species found in the Karnabchul grassland varies between 32-61 species, i.e. the species diversity has declined by four-eight times in the past 40-48 years (Table 1)

Table 1.

Consolidated list of plants of the Artemisia-Ephemera pastures of Karnabchul

№	Type of plant	2019	2020	2021
1	Artemisia diffusa	+	+	+
2	Alhagi pseudalhagi	+	+	+
3	Peganum harmala	+	+	+
4	Iris songarica	+	+	+
5	Convolvulus hamadae	+	+	+
6	Cousinia resinosa	+	+	+
7	Cousinia hamadae	+	-	+
8	Tamarix hispida	+	+	+
9	Astragalusfilicautis	+	+	+
10	Altea oficinalis	+	+	+
11	Artemisia halophilla	+	+	+
12	Ceratocarpus arenarius	+	+	-
13	Atriplex laciniatum	+	+	+
14	Polygonum aviculare	+	-	-
15	Ixioliron tataricum	+	-	-
16	Ferula assafoetida	+	+	+
17	Glaucum corniclautum	+	-	-
18	Barbarea vulgaris	+	-	-
19	Poa bulbosa	+	+	+
20	Carex physoides	+	+	+
21	Papaver pavoninum	+	-	-
22	Picrus hieracioides	+	+	+
23	Cichorium intybus	+	-	-
24	Leontadon autunalis	+	-	-
25	Koelpinia linearis	+	+	+
26	Strigosella africana	+	-	-
27	Hipecoum parviflorum	+	-	-
28	Holosteum polygamum	+	+	-
29	Veronica didyma	+	-	-
30	Salsola sclerantha	+	+	+
31	Malcolmia turkestanica	+	+	-
32	Delphinium leptocarpum	+	+	-
33	Goldbachia laevigata	+	-	-
34	Erodium cicutarum	+	+	-
34	Eremophyrum buonaparttis	+	-	-
35	Galium pamiralaicum	+	-	-
36	Rochelia bungei	+	+	+
37	Roemeria refracta	+	-	-
38	Trigonella grandiflora	+	+	-

39	Goebelia pachicarpa	+	+	+
40	Rochella bungei	+	+	-
41	Lappula tuberculata	+	+	-
42	Bromus tectorum	+	+	+
43	Bromus danthoniae	+	+	+
44	Achillea millefolium	+	+	-
45	Matricaria inodora	+	-	-
46	Carthamus lanatus	+	+	+
47	Centaurea picrus	+	+	+
48	Chondrilla juncea	+	+	+
49	Ceratocephala festiculata	+	+	+
50	Ziziphora tenuior	+	+	+
51	Verbascum orientale	+	+	+
52	Veronica incana	+	+	-
53	Veronica chamaedrys	+	+	-
54	Plantago maritima	+	+	-
55	Campanula glomerata	+	-	-
56	Carelina caspica	+	+	+
57	Climacoptera lanata	+	+	+
58	Tragopogon orientalis	+	+	-
59	Aegilops cylindrica	+	+	-
60	Gagea bulbifera	+	+	+
61	Allium victoralis	+	+	+

Source: Author's own elaboration.

The seed regeneration of such virtually inedible plant species as Peganum harmala, Iris sogdiana and -Iris songarica is progressing. Due to their inedible nature, these species produce abundant fruit every year, and the seeds have a high germination rate in the ground.

© FAO. Photo 1. Iris association

© FAO. Photo 2. Adraspan Association

On the other hand, wormwood is constantly being strangled, produces hardly any seeds, and is gradually disappearing from the grass stand, making its ecological niche available to non-edible plant species. At present, dense thickets of garmala and Sogdian iris occupy almost half of Karnabchul's territory. Thus, under the influence of unsystematic year-round overgrazing in the Karnabchul pastures, anthropogenic successional processes aimed at impoverishing the floristic composition of vegetation cover, deteriorating the quality of pasture forage, and reducing the fodder productivity are intensifying (Table 2).

Table 2.

Forage productivity of Karnabchul natural pastures centner/ha

Plant associations	2019	2020	2021
Wormwood-ephemera	3.5	3.2	2.1
Iris-ephemeroids	2.2	1.7	0.8
Adraspan-ephemeroids	1.3	1.1	0.6

Source: Author's own elaboration.

The fodder productivity of pastures where natural vegetation is preserved (Artemisia ephemera pastures) ranged between 2.1-3.5 centner/ha. Moreover, in plant communities where Peganum harmala is the dominant species, the figure was 1.3 centner/ha even in the favourable 2019 and 0.6 centner/ha in the drought year 2021. This data shows that prolonged unsystematic overgrazing will lead to the complete disappearance of wormwood from the grass stand, and the fodder productivity of the pastures is reduced by almost a factor of 3. The impact of grazing on pasture vegetation has been studied by many researchers (Amelin, 1944; Gaevskaya, Krasnopolin, 1955; Gaevskaya, 1971; Abaturov, 2006). They argue that grazing on vegetation cover is manifold and not always negative. With proper grazing, grazing increases the productivity and capacity of pastures and improves the composition of forage plants.

© FAO. Photo 3. Wormwood-ephemera grassland

© FAO. Photo 4. Overgrazing of wormwood-ephemera

According to I.S.Amelin (1944), the use of grazing rotation increases the capacity of desert pastures by about 20-30 percent. However, under haphazard grazing and overstocking conditions, it is not uncommon to observe deterioration and even deterioration of pastures. Analysis of scientific papers on the impact of grazing on pasture vegetation shows that overgrazing of ephemeral pastures in springtime is very harmful. Complete overgrazing of pasture plants in spring for three years proves to be harmful: the yield of the main components of the cover - rangier, bluegrass and feathergrass and the number of inedible and weedy large grasses - burgen, goat-grass, boritken - decreases. Intensive full use of the wormwood-ephemeral pastures for four years in the spring reduces the yield of ephemeral vegetation and wormwood. The most dangerous for wormwood is mid-spring (Gaevskaya, 1971). Studies have established that a moderate 67-75 percent grass cover reduction in spring or autumn, or two seasons (spring+autumn) for three years, does not harm the wormwood-ephemera pastures. However, after three-four years, there is a slight decrease in the yield since the grass, bluegrass, and ephemera are depressed, while the wormwood does not suffer.

Therefore, with moderate grazing, wormwood-ephemera pastures only require a spring season change once every four-five years. With double-season moderate grazing of Artemisia ephemera pastures over a period of four years, only spring grazing has a major impact on the vegetation cover. Consequently, it is recommended to widely use bi-seasonal grazing on sagebrush-ephemeral pastures on typical sierozem soils. Such use significantly increases the carrying capacity of the pastures. At the same time, it is important to change exactly the spring season of grazing; in winter, all varieties of wormwood-ephemeral pastures in the conditions of Uzbekistan can be used permanently. Current changes in the vegetation cover of Karnabchul desert pastures indicate that the current technology of pasture use does not meet the requirements of the principles mentioned above of rational use of wormwood-ephemeral pastures at all.

Further, such use leads to the complete disappearance of wormwood from the herbage and a sharp decrease in pasture fodder productivity. Another of the main reasons for the intensification of degradation processes on pastures is the presence of a heavy load on pastures. Taking into account that an annual physiological requirement of one Karakul sheep for pasture fodder is about 900 kg, three ha of pastures are required to provide one sheep with an average pasture yield of 3.0 centner/ha. However, the number of grazing animals in all livestock units is much higher than the permissible norms for the available pastureland (table 3).

Table 3

The number of grazing animals and grazing areas on Karakul Sheep farms in the Karnabchul desert

№	Karakoulian farms	Number of sheep and goats, heads	Horses, head	Camels, heads	Pasture areas, ha
1	Tutli karakul zamini	11 585	4	22	45 301
2	Sahaba ata karakul-nasl	13 192	-	129	35 312
3	Tim-Agron chorvadorlari	5124	-	-	18 052
4	Nurli el chorvadorlari	24 800	4	-	42 009
5	Olga	6697	-	-	12 056
6	Kattakurgan	14 450	40	-	18 589
7	Karnabata	15 370	-	-	39 437
	Total	91 218	48	151	210 756

Source: Author's own elaboration.

From data of the table, it is visible that only in farms the number of the grazed sheep and goats is 91 218 heads if to take into account the number of horses and camels (one horse and a camel are equated to six heads of sheep), the number of the grazed animals is 92 412 heads. That is not all; these pastures also graze private cattle of the local population, which, according to preliminary calculations, makes up at least 50 thousand heads. Thus, on 210 756 ha of pastures, 142 412 heads of sheep and goats are grazed, i.e. there are 1.47 ha of pastures per one sheep or goat. This is two times less than the permissible norm.

Discussion

In the pastures of the Karnabchul Desert, degradation processes have taken on a progressive character due to the heavy load on the pastures. Overgrazing is the main reason for the disappearance of wormwood. To prevent further wormwood disappearance, we consider it necessary to use the pasture areas, where wormwood still exists only in late autumn and mainly in winter. The use of wormwood in spring and summer entails depletion of the plant and its disappearance from the grass stand. Phytoreclamation measures are urgently needed in the region. First of all, it is necessary to widely apply methods of radical improvement of pastures on massifs occupied by continuous overgrowths of Peganum harmala, Sogdian iris -Iris songarica.

The Institute of Karakul Sheep Breeding and Desert Ecology has developed effective technologies for phytomelioration of pastures, technologies for creating multi-component highly productive pasture agrophytocenoses, and created more technologies than 15

promising varieties of desert fodder plants and developed agronomic techniques for growing these varieties. The introduction of these innovative developments and promising varieties into production allows increasing the productivity of natural pastures by eight-ten times, sharply improving the quality of pasture forage increasing the economic indicators of desert pastures use.

© FAO. Photo-6. Pasture agrophytocenoses for autumn and winter use

© FAO. Photo-5. Grazing agrophytocenoses for spring-summer use

Conclusions

Modern pasture use technologies in Karnabchul are completely inadequate for the rational use of wormwood-ephemera pastures. Pastures are used all year round, with a heavy load, exceeding the permissible norm by almost two times. The species composition of plant cover is highly impoverished; pastures are intensively overgrown with Adrapanum and Sogdian iris, which are inedible plants. As a result, the fodder productivity of the pastures has been drastically reduced. This limits the further growth of livestock and puts Karakul Sheep farms in the region in an extremely difficult situation in bad harvest years, which have often recurred in recent years. In the region, there is an urgent need for the widespread introduction of technologies for the rational use of Artemisia-ephemera pastures and methods of radical improvement of pastures, allowing first to stop the disappearance of Artemisia from the herbage and to revive the seed regeneration of this plant. Radical improvement of pastures allows increasing pasture fodder productivity up to 20-25 ц/га, which significantly reduces the load on pastures, stabilizes the provision of animals with pasture fodder and reduces the cost of livestock production.

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Importance of pasture plant protection measures and involvement of local communities in them

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Abstract

This article highlights the problems of protection of pasture plants in deserts from pests. The main types of pests of desert plants in the Republic of Uzbekistan are described here. Besides, methods of protection of pasture plants against pests have been analysed and proposals on the organization of plant protection in deserts with the involvement of local communities have been recommended.

Introduction

There are more than 20.0 million hectares of rangelands in the Republic of Uzbekistan, and more than 80 percent of these rangelands are located in semi-desert and desert areas. These are the main basis for the development of karakul sheep breeding. However, karakul farming entirely depends on climate conditions, pasture fodder yields, pests and diseases of pasture plants. Therefore, the issue of conservation and improvement of pastures and implementation of protective measures becomes particularly critical in the republic.

In the Republic of Karakalpakstan, Navoi, Bukhara, Djizak and some other regions not only as a result of unsystematic use, but also due to the lack of protective measures against pests and diseases of pasture plants many pasture areas have lost their capacity of ecological productivity. According to "Uzdaverloyiha" Institute, the area of degradation annually increases by 16-17 thousand hectares in the country. For the last 25 years it was 413 thousand ha. The area of shifting sands and other areas with no vegetation is increasing. Soil is being moved out by wind and water erosion. If no urgent measures are taken to restore and save natural vegetation on pastures, an irreversible process will take place - desertification of pasture landscape and complete loss of soil and vegetation cover, consequences of which will negatively affect ecological situation, state of flora and fauna, health and social wellbeing of local population.

The depletion of rangeland vegetation due to pest and disease disease significantly reduces carbon sequestration (CO_2 is released into the atmosphere), which contributes to global warming and climate change.

The current state of desert and semi-desert pastures of Uzbekistan is characterized by the progressive reduction of fodder yields and quality, increasing area of degradation and deterioration not only under the influence of anthropogenic and technogenic factors, and overgrazing, but also by considerable damage caused by pests and diseases of pasture plants. According to "Uzdaverloyiha" Institute, the average reduction of pasture productivity in the republic is 23.3 percent or 1.5 percent annually.

In the process of pasture degradation, plant pests take a major place among other negative factors, such as unsystematic use and drought. According to FAO, plant pests and diseases cause a serious risk to food security, considering the 30-40 percent of food losses, which is equal to $290 billion annually in monetary terms. [14;15;16;17].

Methods

Generally accepted methods of material collection were used - mowing with an entomological net and manual collection (Fasulati, 1961; Viktor Golub, Mikhail Tsurikov, Alexander, 2012). Quantitative surveys were conducted by catching insects during a certain time frame (10-40 min). The species diversity was determined according to Yu.A. Pesenko (1982). Taxonomic nomenclature was adopted according to G.Y. Bey-Bienko (1964) and A.V. Lachininsky *et al*. (2002), the system of life forms was determined by F.N. Pravdin (1978). For the ecological and faunistic analysis of orthopterofaunts of the belt, the Chekanovsky-Sierensen Community Index (Ics) was used (Pesenko, 1982). The data obtained were processed using the Statistica - 7.0 software package. [18;304 pp, 4; 363 pp, 10; 3; 13; 11; 12;263 pp].

Findings

Currently, over 185 pest species have been identified (Research Institute of Karakul Sheep Breeding and Desert Ecology - 1959, Samarkand State University - 2004-2005), feeding mainly on forage plants, such as *artemisia*, *alhagi*, *milk thistle*, *saxaul*, *saltwort*, *salsola/ chogon (Halothamnus subaphylla Botsch), wormwood, keyreuk (Salsola orientalis SC Gmel.), camphor-fume* and others. Damage caused by pests is very high. Out of 185 species of pests, 50 species are considered to be the most dangerous pests.

Polyphagous insects damage many plant species. They include green *grasshopper, steppe cricket*, *Asian locust*, *cockchafer*, *noctuid moths etc*.

Other insects are oligophages. They damage plants of similar species. These pests include *wormwood red leaf beetles, wormwood tube-builder, goldenrod seed beetle*, etc.

Monophagous pests damage only one or two similar plant species represent a large group of pests. They include *large saxaul grasshopper, Juzgun black boring beetle*, etc.

Among root pests, root and soil b*eetles, sawyers, pinhole borers* and *billbugs* are the most damaging pests. The loss (death) of plants from the activity of root pests in natural conditions is 40 percent, and in grasslands their harmfulness increases and reaches up to 90 percent.

Vegetative organs are consumed and significantly damaged by *leaf aphids, leafminers, cerambycids, weevils, gall gnats, bentwings, pickleworm, noctuid moths*, and others.

Caterpillars of the Artemisia geometres not only consume leaves, but also stamp the tops of plants, scrape young skin of stalks, and as a result, plants dry up. Green mass yield losses caused by *pinacate beetles, scarab beetles, gall gnats, noctuid moths, gall gnats, psyllas* and *aphid* reach 30 percent in early spring and up to 60 percent in favorable for pest's development years.

Fungal diseases such as *powdery mildew* and *rust* also cause significant damage to forage plants. Over 65 percent of saxaul seeds and stems are destroyed by *powdery mildew*, and repeated damage in 3-4 years leads to complete destruction of bushes.

Over 320 species of insects and four species of rodents damage important economic pastures of desert zones, with such plants as *prostrate summer cypress, eurotia, saltwort, saxaul* and *wormwood*. Among those insects, 43 species are considered to be the most harmful, which are mainly: *locusts, flea beetles, aphids, hemipterans, metallic wood borers, ladybugs, bark beetles, leaf beetles, weevils, gall gnats* and *scale-winged insects*. Their mass reproduction leads to serious damage of pastures on large areas.

The remaining 277 species are classified as potential pests and their economic importance is usually small and limited to small territories. They rarely cause noticeable harm, only when their reproduction due to a temporary, especially favorable combination of various factors takes place.

The influence of the above-mentioned insects can reduce the biomass of fodder plants by 30-70 percent and they can destroy up to 50-70 percent of seeds. For example, seeds of prostrate summer cypress are damaged by 30-54 percent, eurotia by 18-50 percent, saltwort by 15-25 percent, and saxaul by 60 percent. Insects living in trunks and roots are less harmful. Among four species of rodents inhabiting the south-east of the republic, the most harmful are large and red-tailed sand lances, which reduce the biomass of pasture plants by 32 percent or more.

During an invasion, the desert locust can spread over a vast area of about 29 million square kilometres, covering up to 60 countries - in whole or in parts. An adult desert locust can consume as much fresh food as it weighs in a day. To illustrate, just one small swarm (per 1 km^2) is able to consume the same amount of plant food in a day as 35 000 people.

Such high losses of pasture plants caused by pests require development of protective measures taking into account landscape-economic and geographical features of deserts. Under desert conditions, one of the main methods to limit the number and harmfulness of

pests of pasture plants are organizational and economic, agrotechnical, chemical and biological methods. Agrotechnical measures to control pests and plants diseases include mainly harrowing and application of mineral fertilizers.

Biological and chemical methods of plant protection occupy a special place among measures of active pest control.

Chemical methods of pest and disease control based on the use of chemicals are used in Uzbekistan since 1958. Chemical control of pests and diseases in pastures is carried out by ground-based mechanized equipment, hand sprayers and by aviation. Due to complexity of landscape relief and remoteness of areas required control measures can be applied not everywhere in the areas of infestation.

Application of backpack sprayers and manual collection of locusts on infested areas is labour consuming and low efficient because the efficiency of chemical treatment depends on prompt treatment, which, depending on the pest species, is carried out at the beginning of development of caterpillars or flying out of butterflies and beetles. Aerial treatments are still very expensive.

Chemical method of plant protection has an alternative - a biological method that involves the use of their natural enemies against pests: predators, parasites and antagonists. The cost of integrated pest management using mainly beneficial organisms represents less than 50 percent of the costs of chemical methods of plant protection.

Biological protection of plants is a complex of measures in which beneficial organisms that increase plant immunity are mobilized and, in parallel, pests are suppressed, as a result of which the number of populations of phytopathogens and phytophages is reduced to such an extent that the damage caused by them is reduced to a level safe from an economic and sanitary and hygienic point of view. It is important that the basic beneficial antagonist organisms do not lose their activity, maintain their regulatory functions for a long time and provide an opportunity to create a stable equilibrium between the pests and their natural enemies. Biological control is environmental complex measure, but it is economically and socially feasible solution.

The idea of biological methods of plant protection is to use their natural enemies as well as pathogens to control pests. The enemies of pests include insect-eating birds, predatory and parasitic insects, beaked mites, nematodes, etc. Organisms that consume insects are called entomophages, mites are called acariphages.

More than 300 projects on biological control of different pest populations have been successfully carried out worldwide, especially in China and the CIS countries. Recently, the tiny wasp was used to prevent the destruction of the cassava crop in Africa by the earth pearl. Wasps saved this vital crop for 200 million people in 35 countries. A promising trend in reducing the use of herbicides to regulate weed growth is the use of mold, bacteria and other disease-causing agents.

The biological methods of pest control for pasture plants have not yet found widespread use in the conditions of Uzbekistan. Therefore, it is necessary to expand the scope of biological measures on pastures, to pay more attention to protection and implementation of measures to increase the number of insectivorous birds (starlings, kestrels, owls and others), which eat pests and rodents of pasture, as well as predatory and parasitic insects which are laying eggs in pest body, in their eggs or grub and propupa. At the same time, it is necessary to know the biology of insect pests actively involved in the regulation of internal processes in the ecosystem to establish the right timeframe for agrotechnical, biological and chemical control measures.

The use of biological methods of pest control prevents the pollution of the natural environment with pesticides and contributes to the conservation of beneficial fauna. These methods are increasingly being introduced in agricultural production. At the moment, some beneficial insects such as Trichogramma, Telenomus, Brakon and red-tailed wheatear are widely used on irrigated areas of Uzbekistan. But some of them, especially trichogramma is not able to target search for a host, so its use in forest pest hotspots is largely ineffective. However, coccinellid beetles (ladybugs), lacewing-chrysops, syrphid flies (syrphids) and carabid beetles haven't yet been used and can be quite effective.

The first three predators consume aphids and other plant pests, while carabid beetles are enemies of caterpillars and grubs. The beetle, a seven-spotted ladybug, kills over 5 000 aphids in its lifetime, and its grubs consume over 350 in eight days. The lacewing grubs consume more than 500 aphids in 10 days. The grubs of the hymenoptera consumes more than 400 aphids in the same period of time. The ground beetles are found in the soil; they are large, dark blue, and shiny. The beetles' main food is caterpillars, grubs, and other harmful insects. Most ant species are also predators. They feed on caterpillars, grubs, and other insects. Black garden ants and some other species prefer to "eat" the secretions of aphids. The appearance of black garden ants on leaves is a sure sign that the plant is infested with aphids. Predatory bugs and thunder flies also occur on fruit-bearing trees and shrubs, as they suck the eggs of insects and grubs of many pests; predatory mites destroy the eggs and grubs of plant-eating mites. [1;352 pp., 2;367 pp., 5;400 pp., 6; 7;32 pp., 8;200 pp., 9; 392 pp.,].

Conclusions

As can be seen from the above mentioned, the scale and importance of diseases and pests of desert plants are an important ecological, socioeconomic problem and require the development of appropriate protection measures taking into account the landscape and economic characteristics of desert pastures.

Recently, millions of people pay more and more attention to environmental problems, and it seems quite logical. Given this context, the importance of organizational and economic measures in connection with the above-mentioned factors is increasing. Generally, those

issues arise in remote location of desert large size pastures; it is advisable to involve workers of forest farms, Karakul Sheep farms and other households as well as the local population to such protective measures.

Measures to attract local communities and farmers must be supported by the state through benefits and incentives related to the use of local pastures. In addition, public-private partnerships in the form of biolabouratories for the cultivation of useful insects can be significantly helpful for the organization of the above-mentioned activities.

For example, the dissemination (distribution) of bio-products produced in biolabouratories established on the basis of public-private partnership will be carried out by the local population, which, will have opportunity to use the pasture as part of beneficiaries of pasture plant protection.

Also, when establishing the rules for the use of pastures, a relevant clause can be included in the pasture lease agreement, as part of the measures taken to improve the conditions of the pastures by the temporary users of pastures, i.e. the lessees.

In addition, students of educational institutions of different levels and volunteers can be involved in these activities.

As a result of successful implementation of pest management control measures the productivity and capacity of pastures will increase by 25-30 percent. The yield of fodder crops will increase by 2-2.5 times, which contributes increase of pasture lands' grazing capacity per 100 ha, and it will increase livestock production - meat, wool, karakul, and reduce ecological tension, improve living standards of shepherds and communities in semi-desert and desert zones.

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The best fodder plant varieties for increasing the productivity of Uzbekistan's desert rangelands

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Keywords: desert, rangelands, productivity, degradation, introduction, breeding, varieties, pastoralism

Introduction and objectives

Desert and semi-desert pastures, which occupy about 65 percent of the total area of the Republic of Uzbekistan, are the main source of fodder for desert-pasture cattle breeding. They are characterized by relatively low (1.5-3.5 at/ha) fodder productivity, sharp fluctuations in yields from year to year and from season to season, depending on the amount of precipitation. In addition, due to unsystematic overgrazing, desert and semi-desert pastures are currently degraded to varying degrees, and there is a sharp decline in pasture yields. According to some published materials, the average pasture yields have decreased by an average of 25 percent in recent years (Makhmudov, 2005). Due to degradation of vegetation cover, yields have decreased by 20 per cent on 9 million ha of pastures, by 30 per cent on 5 million ha of pastures and by 40 or more per cent on 2 million ha of pastures (Otakulov, 2013). In this regard, intensification of fodder production through phytomelioration of degraded pastures using highly productive varieties of desert fodder plants is extremely necessary for the sustainable development of desert-pasture cattle breeding in the republic. Because of many years of introduction, breeding and seed-farming activities, more than a dozen promising varieties were created and released by the Breeding Center of desert fodder plants at the Research Institute of Karakul Sheep Breeding and Desert Ecology to improve the productivity of degraded pastures. These varieties are characterised by high fodder productivity, resistance to drought and diseases, high fodder properties, productive longevity, and good eating ability by all types of farm animals.

Research objects and methods

The research objects were wild populations of the prostrate summer cipress, eurotia, chohan, saltwort collected from different points of their distribution range and a species of perennial atriplexus brought from the Syrian Arab Republic. Various desert fodder plant species and specimens were comparatively evaluated in the collection nurseries according to their ecological and biological characteristics and economically valuable traits. The most promising species and specimens were selected as starting materials for breeding. Selection methods were used in the breeding process: ecotypic, mass multiple, individual-family, inter-ecotype hybridisation method (Novoselova, Cheprasova, 1974; Novoselova *et al.*, 1978).

Results

157 specimens belonging to three ecotypes represented the genepool of ibex: var. canescens- (19 percent), var. virescens- (47 percent), var. villosissima- (34 percent), which are adapted to specific desert ecological conditions. Specimens of the stony (var. canescens) ecotype were the most adapted to the conditions of the Karnabchul Desert. 149

specimens belonging to its species represented the gene pool of Chogon: Halothamnus subaphyllus, H. serafshanicus, H.glaucus, H. dendroides. The local species, Halothamnus subaphyllus, turned out to be the most adapted to the conditions of the Karnabchul desert and the foothill semi-desert of Nurata. The tested samples of eurotia - Ceratoides ewersmanniana (38 specimens) consisted of Tajik, Kyrgyz, Kazakh and Uzbek ecological-geographical groups. The specimens collected from Kyrgyzstan were the most promising source material for breeding. In the collection, nurseries were evaluated over 120 specimens of Keireuk-Salsola orientalis collected from different locations of its distribution and established the perspective of local samples as source material for breeding. Seeds of the tested species and perennial atriplexes were obtained from ICARDA and ICBA. Because of long-term trials, it was found that the species of perennial Atriplex undulate is well adapted to growing in the Karnabchul desert conditions, has a high survival rate of individuals, forms large phytomass and seeds, even exceeding the productivity of some local species. As a result of many years of research on the introduction and breeding of desert fodder plants, promising local varieties have been created to raise the productivity of desert pastures in Uzbekistan to 15-25 dt/ha. These varieties have successfully passed the State Variety Testing and are included in the State Register of Crop Varieties recommended for cultivation in Uzbekistan.

The variety ischium Kochia prostrata (L.) Schrad. - "Otavnyi" is bred by multiple mass selection from a wild population of the stony ecotype distributed in the mountainous areas of the Osh oblast of the Republic of Kyrgyzstan. The perennial semi-shrub is 75-130 cm tall. The bushiness is high (65-85 annual shoots per bush). The growing season in the conditions of the Karnabchul Desert is 260-265 days. Yield of dry fodder mass is 17.3-22.5 dt/ha, seeds-1.7-2.5 dt/ha. The dry matter contains 14.9 percent raw protein. In 100 kg of hay, there are 44.9 fodder units. The productive longevity of this variety is 15-20 years. It is recommended to use the variety Otavniy to create highly productive pasture agrophytocenoses in conditions where the average annual atmospheric precipitation is 160-350 mm per year (Rabbimov, Akhmadalieva, 2019).

© FAO. Figure 1. Prostrate summer cipress

© FAO. Figure 2. Gathering seeds from nature

The variety Kochia prostrata (L.) Schrad.-"Nurota" was developed by hybridising two ecotypes of the variety common in southern Kyrgyzstan (var. virescens X. var. canescens).

It is a perennial semi-shrub 100-135 cm tall. Shrub size is high (75-80 annual shoots in a bush). The vegetation period lasts 250-255 days in the foothill semi-desert conditions of Nurata. Yield of dry fodder mass is 20-25 dt/ha, seeds- 2,0-2,5 dt/ha. In the dry mass contains raw protein - 15,3 percent. In 100 kg of hay, there are 46.5 fodder units. The productive longevity of this sort - 15-17 years. It is recommended to use the variety "Nurata" to create highly productive pasture agrophytocenoses in conditions of foothill semi-deserts, where the average annual precipitation is 200 - 350 mm per year (Rabbimov, Ahmadalieva, 2019).

Chohan variety - Halothamnus subaphyllus (Aellen.)- 'Zhaihun' has been bred by multiple mass selection from a wild population distributed in the Mubarek district of the Kashkadarya region of the Republic of Uzbekistan. It is a perennial semi-shrub with a height of 75-120 cm. Brushiness - high (65-85 annual shoots in the bush). The growing season in the Karnabchul Desert is 245-250 days. Yield of dry fodder mass is 15.6-19.0 dt/ha, seeds-1.65-3.5 dt/ha. The dry matter contains 14.6-16.6 percent raw protein. In 100 kg of hay, there are 43.5 fodder units. Its productive longevity is 20-25 years. It is recommended to use the "Zhaihun" variety of Chohan for creating highly productive pasture agrophytocenoses in conditions of foothill semi-deserts and deserts, where the average annual rainfall is 160 - 350 mm per year (Rabbimov and Mukimov, 2012).

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The perennial Atriplex undulata- 'Yagona' variety has been bred by multiple mass selection from a wild population introduced from the Syrian Arab Republic. A perennial semi-shrub with a hemispherical shape. Produces numerous generative shoots 75-125 cm long. The growing season in the Karnabchul Desert is 230-235 days. Yield of dry fodder mass is 25.6-29.0 dt/ha, seeds- 2.65-3.5 dt/ha. The dry matter contains 12.6-14.6 percent crude protein. In 100 kg of hay, there are 46.5 fodder units. The productive longevity of the variety in the conditions of the Karnabchul desert was five - six years. It is recommended to use the variety Yagona when creating high-yielding pasture agrophytocenoses in the conditions of foothill semi-deserts and deserts, where the average annual rainfall is 160 - 350 mm per year. The variety reproduces well by self-sowing; the seeds keep their germination for three-six years.

The eurotia variety Ceratoides ewersmanniana-"Tulkin" has been bred by multiple mass selections from a wild population collected in the mountainous areas of the Kyrgyz Republic. The plant is a semi-erect shrub, perennial semi-shrub 75-85 cm high. Well foliated

(45 percent), the leaves are broad ovate; in summer, when there is a severe drought, the large leaves fall off. The growing season in Karnabchul desert conditions lasts 210-220 days. Yield of dry fodder mass is 12.0-16.0 dt/ha, seeds 1.5-2.5 dt/ha. The 100 kg dry eurotia fodder contains 40-45 fodder units and 9.1 kg digestible protein. The productive longevity of the variety is 25-30 years. It is recommended to use eurotia variety "Tulkin" when creating highly productive pasture agrophytocenoses in conditions of foothill semi-deserts and deserts, where the amount of average annual precipitation is 160 - 350 mm per year (Rabbimov, Mukimov, 2012).

© FAO. Figure 5. Eurotia

© FAO. Figure 6. Saltwort

The saltwort variety - Salsola orientalis- "Karnab's first-born" has been bred by multiple mass selection from a wild population collected from Mubarekchul, Mubarek district, Kashkadarya province, Uzbekistan. The plant is a semi-erect shrub, perennial semi-shrub 65-70 cm high. Well foliated (35 percent), the leaves are narrow, cylindrical, succulent. The growing season in the conditions of the Karnabchul Desert is 240-260 days. Yield of dry fodder mass is 12.0-17.0 dt/ha, seeds - 2.5-4.5 dt/ha. Its dry weight contains 49-55 fodder units and 8.2 kg of digestible protein per 100 kg of forage. The productive longevity of the variety is 20 to 30 years. It is recommended to use the saltwort variety Pervenets Karnaba when creating highly productive pasture agrophytocenoses in deserts, where the average annual rainfall is 160-200 mm per year.

Peculiarities of agrotechnics of creating highly productive pasture agrophytocenoses in desert and semi-desert zones. When creating highly productive pasture agro-phytocenoses, areas with thinned grass stand, i.e. highly degraded areas, are selected. In spring, when the soil is sufficiently moist, plough up the soil to a depth of 20-25 cm. Before sowing the seeds, it is necessary to carry out a harrowing, then sow a mixture of seeds of different varieties in even proportions by hand - scatter method. The consumption rate is 10-12 kg/ha of conditioned seeds. After sowing, in order to minimise seed embedding, light sprinkling is carried out. The optimum sowing time is late autumn winter (November-February). It is recommended to use pasture agrophytocenoses from the third year onwards.

Discussion

Arid zones are areas with sharply pronounced extremity and extreme instability of ecological conditions. An objective consequence of this is the low productivity of pastures and its sharp seasonal and year-to-year fluctuations. In the process of economic development of arid lands, both positive and negative results have been accumulated. The latter are reflected in the development of anthropogenic desertification of pasturelands. Especially, these processes have intensified and aggravated in the last 20-25 years due to irrational exploitation of pasture ecosystems. All this gives pasture and sheep farming in arid zones an unsustainable branch of agricultural production. In this regard, it is necessary to develop and implement a set of measures to create a reliable, balanced and sustainable fodder base in the arid zones of the country. This function is performed by the adaptive system of arid fodder production, which emerged as a science and technology at the interface of agronomy, meadow science, ecology, phytocoenology, botanical resource science, introduction, and breeding because of activities of scientific institutions of the Central Asian region (Shamsutdinov Z.Sh. *et al.*, 1989). An important link in the system of arid fodder production, an indicator of its intensity, is the species, ecotypes and varieties of fodder plants used in phytoreclamation of pastures. They have a definite norm of reaction, developed in the process of their historical formation and development. It has been experimentally established that no universal species, ecotypes, and varieties of desert fodder plants are equally suitable for cultivation in extremely diverse natural conditions of the vast arid zone. The above-recommended varieties of desert fodder plants have regional adaptability resistance to a complex of abiotic, operational, competitive stress in specific desert conditions.

Conclusions

- The current state of desert and semi-desert pastures in Uzbekistan does not ensure sustainable development of desert-pasture cattle breeding, which plays an important role in ensuring food security of the population. Significant parts of pastures (about 50 percent) are degraded to varying degrees, and fodder productivity has decreased by an average of 25 percent or more.

- The natural wild flora of arid zones is a rich source for selecting and introducing new desert fodder plant species for phytomelioration and restoration of vegetation cover of degraded pastures.

- Bred varieties of iesenium, chohan, eurotia, saltwort, and perennial atriplexus have regional adaptability, drought tolerance, resistance to diseases and pests, with high fodder properties, high fodder and seed productivity. Fodder productivity of multicomponent pasture agrophytocenoses created with the participation of these varieties in different years is 15-25 dt/ha, exceeding the productivity of natural wormwood-ephemeral pastures by five-eight times.

The Research Institute of Karakul Sheep Breeding and Desert Ecology expresses its deep gratitude to the international scientific centres ICARDA and ICBA for their practical assistance in creating a gene pool of desert fodder plants!

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Valuation of ecosystems and their services in Central Asia

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Keywords: Ecosystem services, functions of nature, applied evaluation methods, stakeholder participation, common language and understanding, payment, spatial application in watersheds, land use.

Introduction

Central Asia is a vast and diverse region, ranging from Siberian boreal forests to the Caspian Sea and from the Central Asian steppes and deserts to the Tibetan plateau and Himalayan Mountain range. Recognised internationally for its species richness and levels of endemism, several of its ecosystems are identified as areas crucial for the conservation of global biodiversity. With several of its ecosystems identified as playing key roles in supporting national economic activities and sustaining livelihoods at a local level identified as under serious threat, it is clear that a 'business as usual' approach is not sustainable for future, or indeed current, generations. In looking for a new approach to sustainably deliver human health and well-being, an approach receiving increasing international attention is that of an ecosystem approach (EA). A framework to engage with environmental values in a more holistic and equitable manner, an EA recognises that ecosystems are fundamental to human health and well-being and that their physical, chemical and biological components are interdependent. However, rather than a new approach per se, an EA can be seen as an approach to support the integration of data from a range of disciplines to inform policy-development and delivery from a more holistic perspective. Current research challenges include the need to develop a detailed understanding of the process and mechanisms through which ecosystem functions link to human health and well-being, and how this knowledge can inform policy development.

Within this context, the aim of this study is to provide a comprehensive evaluation of five pilot EA projects implemented by CAREC within Central Asia, to-date. Specifically, it aims to to identify the processes which link ecosystem services (ES) to the benefits (and dis-benefits) experienced by individuals and make recommendations on how this emerging understanding can be integrated within policy and practice.

Methodology

The five pilot projects evaluate are located within the Shirkent Natural Park (Tajikistan), the Turkestan Irrigation System (TIS) on the Syrdarya plain, the Ikansu river basin in Turkestan district (both Kazakhstan) and the Chon Aksuu and as Zerger river basins (both in Kyrgyzstan). All five ES case studies were implemented under the auspices of the Ministry of the Environment of Norway-funded project "Support towards local initiatives on environmental governance and water resources management in Central Asia", an initiative aimed at supporting the development of expertise and institutional capacities in

environmental governance and water resources management within the Central Asia region. Phase I of the project involved supporting the development of new skills by local actors and communities in the fields of environmental governance and water resources management of small watersheds through the following activities:

- capacity building and dissemination of knowledge regarding improvement of environmental governance and enhanced regional cooperation within the water sector of Central Asia;
- the introduction and piloting of an ecosystem services approach at a local level;
- sharing of local actions and activities to contribute to transboundary cooperation management (e.g. establishment of a basin plan and implementation of its recommendations).

Phase II of the project supported the strengthening of institutional arrangements for sustainable basin management at a small transboundary watershed scale, and further contribute to creating a critical mass of knowledge on sustainable development issues within Central Asia (CA) through the following specific objectives:

- enhance understanding and capacities to improve environmental governance and regional cooperation in the water sector of CA
- integrate the concept of water-related ecosystem services within basin management
- strengthen local initiatives with new technical and management capacities for sustainable basin management.

The evaluation process involved the following actions:

- review of internal and external reports pertaining to five case studies focused on the introduction of an ecosystem approach within Central Asia
- analysis of the use of ES tools utilised including payment for ES, ecosystem and ES service mapping, economic valuation of ES, engagement of local communities and approaches to raising awareness
- identification of regional institutional and legislative conditions and identification of opportunities for the introduction / mainstreaming of an EA approach in national strategic planning processes
- development of matrices to provide a side-by-side overview of EA project characteristics, activities and stakeholders
- development of recommendations to enhance the sustainability of ES research and implementation in the region

Results and discussion

A selection of tools and approaches were applied within one or more of the five ES case studies implemented in Central Asia (CA). Table 1 gives an overview of the methodologies utilised to-date within each case study. Table 2 gives an overview of the key pressures identified within the five case studies

Table 1 Methodologies used to evaluate ecosystem services in each of the five case studies (based on data provided by internal project reports of CAREC)

Case study / **Methodologies**	Zerger river basin	Chon Ak-Suu river basin	Shirkent Natural Park	Ikansu river basin	Turkestan Irrigation System
Ecosystem and land use mapping	**x**	**x**	**x**	**x**	**x**
Ecosystem service mapping	**x**	**x**	**x**	**x**	
Economic valuation	**x**	**x**	**x**	**x**	**x**
Local community engagement	**x**	**x**	**x**	**x**	**x**
Payment for ecosystem services		**x**		**x**	
Monitoring of ecosystem services and construction of water distribution facilities	**x**	**x**	**x**		
Raise awareness of ecosystem services		**x**			
Modelling for policy advice					**x**
Focus groups, questionnaires, and interviews					**x**

Source: Author's own elaboration.

Table 2 Overview of the key pressures identified within the five case studies

Case study / **Pressure**	Zerger river basin	Chon Ak-Suu river basin	Shirkent Natural Park	Ikansu river basin	Turkestan Irrigation System
Overgrazing	**x**	**x**		**x**	
Drinking water supply and quality	**x**	**x**	**x**	**x**	**x**
Upstream pollution					**x**
Deforestation				**x**	**x**
Pasture degradation	**x**	**x**		**x**	**x**
Glacier melting		**x**	**x**		
Inefficient irrigation systems and increasing soil salinization		**x**			**x**
Pressure on biodiversity	**x**	**x**	**x**	**x**	
Ecotourism		**x***	**x****		

Key: * too much ecotourism; ** no ecotourism

Source: Author's own elaboration.

Table 3 identifies the ecosystem services (by category) evaluated within each of the case study areas. An overview of the methodologies utilised to evaluate ecosystem services in each of the five case studies given in Table 4 by focusing on diverse user groups /stakeholder organisations engaged.

Table 3. Ecosystem services evaluated in the five case studies by ecosystem service category

Case study / **ES category**	Zerger river basin	Chon Ak-Suu river basin	Shirkent Natural Park	Ikansu river basin	Turkestan Irrigation System
Supporting services	Biodiversity	Biodiversity	Biodiversity	Biodiversity	
Provisioning services	Grazing; Agriculture Forest products	Grazing Agriculture Mushrooms	Grazing; Agriculture Non forest products	Grazing; Agriculture	Grazing; Agriculture
Regulating services	Carbon sequestration	Carbon sequestration	Carbon sequestration	Carbon sequestration	
Cultural services		Ecotourism			

Source: Author's own elaboration.

Table 4 Overview of stakeholder organisations engaged within the five case studies

Case study / **Stakeholders**	Zerger river basin	Chon Ak-Suu river basin	Shirkent Natural Park	Ikansu river basin	Turkestan Irrigation System
Water Users Association	**x**	**x***		**x**	**x**
Federation of Water Users Associations		**x**		**x**	
Pastures Committee	**x**	**x**	**x**	**x**	
Forestry Department**	**x**	**x**	**x**		
Association of Mushroom Pickers		**x**			
Local community / farmers	**x**	**x**	**x**	**x**	**x**
Policy-makers / local authorities	**x**	**x**	**x**	**x**	**x**
National Park			**x**	**x**	**x**
Basin Council		**x**			**x**
Research scientists		**x**	**x**		**x**

Key: x = stakeholder organisation active partner in case study; * 4 Water Users Associations (1 per village); ** = governmental department
Source: Author's own elaboration.

The UN Convention on Biodiversity (UN CBD, 2000) outlines 12 principles to support the operationalisation of an EA. In the study the 12 principles and their supporting descriptors were identified together with a brief summary of how the research and practice undertaken with the five case studies cross-links to each component. In a Central Asian context, the

Regional Environmental Centre for Central Asia (CAREC), in partnership with the Norwegian Government, is leading research into the applicability and impact of an EA within the region. Reflecting on activities which commenced in 2008 till 2017, a report with the aim to provide a comprehensive synthesis of CAREC EA activities in Central Asia over the last ten years was developed. It provides a timely opportunity to document experiences and progress made to-date, to develop evidence-based recommendations to enhance the sustainability of EA research and mainstream its use within policy development and practice at a regional and national level. Hence this report provides an independent review of five EA case study areas; two located in Kazakhstan, one in Kyrgyzstan and one in Tajikistan. The case study review process involved a combination of field visits, stakeholder interviews and desk-based review of internal and external project documents. These activities directly informed an assessment of the use of alternative ecosystem service (ES) tools (e.g. payment for ES, ecosystem mapping, economic valuation, engagement of local communities) and identification of regional institutional and legislative conditions and opportunities for the introduction / mainstreaming of an EA in national strategic planning processes.

Ecosystem service research is a science-in-the-making but one which is already embedded in international policy and practice. The research completed under the auspices of the CAREC/Norwegian Ministry of the Environment reflects a considerable body of work and its synthesis provides a clear insight into the potential for an EA to support Central Asia's transition to a more sustainable development pathway. Within this context, a notable current opportunity would be the decision to use an EA as a framework to move towards and benchmark progress in achieving the SDGs. The implementation of a diverse range of ES methodologies within five case studies located within three Central Asian countries represents a novel contribution to ES research at a regional and international level, with the use of the same methodologies in different countries, case study areas and ecosystem types adding to its value. In terms of evaluating tools used to-date, notable successes (the novel use of PES and best practice in relation to stakeholder engagement) and areas for further development (need for greater clarity over ecosystem and ES mapping methodologies) have been highlighted. This report concludes that the case study work undertaken to-date clearly demonstrates the applicability of a range EA tools and methodologies to consideration of impact at a local scale and identifies opportunities for an EA to feed into policymaking at a national and regional scale.

Based on the synthesised evaluation of the activities undertaken within the five case studies, a series of six recommendations to enhance the delivery and sustainability of an EA within a Central Asia context were formulated and discussed with stakeholders in a conference as follows:

1. development of a common typology of Central Asian ecosystem types;

2. development of a common ecosystem service classification framework;

3. development of a common scoring system to support the consistent qualitative assessment of ES throughout Central Asia;

4. invest in approaches to raise awareness of soft and hard infrastructure to support implementation of PES schemes;

5. evaluate the Sustainable Development Goals (SDGs) within an Ecosystem Approach;

6. develop an on-line, open-access Central Asian ES portal.

Conclusions

The results of this independent assessment indicate the potential for an EA to support Central Asia's transition to a more sustainable development pathway. A series of notable successes (the novel use of the payment for ecosystem services and best practice in relation to stakeholder engagement) and areas for further development (need for greater clarity over ecosystem and ES mapping methodologies) are highlighted, and a comprehensive set of recommendations to enhance the delivery and sustainability of an EA within a Central Asia context developed. Key recommendations include the development of common Central Asian ecosystem and ES typologies and scoring systems to support their consistent application throughout the region. A further major recommendation relates to facilitating an EA in practice; the need to map ES terminology to the Central Asian policy sphere, development of policy briefings on the 'what, why and where' of integrating ES knowledge within a range of legislative areas such as national Water Codes, ecosystem monitoring programmes, biodiversity strategies and land use planning frameworks. Such work is urgently required to ensure that developments to-date are consolidated and to begin the process of capacity building within the Central Asian policy and practitioner communities.

Acknowledgements

The study on the introduction of an ecosystem services concept in Central Asia: towards a framework for the sustainable management of nature and land use was developed with the support and collaboration of many people. The authors would like to take this opportunity to gratefully acknowledge on multiple staff members of Regional Environmental Centre for Central Asia (CAREC) and the Norwegian Ministry of the Environment for their financial and material support which enabled us to undertake this research. We are also extremely grateful for the multiple contributions of stakeholder in Kyrgyzstan and in Tajikistan. We are again grateful to the many people who generously gave their time and knowledge to support our work

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Improving food security of smallholders through introduction of improved wheat varieties in the cold winter desert of Uzbekistan

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Keywords: Cold winter desert, Food security, Households, Wheat variety

Introduction, scope, and main objectives

Wheat production is directly linked to food security in Uzbekistan. Wheat is produced on 1.35 million hectares with productivity of 4.56 t/ha in Uzbekistan (FAOSTAT, 2022). This productivity level is higher than wheat yields in other Central Asian countries. Both improved varieties and improved management practices have contributed to high yield of wheat in Uzbekistan. There are more than 20 improved wheat varieties being cultivated by the farmers in Uzbekistan. These varieties are adapted to different agroclimatic zones, have different yield potentials, and possess tolerance to diseases and pests. Wheat yellow rust is the most important disease that cause substantial yield reductions in Uzbekistan (Sharma *et al.*, 2016). Despite the availability of resistant varieties, numerous farmers grow susceptible varieties and spend substantial money on fungicide sprays to control the disease. A lack of proper information to the farmers about salient features of the available wheat varieties and unavailability of their high-quality seed are important bottlenecks in the spread of the improved varieties. This is even a more serious problem for smallholders living in the cold winter deserts of Uzbekistan who neither receive information about improved wheat varieties nor have access to the improved seed.

This study was conducted in Durmon village (Figure 1) in Karakul district of Bukhara province of Uzbekistan. Durmon village is located in the cold winter deserts (CWD) and substantial number of the inhabitants are smallholders and households with limited access to rural advisory services about modern agricultural practices (Kassie *et al.*, 2022). These households cultivate wheat either on a part of their homestead land or on small plots rented from the local forestry department. Since the households do not receive information about the improved wheat varieties and quality seed, they plant wheat by buying seed from the grain market and name it as 'Mahalli' (local) wheat. The use of grain as seed results in less than 1 tonnes/ha yield. Besides, there is severe incidence of yellow rust on Mahalli wheat in the year of

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Figure 1. Landscape showing harsh, dry cold winter desert present in Durmon village, Karakul district of Uzbekistan.

disease epidemics. Yellow rust is endemic to irrigated what in Central Asia including Uzbekistan (Sharma *et al.*, 2013).

Since the households in Durmon did not have access to improved wheat varieties and seed as expressed in the group interview (Figure 2) and household survey (Kasey *et al*, 2021), this study was conducted to demonstrate comparative performance of improved seed of newly released wheat variety 'Shams' and 'Gozgon' and the local wheat Mahalli. The wheat varieties Shams and Gozgon have been developed by the Southern Agricultural Research Institute located Karshi in Kashkadarya which is the neighboring province of Bukhara.

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Figure 2. Group discussion to decide the activity to be undertaken in the Farmers Field School in Durmon village, Karakul district of Uzbekistan

Methodology

This study was conducted in Durmon village in Karakul district in Bukhara province of Uzbekistan. The research site is presentative of the cold winter desert climate of Central Asia. The on-farm research activities were conducted using the Farmers Field School (FFS) as outlined by FAO (2006) and CRAFT (2020). The five participant farmers of the study were small holders with landholding 0.2 to 0.4 ha. The field activities were discussed with the small farmers of the Durmon village residing in the CWD through a participatory method. Considering food security of the smallholders as an important issue, and since the farmers did not have access to recent technology, introduction of improved wheat varieties was jointly decided. All field activities were managed by the farmers using their local wheat production practices. The only intervention through the project was introduction of improved wheat varieties.

The two wheat varieties included in the FFS experimentation were farmers" variety "Mahalli" procured locally, and improved variety "Shams" received from Kashkadarya Research Institute. Another improved variety 'Gozgon" was also introduced to give the farmers options for selection of variety.

The farmers planted the two varieties using their conventionally used production practices. The seed rate of 250 kg/ha is the maximum recommended rate for the improved variety. However, the farmers used 350 kg/ha seeding rate for the local variety Mahalli because of its poor physical appearance. Planting was done by broadcasting (Figure 3) seed on finely

prepared seedbed using a tractor drawn plough followed by planking. Since seeding had been done on dry soil, one irrigation was provided for germination.

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Figure 3. A participant household planting wheat by broadcasting in Durmon village in Karakul district of Uzbekistan.

Both local and improved varieties received the same production practices usually used by the farmers and no intervention was made by the research team. All the learning processes took place in the famers' fields and no activities were conducted elsewhere than in the farming community as decided during participatory meetings. All learning exercises involving discussion were organized either in a small gathering place in the village or at the FFS field site. The participants householders were fully involved in observing and learning through the field work. The farmers were encouraged through discussion to adopt improved production practices suitable for their prevalent local conditions including local knowledge and agroecological conditions.

Data were collected on seedling count per unit are as a measure of plant population to assess plant stand. At maturity, the crops were harvested, threshed and grain yield was recorded in three farmers' field. Two fields with wheat crops as a part of the FFS were discarded because of heavy damage to the fields by storm as well as excessive weed infestation. All data were recorded by the farmers (Figure 4).

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Figure 4. The farmers determining the number of grains per spike in the sample of 30 spikes each from local (Mahalli) and improved (Shams) varieties in in Durmon village, Uzbekistan

Results

Both Mahalli and improved wheat varieties germinated well; however, initial plant growth rate was more vigorous for improved compared to Mahalli variety (Figure 5). At maturity, the local variety showed a mixture among the plants for height, spike colour and maturity compared to the uniformity among the plants of the improved variety.

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Figure 5. More vigorous early vegetative growth of improved wheat variety (left) as compared to a lower vegetative growth of the local variety (right) in Durmon village, Uzbekistan

Seedling count of the improved and local varieties in the four fields are presented in Table 1. There were variations in plant population within local and within improved varieties among the four farmers' fields. However, the number of seedlings didn't differ significantly between local and improved varieties except in one farmer's field. This was despite the use of higher seed rate (350 kg/ha) compared to the improved variety (25 kg/ha).

Table 1. Number of seedlings recorded in the four householders' fields of the local and improved varieties of winter wheat in Durmon village of Karakul district, Uzbekistan, 2020

Householder name	Gender	Sample number of local variety					Sample number of improved variety					Mean	
		1	2	3	4	5	1	2	3	4	5	Local	Improved
Gulchehra Jabborova	Female	369	391	375	403	371	405	394	388	401	411	398	416
Golib Barrayev	Male	419	414	413	421	420	353	374	407	371	386	427*	388
Sadoqat O'dayeva	Female	396	413	418	401	408	417	399	395	412	414	417	398
Aziz Safarov	Male	451	438	452	446	439	445	439	427	374	446	408	408
	Mean											413	403
	CV (%)											4.1	

*Difference between two varieties significant based on $LSD_{0.05}$.

Source: Author's own elaboration.

Grain yields of the local and improved varieties are presented in Table 2. Grain yield of the local variety ranged from 0.75 to 1.00 t/ha in the three farmers' fields. Grain yield of the improved variety varied from 2.16 to 2.56 t/ha. Yield advantages of the improved variety were 116, 175 and 241 percent higher as compared to the local variety.

Table 2. Summary of grain yield harvested by three households participating in the Farmers Field School in Durmon village in Karakul district of Uzbekistan, 2020

Name of farmer	Local variety (Mahalli)			Improved variety			Yield advantage of improved variety (%)
	Area planted (ha)	Grain production (kg)	Yield (t/ha)	Area planted (ha)	Grain production (kg)	Yield (t/ha)	
Aziz Safarov (Male)	0.4	400	1.00	0.4	863	2.16	116
Sanjar Khujakulov (Male)	0.3	237	0.79	0.3	651	2.17	175
Gulchehra Jabborova (Female)	0.1	75	0.75	0.1	256	2.56	241

Source: Author's own elaboration.

Discussion

As expected, the improved variety showed its superiority to the local variety in several aspects. The superiority of the improved variety was evident in the early growth stage through more vigorous plant growth prior to entering winter. More biomass accumulated prior to winter not only allows a variety to better withstand harsh winter conditions, but also helps in faster and higher biomass accumulation once plant growth resumes in the beginning of the spring. Finch-Savage and Bassel (2016) reported that seed quality plays important role in crop establishment in wheat.

Due to genetic purity as a pure-line, the plants of the improved variety were uniform in height, colour, and maturity compared to the mixture for these traits in the local variety. When plants mature at the same time, it is convenient to harvest them at right time. A mixture for maturity would force the farmers to wait till all plants reach maturity. This can cause grain shattering of the early maturing plants in the mixture.

Despite the same number of plants for both varieties, the improved variety produced higher grain yield compared to the local variety. This was primarily due to more grain per spike and heavier grain of the improved variety as compared to the local variety. It was also noted that the storm caused breaking of the spikes of the local variety that would have also resulted in reduction in its grain yield. A previous publication from this study had reported that improved wheat variety tolerated the windstorm as shown by its undamaged plants as compared to the local variety (FAO, 2021a).

Higher grain yield of the improved variety demonstrated that food security can be improved for the farmers in Durmon village by using high quality seed of improved wheat variety. Depending on the management factors, food security can be increased by two to three folds. Genetic yield potential of the improved variety is 9 t/ha; however, only 2.56 t/ha highest yield was obtained in this study. This can be attributed to the conventional crop

management practices, which can be improved by undertaking another FFS activity focusing on wheat crop management.

At the end of the project the participant households expressed a great deal of satisfaction because they had produced more wheat on their homestead land in 2020 than all years in the past. Success stories of the two participants have been published before (FAO, 2021b, 2021c). On the issue of what the participant households would do in the following year in the absence of the project that supported them in 2020, the farmers responded that they would consume part of the produce and save remaining seed of the improved variety to plant in the following year. They might also share part of the seed with other households either by selling or by exchanging.

Conclusions

Often, a project like this fails to sustain after its completion. However, the technology of improved variety introduced through this project continued in the following year 2021 where area under improved wheat variety increased by five folds. This is based on the information received by the senior author through site facilitator of the project. The use of FFS approach in this project was highly successful in demonstration and adoption of improved wheat variety for improving food security in the rural community living in the cold winter desert. The FFS approach used in this project allowed the farmers to experience by doing the benefits of good quality seed and improved variety.

Acknowledgements

This study was conducted by ICARDA under funding support of the "Central Asian Desert Initiative" project implemented by FAO as part of the International Climate Initiative (IKI). The Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety (BMU) supported this initiative based on a decision adopted by the German Bundestag. The authors greatly appreciate the funding received from FAO-Uzbekistan and the Central Asian Desert Initiative (CADI). The support of the farmers in Durmon village in conducting the field studies is highly appreciated.

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Improvement of black saxaul cultivation agrotechnics in western Kazakhstan

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Keywords: Black Saxaul, location, survival rate, height, plant health, width of bushes, taxonomic indicators

Introduction and main objectives

Nature uniqueness of the Republic of Kazakhstan includes an exceptionally high value of forests due to their unusual protective ecological role.

17821.2 thousand hectares of land in Kazakhstan occupied by saxaul forests (according to Kazakh forest management enterprise as of 01.01.2018). [1] Saxaul plantations in recent decades are severely degraded as a result of intensive industrial and agricultural exploitation.

The intensive use of natural resources and increased anthropogenic pressures have led to a tense ecological situation in the western regions of Kazakhstan.

The reality of the current situation requires a number of urgent measures aimed at improving the ecological situation in the region, of which the most important are the improvement of methods of establishment of forest seed production nurseries for black saxaul on the basis of breeding and genetics research, development of agricultural techniques for growing seedlings in sand nursery and development of technology for afforestation of flat areas and barchan sands using valuable forage shrubs and semi-shrubs. At the same time, special attention should be paid to the expansion of saxaul plantations. Considerable interest to plant saxaul is also caused by the fact that saxaul protects soil, helps to conserve pastures, regulates the climate and contributes to the ecological purification of the environment.

The need to expand the area under saxaul is particularly acute in Western Kazakhstan, where long-term and excessive exploitation of plantations as a source of firewood, carried out without compliance with measures of natural regeneration, combined with unregulated cattle grazing led to their complete loss in large areas and greatly reduced the productivity of the remaining saxaul plantations. [2]

The object of the research is forest crops and plantations of black saxaul in Mangystau and Atyrau regions.

The aim of the research is to develop a science-based technology for artificial cultivation of saxaul plantations with minimal labour and investment, allowing to achieve high survival rate, intensity of growth and development of plants.

Methodology

The survey of forest plantations is carried out by the method of reconnaissance survey in order to get acquainted with the natural conditions and vegetation cover of the study area. During the reconnaissance survey, changes of vegetation, topography, and soil are characterized in the form of brief notes on route crossings. In order to clarify the relationship between vegetation and conditions of local habitat, temporary plots are established in the most representative areas on the basis of the reconnaissance survey.

During the research, the methodological recommendations of V.V. Ogievsky and A.A. Khirov [3] were used. The establishment of pilot plots is carried out according to State Standard 16128-70 and Sectoral Standard 56-69-83 [4]. Selection and description of the pilot plots must be accompanied by familiarization with the surrounding area and making additions and corrections, if necessary, to the data obtained from the pilot plots. In-situ pilot plots are marked with labels and attached to a permanent landmark.

The survival rate, growth, and condition of plantings are determined during the fall crop inventory.

Three trial areas were established for each type of plantation or plot, where the survival rate, height, crown projection diametres along and across the row, and condition are determined.

The height of bushes up to 3 years old is measured with a measuring stick with an accuracy of 1 cm, and for older bushes with an accuracy of 5 cm, the growth of crops in height is determined by the method of A.A. Molchanov and V.V. Smirnov [5].

The survival rate is determined by continuous inventory of bushes on plots on each strip or variant following the end of the vegetation period. Assessment of saxaul plants condition on all plots is evaluated according to G.G. Wiebe's scale [6] slightly revised as applied to saxaul plantations, where the growth is determined by six characteristic features: C1 - C3 - height increases respectively - more than 30, within 5-30 and less than 5 cm, C4 - no top growth, but there are assimilative shoots in the bottom of the plant in the current year, C5 - no assimilative shoots in the current year, but the plant is not shrunken, alive, C6 - dead plant (dry).

Depending on the type of silvicultural conditions, we planted forest crops according to the following patterns:

1. planting in two rows in ploughed furrows of 8.4 m width with planting of seedlings in rows every 1.0 m, width of row-spacing within one furrow is 2.8 m and width of inter-row spaces is 8.4 m;
2. planting in three rows in 11.2 m wide ploughed furrows with seedlings in 1.0 m row-spacing, 2.8 m width of row-spacing within one furrow, and 11.2 m width of inter-row spaces between furrows;

3. planting in two rows in ploughed furrows of 8.4 m width with planting seedlings in 1.5 m row-spacing, 2.8 m width of row-spacing within one furrow and 8.4 m width of inter-row spaces between furrows;
4. planting in three rows in ploughed furrows of 11.2 m width with seedlings in 1.5 m row-spacing, 2.8 m width of row-spacing within one furrow and 11.2 m width of inter-row spaces between furrows;
5. 3-row planting along 12.0 m wide ploughed furrows with seedlings planted in rows every 1.0 m, with 3.0 m of inter-row spaces between furrows;
6. 3-row planting in 12.0 m wide ploughed furrows with seedlings in rows every 1.5 m, with 3.0 m of inter-row spaces between furrows.

Results

The harsh climatic conditions of the arid zone of Western Kazakhstan specify a number of biological features of saxaul plants, one of which is low density. Therefore, the study of growth and condition of artificial plantations depending on the place in a row is of particular practical significance and can serve as a basis for determining the optimal density of crops, in which they will have the best survival rate.

For this purpose, in the spring of 2015, employees of the West Kazakhstan branch of the Kazakh Research Institute of Forestry and Agroforestry Amelioration planted experimental 1-year standard seedlings of black saxaul in the Samsk State Forestry Department of Mangystau region on a total area of 15.9 ha with different space area in a row.

The soil was tilled by strips of 8.4 m and 11.2 m width to a depth of 25 - 27 cm. Ploughed furrows were planted with distance of 8.4 m and 11.2 m. Two and three rows of seedlings were planted in the strips with 2.8 × 1.0 m spacing. Planting was carried out mechanically, by forest planting machinery. Time of planting was early spring; planting material was one-year standard black saxaul seedlings.

The results of the assessment are shown in Table 1. (Figure 1 and 2)

a

b

c

d

e

F

Photos a-f: © FAO

Figure 1 - Planting of trial crops of black saxaul on a total area of 15.9 ha in different layout in Mangystau province.

Table 1: Taxation indicators of 3-year-old Black Saxaul plants with different arrangement in the forest area

№	The averages indicators	Number of rows / planting layout, m					
		2/2.8×1.0	2/2.8×1.5	3/2.8×1.0	3/2.8×1.5	3/3.0×1.0	3/3.0×1.5
		Width of strips, m					
		8.4	8.4	11.2	11.2	12.0	12.0
1	2	3	4	5	6	7	8
1	Survival rate, percent	42.0	46.0	48.0	60.0	52.0	58.0
2	Height, cm	86.9 ± 3.3	101.6± 4.1	113.5±4.4	140.7±5.1	126.4±4.8	133.5±4.9
3	State, points	C_2	C_2	C_1	C_1	C_1	C_1

Source: Author's own elaboration.

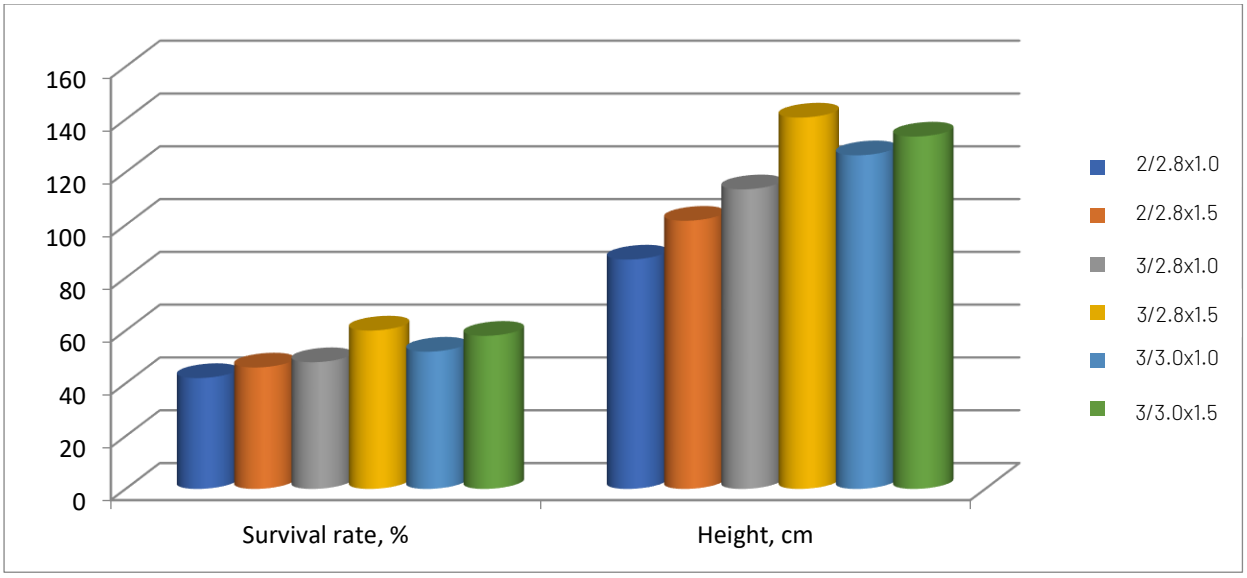

Figure 2 - Taxation indicators of three-year black saxaul plants with different arrangement in the forest area. Source: Author's own elaboration.

Discussion

In two row strips it is 46 percent, in three row strips with row spacing of 2.8 m it increases by 14 percent and in three row strips with row spacing of 3.0 m it increases in comparison with two row strips by 12 percent.

The same patterns are observed for black saxaul heights. In two-row strips it is 101.6 cm, in three-row strips with a row spacing of 2.8 m it increases by 39.1 cm and in three-row strips with a row spacing of 3.0 m it increases compared to two-row strips by 31.9 cm.

Conclusion

Analyzing the obtained data, the following conclusions can be made:

- In the Mangystau province, the black saxaul crops should be planted with strips wide of 11.2 m and 12.0 m. Plants in the strips should be planted in three rows with a row spacing of 2.8 m and 3.0 m and a row spacing of 1.5 m. At such arrangement of saxaul in forest cultivation area, the average height of saxaul is higher by 39.1 and 31.9 cm, respectively, than at similar planting with 8.4 m width of strips, and the survival rate is 14 and 12 percent higher, respectively.
- In three-row crops, plants had better results if plants were planted in 1.5 m row spacing than if seedlings were planted in 1.0 m row spacing.
- Increasing the distance between plants in a row from 1.0 to 1.5 m increases the growth rate of saxaul by 5.6 - 23.9 percent.

Acknowledgments

Studies were conducted under the program-targeted funding of the Kazakh Research Institute of Forestry and Agroforestry named after Bukeykhan A.N. and Development of technology for artificial cultivation of black saxaul in arid regions of Kazakhstan" in 2015-2017

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The importance of fuelwood for local needs and the creation of their plantations in the desert areas of Uzbekistan

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Keywords: firewood, fuelwood, protective forest plantations, plantation growing of fuelwood, saxaul, Salsola, Calligonum and tamarisk

Introduction and main objectives

Currently, the population of our republic in all districts is sufficiently provided with oil products and electricity. However, the local population's need for fuelwood is increasing. Locals still use "uchak", a special device on the ground for cooking on wood and a tandoor for baking cakes. When the stoves are heated with firewood in winter, the rooms are quickly heated. Some villagers still use sandals. A sandal is a special table under which smouldering firewood is placed, and the table is covered with a blanket on top. People heat their feet on sandals, and this is considered very useful. At weddings and other events, villagers mainly use firewood for cooking.

Therefore, their lives without the use of firewood are not possible. Firewood is the simplest, most convenient, and cheapest material for fuel for local residents. However, there is currently a fuelwood shortage in many parts of our country. Therefore, local residents allow felling of forest, trees in yards, household plots, and settlements in some regions.

It indicates the need to develop a new direction in the forestry system – the organization of plantation growing of fuelwood and providing the needs of local residents with high-quality fuel material. If this activity is organized, a framework will be established to provide fuelwood to the local population.

Methodology

The local population's need for fuelwood will continue to increase. Moreover, its stocks to meet the needs of local residents are not sufficient. On the other hand, the provision of fuelwood to the local population is part of the state policy and the responsibility of forestries.

Based on the materials of forest management, forest fund accounting and based on their own surveys, the areas of distribution of saxaul and other desert plants were determined, and descriptions of the main forest-forming species were compiled. We determined the areas requiring the creation of forest plantations on the state forest fund, including the types of growing conditions for the most suitable for planting fuelwood plantations. Based on the analysis, methods of creating forests and methods of felling in desert forests are proposed.

Results and discussions. Fuelwood is a product of the green world. Fuelwood can be harvested from the dried branches of any plant. However, high-quality can be harvested only from the trunk and branches. Saxaul wood produces high thermal calories. Its energy

potential reaches 3 420 – 4 600 calories, and in terms of efficiency, it is not inferior to coal. Indicators of other types of tree species range from 2 800-3 200 calories. Therefore, in the desert zone, special attention should be paid to creating plantations of saxaul, Salsola and Calligonum to obtain fuelwood. The main types of desert plants distributed on the lands of the state forest fund of the Republic of Uzbekistan are shown in Table 1.

Table No. 1

The main species of desert plants are distributed on the lands of the forest fund of the Republic of Uzbekistan as of. 01.01.2019

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No.	The main types of desert plants	including areal covered by forest, thousand ha	Of which:		General stock of green spaces, thous. m3	Open forest crop lands, thousand ha	Areas requiring afforestation in the desert zone, thousand ha
			Natural, thousand ha	Forest crops, thousand ha			
1	Saxaul	2 483 188	1 666 735	816 453	28 750 402	160 799	Creation of new forests around - 2 000 000[1] Compaction of thinned forests 1 000 000[2]
2	Salsola	139 603	79 106	60 497	2 252 029	2 433	
3	Calligonum	57 185	48 778	8 552	1 365 544	650	
4	Tamarisk	4 388	4 055	333	31 498	0	
	Total:	2 824 112	1 798 674	885,835	32 682 958	163 882	

Source: Author's own elaboration.

Note:

1. Areas of open stands, glades, pastures and sands require the creation of new forests

2. Areas of low-complete plantations requiring compaction by supplementing

From Table 1, it can be seen that the thickets of saxaul occupy the largest area. They belong to the goosefoot family plays a huge role in maintaining the balance of the desert ecosystem. The branched root system, which reaches 15 metres, restrains the onset of desert sands. Of the total area of saxaul, 816 453 hectares is covered by black saxaul (Haloxylon arhyllum)**.** It is the largest tree among desert plants. It is perfectly adapted to live on loose sands; in these conditions, it reaches a height of 5-8 (12) metres and in diametre can reach up to 1 metre. Wood reserves in them exceed 70-80 m3 per hectare. In some cases, under relatively favourable conditions at a high age, the wood stock can reach 100 m3 and higher per hectare. On gypsum soils, it grows poorly and reaches only 1 metre. It has a good germinating ability, which is of great practical importance since animals' eating of young twigs does not lead to their death.

White saxaul. (Haloxylon persicum) Typical psammophyte. The habitat is the gentle peaks of sandy ridges, bumpy and ridge-bumpy sands. Closed plantations do not form (30-50

bushes per 1 hectare) but are widespread over large areas. Very poor soils, often saline and intermittent sands, harshen the environment. Therefore, white saxaul forests are not characterized by high productivity. Wood reserves do not exceed 5-10 tonnes per hectare. In some cases, under relatively favourable conditions at the bottom of the rivers, the gross stock of white saxaul wood can reach 10-15 tonnes per hectare. Here, it reaches an average height of 3.5 m and 12-15 cm diametre.

Salsola richteri is a small deciduous tree or shrub of the goosefoot family. Height 2-5 m. Open crown. The root system is usually superficial gives accessory roots when filling the trunk with sand. It forms root offspring. It lives 15—20 years.

It is distributed in steppe habitats on sands, sand dunes, on crushed rocks and in sandy-clayey deserts of Uzbekistan. The characteristic landscape plant of sandy deserts, sometimes forming clean plantations, is common in the saxaul desert, serving as one of the dominant species. Salsola is widely used to strengthen sands landscaping in desert and semi-desert areas; fragile wood goes to fuel. A valuable fodder plant. They are bred with seeds and cuttings. Wood reserves do not exceed 30-40 tonnes per hectare.

Calligonum is a genus of perennial branched shrubs of the buckwheat family. A highly branched shrubs from 0.4 to 3 m in height. The root system is superficial but extremely extensive, gives abundant overgrowth and root offspring is able to spread at a distance of up to 12 m from the bush. Adaptation to habitation on mobile sands is the abundant and extremely easy formation of accessory roots; as a result, plants grow faster the more sand falls as they fall asleep. Wood reserves are 5-6 tonnes per hectare.

Tamarisk Numerous genera. In Uzbekistan, tamarisks occur in drier parts of river valleys, on ancient terraces, on the edges of sands, and in dry channels of temporary streams, forming particularly lush thickets along the rivers' banks lakes, on sandy and pebble-cartilage sediments. Natural growing conditions convince that tamarisks are salt-resistant, which is especially valuable, drought-resistant, photographic, undemanding to soils. They grow fast. It reaches a height of 3-4 metres, the wood reserve is up to 15-20 tonnes per hectare, in the best habitat conditions, it accumulates a wood reserve of up to 30-40 tonnes per hectare.

Currently, there are few protective forest plantations around settlements in desert zones, and the existing forests are low in fullness. Therefore, around the cities of Zarafshan, Uchkuduk, Tamda, Gazli, Nurata, and other settlements where there is a need for fuelwood, it is necessary to create protective forest plantations and fuelwood plantations. Forestry has sufficient land and other opportunities to establish fuelwood plantations and protective forest plantations. For this purpose, the state allocates certain funds. According to the data of the forest fund, the area requiring the creation of forest plantations on the territory of the forest fund is about 2.0 million hectares; in addition, it is necessary to carry out in low-complete plantations on an area of about 1 million hectares.

Over time, the established fuelwood plantations will serve as objects for protection against natural disasters (severe storms, salt-dust transfer and sanding). They increase air humidity, create a microclimate, and generally contribute to improving the environmental situation.

In the desert zone, the needs of local residents in the wood of saxaul, Salsola and Calligonum were partially met by felling ripe protective forest plantations.

Strips usually create protective forest stands. The distance between the lanes is 10 -15 metres. The width of the ploughed strip is from 1.05 to 1.4 metres, the depth of ploughing is 25-30 cm. During sowing, 3.5-5 kg of seeds are usually sown on the ploughed strips; during planting, annual saxaul seedlings are planted according to the scheme of 10 x 1 metre. After 10-15 years, the completeness of the created plantings increases in certain areas due to sowing. On average, 30-50 tonnes of saxaul wood can be harvested from each hectare of forest. On average, 15–25 tonnes are harvested per hectare in Salsola plantations, and up to 5 tonnes of fuelwood are harvested in Calligonum deserts; however, the area for harvesting wood is limited. Permission for overcutting is not granted.

In order to obtain fuelwood in the desert zone, it is necessary to create plantations of saxaul, Calligonum and Salsola according to the thickened scheme: when sowing, the distance between the strips can be 3 metres, and when planting, the adopted scheme is 2 x 2 or 2 x 3 metres. To do this, you need to choose good sandy lands. Unlike saxaul, the age of ripeness of Calligonum and Salsola begins at 5 years, and in saxaul somewhat later at 25-30 years. It is possible to plant a comb on saline lands, the age of ripeness of which is 5 years.

According to the studies carried out within the framework of the small grants project in the territory of the Jarkurgan district of the Surkhandarya region (http://sgp.uz/ru/news/http://sgp.uz/en/news/), for 5 growing years among all phytomeliorants, the Salsola showed the best development on sandy soils. In addition to accumulating a large fodder stock, it also had a high wood stock. The average number of Salsola per hectare was about 502 plants. Due to favourable soil conditions, the average height of the Salsola was 3.6-3.8 m, and the diametre of its crown varied in the range of 4.0-4.5 m (Photo 1). At the same time, the Salsola formed 14.6 tonnes of air-dry wood per hectare in the conditions of sand pastures of the project territory.

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Photo 1. General view of the Salsola desert

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Photo 2. General view of the saxaul desert

Saxaul deserts. A peculiar feature of the saxaul desert was the high density of black saxaul per unit area. The average height of the plants varied 2.5-3.0 m, and the crown diametre – 2.0-2.5 m. The black saxaul formed dense thickets within five years, which led to the accumulation of significant tree stock. The average number of black saxaul was estimated

at 2,235 plants per hectare. 14.1 tonnes of absolutely dry black saxaul wood were formed. 82 percent of the wood stock of the black saxaul has a primary trunk diametre from 3 to 8 cm. The rest of the wood consists of secondary shoots, the thickness of which is less than 3 cm (photo 2)

Calligonum deserts. Concerning the formation of wood stock, Calligonum deserts had a relatively low potential compared to Salsola and saxaul deserts. It is due to the smaller crown size of this plant and the features of intensive branches of the secondary shoot. The average height of the crown was about 130-150, diametre - 170-190 cm. The exception was the shrubs, the height of which exceeded 3.0 m (Photo 3). The average number of Calligonum per hectare was about 1400 plants. Despite the high indices of the number of Calligonum, it formed about 1.5 tonnes of air-dry mass of wood stock per hectare.

© FAO/K.Talipov
Photo 3. General view of the Calligonum

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Photo 4. General view of the tamarisk desert

Thus, the restoration measures on the degraded areas contribute to the significant accumulation of wood stocks on the pasture territory. As mentioned above, saxaul and Salsola are above the recommended norm and therefore need to be reduced for the sustainable functioning of these pastureland ecosystems. From this point of view, proper sanitary felling in these areas is a necessary measure. Without prejudice to the health and long-term use of this area of the desert, the average value of sanitary cutting (collection) of wood, after reclamation, can be 1-3 tonnes/ha per year.

Thus, for the restoration of 1 hectare of the desert site, you can get 2-3 tonnes of wood per year, and there is the possibility of using the restored area of the forest for pasture with two-three heads of small cattle, taking into account the average cost of saxaul and Salsola firewood 0.2-0.3 c.u. per 1 kg and the average cost of small cattle in the amount of 150 c.u., 1 hectare of a desert can bring the owner an average annual income of 300-500 c.u. The wholesale price of saxaul in the markets is 160-180 dollars per 1 tonne. In fact, the creation of commercial saxaul plantations with a sustainable collection of dry and sanitary felling can also serve as an example of a good business model while simultaneously solving a more global problem – the restoration of the country's desert areas.

Conclusions

The obtained results and their analysis serve as the basis for the conclusion that this model of restoration of degraded sandy deserts has a high potential for wide application on degraded sandy massifs of Uzbekistan. There are many desert lands in Uzbekistan, many degraded deserts that can and should be restored. And then people living in such areas will be able to get stable fuelwood and use enriched desert pastures for grazing livestock.

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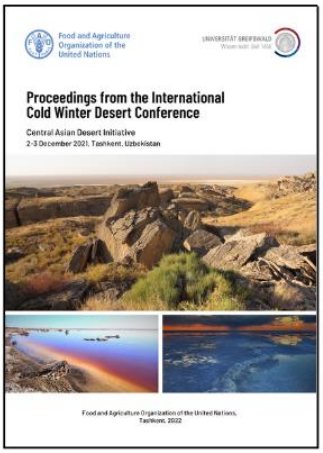

Proceedings from the International Cold Winter Desert Conference

Central Asian Desert Initiative

2-3 December 2021, Tashkent, Uzbekistan

The Proceedings from the International Conference on Cold Winter Deserts contain key highlights and outcomes of the conference, presenting research results of the work undertaken in the scope of temperate deserts.

The cold winter – also referred to as temperate – deserts, spreading from northern Islamic Republic of Iran across Central Asia to Mongolia – are globally outstanding nature regions. They are an important migration area for birds and the last wild herds of ungulates, such as the Saiga antelope. The enormous land masses deliver a broad range of ecosystem services.

Despite their ecological importance, temperate deserts are, according to a study by the International Union for Conservation of Nature (IUCN), one of the least recognized biomes worldwide. Yet, these deserts, their habitats and species are threatened by desertification caused by overexploitation for firewood collection, inappropriate grazing practices, and large-scale infrastructure development.

95 percent of the temperate deserts are located in Central Asia – hence this region carries a high responsibility for the preservation of this biome. Against this background, the Central Asian Desert Initiative (CADI) aims at preserving biological diversity and the conservation and sustainable use of cold winter deserts in Central Asia. Therefore, in close coordination with local partners, a wide package of measures shall be implemented in the main target countries Kazakhstan, Uzbekistan and Turkmenistan.

CADI is jointly implemented by the University of Greifswald (Germany), the Michael Succow Foundation (Greifswald, Germany) and the Food and Agriculture Organization of the United Nations (FAO), Sub-regional Office for Central Asia (Ankara, Türkiye).

Supported by:

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

IKI INTERNATIONAL CLIMATE INITIATIVE

Succow Stiftung

based on a decision of the German Bundestag

This publication is a result of the Central Asian Desert Initiative (CADI) project as part of the International Climate Initiative (IKI). The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) supports this initiative on the basis of a decision adopted by the German Bundestag.

Food and Agriculture Organization of the United Nations
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www.fao.org

ISBN 978-92-5-136958-6

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CC1339EN/1/10.22