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Application of advanced processing of the remote sensing data on land use and land cover changes in Zangilan, East Zangezur

[1,2] Karimli Nilufar Irshad, [2,3*] Ahadov Bahruz Gazanfar, [3] Kadirov Fakhraddin Abulfat

[1] Istanbul Technical University, Institute of Graduate School, Maslak, 34467 Sariyer/Istanbul, Turkiye
[2] Digital Umbrella LLC, Remote Sensing, and GIS Division, Ziya Bunyadov Ave., 1965 Chinar Park Business Center, Baku AZ1075, Azerbaijan
[3] Institute of Geology and Geophysics, Ministry of Science and Educataion of the Republic of Azerbaijan, 119 Huseyn Javid Ave., Baku AZ1143, Azerbaijan

***For correspondence:** bahruz.ahadov@digirella.az*

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Land use and land cover (LULC) changes covering the 32-year period during which the Zangilan region was occupied and liberated from occupation were carried out in this study. The process was compared using and classified open-source Landsat 4, 5, 8, 9, and Sentinel 2 data with 10-year periods, plus the data ingested after the liberation date. The discrete indexing method was developed and applied for this study. The method we applied was based on calculating various indices and their application in the classification process to increase accuracy. The indices we used include the Normalized Difference Vegetation Index (NDVI), Modified Normalized Difference Water Index (MNDWI), and Salinity Index (SI). The validity of the process has been checked using the SNAP ESA algorithm, based on Java Approximator, resulting in over 96.7% correct predictions using the testing dataset.

***Keywords:** Land use and land cover, remote sensing, MNDWI, urbanization, vegetation, agriculture, salinity*

INTRODUCTION

Human societies are constantly transforming nature to obtain food, fibre, fuel, and other materials provided by ecosystems. Human activities have indirectly or directly impacted 83% of the earth's surface (Sanderson et al., 2002). These land use/land cover (LULC) changes are associated with resource availability, climate fluctuations, and a wide variety of socioeconomic factors (Lambin et al., 2003). LULC use change, or simply land change, is a term used for the changes that human beings have brought about on the earth (Erle and Pontius, 2007). Changes in land cover and land changes can negatively affect sustainability in the ecosystem, and human activities are considered one of the most important factors that can accelerate this process (Agarwal et al., 2001). Therefore, it is important to identify any temporary land-use changes and establish plans and a suitable management strategy based on the obtained results.

The advancement of science and space technology has increased access to fast, reliable, up-to-date, and analyzable information is more reachable. Nowadays, Remote Sensing (RS) and Geographic Information Systems (GIS) are used to detect LULC changes. RS and GIS are among the most effective methods used to monitor LULC use changes.

MATERIALS AND DATASETS

The Zangilan region was chosen for the application of our method. The region is located along the Okhchuchay river, 39°03′56″ N/46°41′49″ E (Google Earth, 2022).

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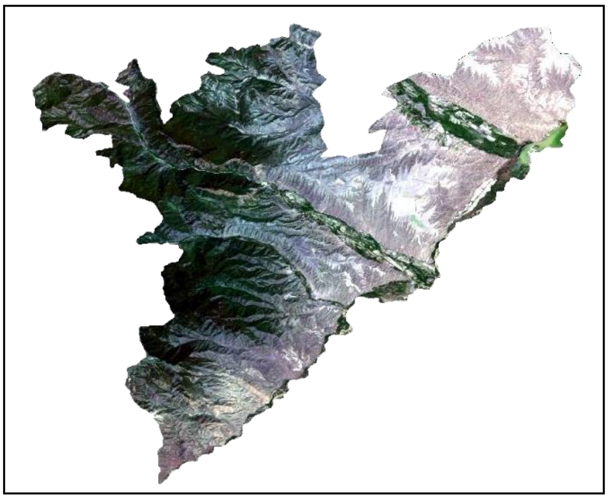


Fig. 1. Landsat 8, June 2020 Satellite imagery of the AOI

The data obtained due to research purposes, and the feature of the high frequency of revisit time, enable the production of geographic information on local and regional scales. In this research, Landsat 4, 5, 8, and 9 images from June 1990, June 2000, August 2010, June 2020, and July 2022, and Sentinel 2 images from June 2020 and July 2022 were used, respectively.

Using these data sources, users interested in subject areas including land management, agro-based conditions, hydrology, nature reserve and vegetation, black carbon, natural resource management, and global agricultural monitoring can modify and alter the information.

The Sentinel Application Platform (SNAP) architecture is used for Earth observation (EO) processing and analysis. The SNAP architecture is optimal for processing and analyzing Earth observation (EO) data due to its extensibility, modular platform, portability, tiled memory management, generic EO data abstraction, and graph processing framework. SNAP and the other Sentinel Toolboxes support several other sensors in addition to Sentinel sensors. The SNAP user tool is made available to the Earth Observation Community without charge by ESA/ESRIN. Considering the mentioned characteristics, the SNAP architecture and the Sentinel 2 datasets provide excellent analytical research and procedures opportunities.

METHODS

Pre-processing: Graph Builder feature of the SNAP architecture has been used in Image pre-processing which consists of the following steps: uploading supported files, reprojecting each data using Optical Sentinel 2 Reprojection tool, resampling each dataset, and masking out the study area (Fig. 1)

Indices: The method we apply is based on calculating various indices and their application in the classification process to increase accuracy. The indices we used include the Normalized Difference Vegetation Index (NDVI), Modified Normalized Difference Water Index(MNDWI), and Salinity Index.

Normalized Difference Vegetation Index: A prevalent and commonly utilized remote sensing index is the NDVI (Bhandari, Kumar, & Singh, 2012). The TOA reflectance of a red band at 0.66 m and a near-infrared (NIR) band at 0.86 m are used to determine NDVI. While water and built-up regions will be represented by near-zero or negative values, the NDVI of a highly vegetated area will lean toward positive values (**Fig. 2**). Orderly, NDVI is given as (Braun and Herold, 2004):

$$\mathrm{NDVI} = \frac{\rho_{\mathrm{nir}} - \rho_{\mathrm{red}}}{\rho_{\mathrm{nir}} + \rho_{\mathrm{red}}}$$

Modified Normalized Difference Water Index: The Modified NDWI (MNDWI) can effectively reduce or even eliminate build-up texture noise, plant noise, and ground noise while enhancing open water characteristics. Therefore, the area of the water samples is exaggerated. This is because the increased water information on the NDWI often masks noise from buildings. MNDWI uses green and SWIR bands to enhance open-water functionality. It also reduces the characteristics of urban areas that often correlate with open water in other indicators (Xu, 2006). The MNDWI has the advantage of reducing and even eliminating constructed land noise over the NDWI, making it ideal for augmenting and extracting water information for bodies of water dominated by background-constructed land areas (**Fig. 3**).

$$MNDWI = \frac{\rho_{Green} - \rho_{SWIR}}{\rho_{Green} + \rho_{SWIR}} = \frac{\mathrm{B3} - \mathrm{B12}}{\mathrm{B3} + \mathrm{B12}}$$

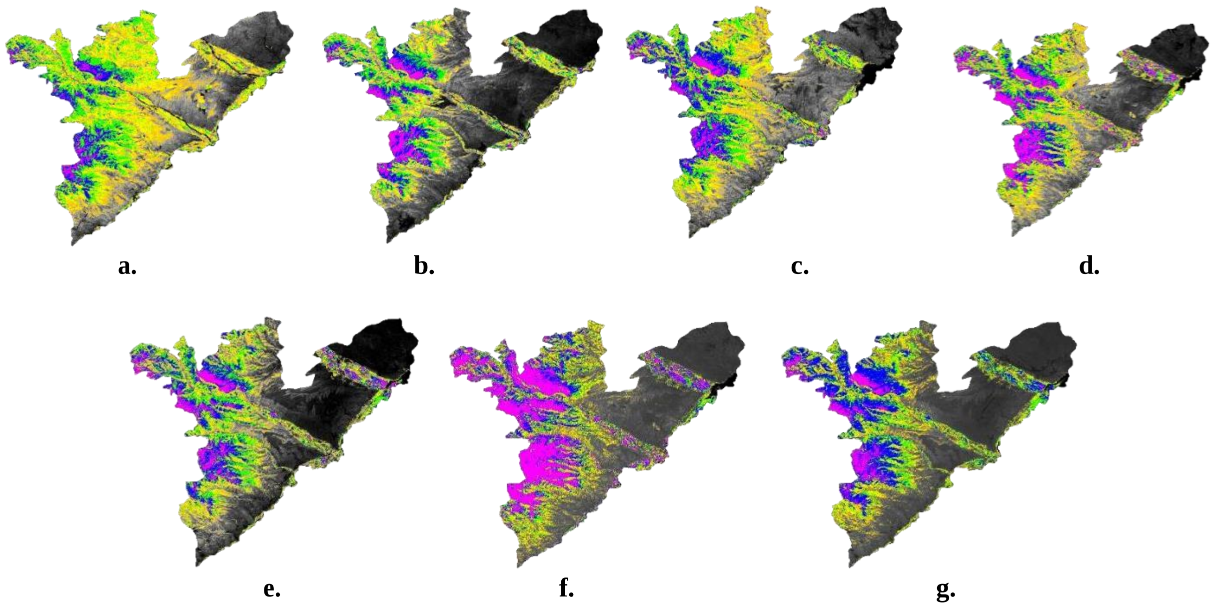


Fig. 2. NDVI visualisation of Landsat 4, 5, 8, 9; a) June 1990, b) June 2000, c) August 2010, d) June 2020, e) July 2022, Sentinel-2; f) June 2020, g) July 2022

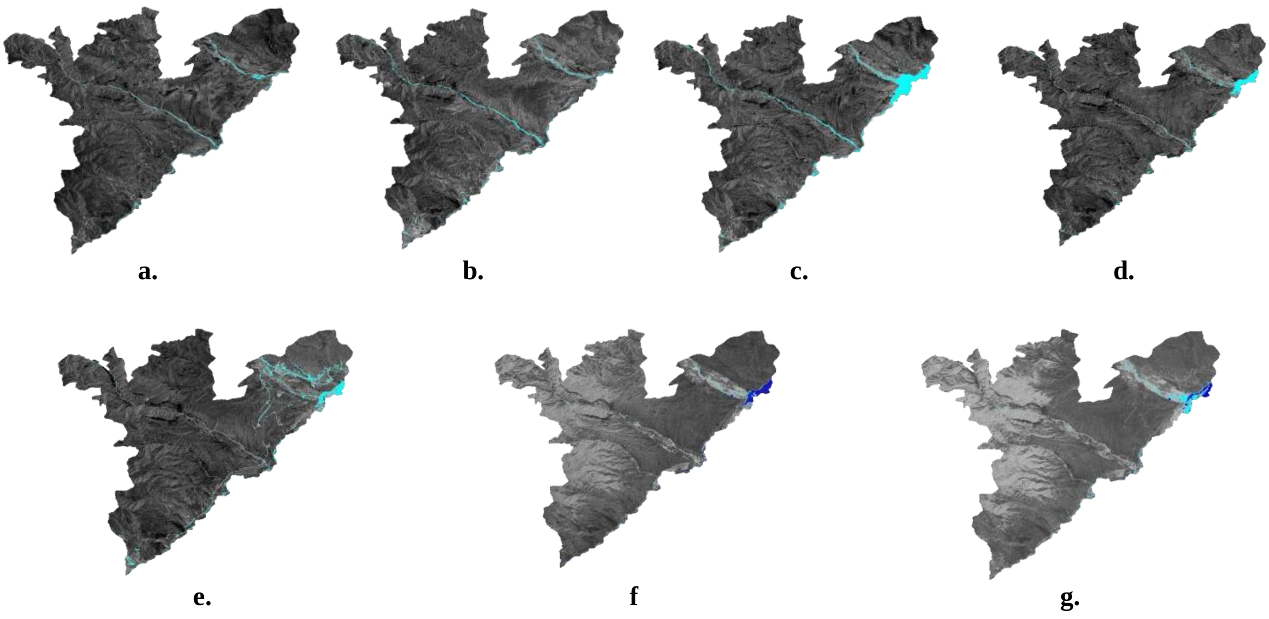


Fig. 3. MNDWI visualisation of Landsat 4, 5, 8, 9; a) June 1990, b) June 2000, c) August 2010, d) June 2020, e) July 2022, Sentinel-2, f) June 2020, g) July 2022

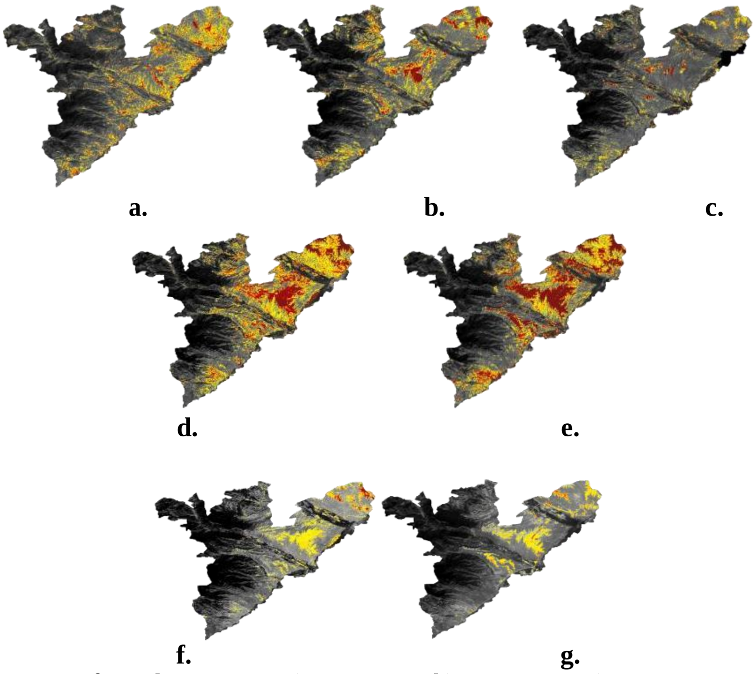


Fig. 4. SI visualisation of Landsat 4,5,8,9; a) June 1990, b) June 2000, c) August 2010, d) June 2020, e) July 2022, Sentinel-2, f) June 2020, g) July 2022

Salinity index: The lack of vegetation can be an indirect indication of the presence of salt in the soil. Saline soils are often characterized by poorly vegetated areas (Fig. 4). The salinity index is the ratio of the red band to the near-infrared (NIR) band (Dehni and Lounis, 2012). The salinity index is calculated as follows:

$$SI=\frac{B3*B4}{2}$$

Classification: Classification is the method of analyzing multiple images or bands that are georeferenced to each other and bringing together the ones with similar statistical properties in these images into groups. As a result of classification, image data with a certain number of thematic classes are obtained.

Due to our purpose, we applied Random Forest (RF) classification method provided by the SNAP ESA architecture. The method we applied is based on the calculation of various indices and their application in the classification process in order to increase accuracy. The indices we used include the Normalized Difference Vegetation Index (NDVI), Modified Normalized Difference Water Index (MNDWI), and Salinity Index (SI). The validation of the technique has been checked using the SNAP ESA algorithm, and the results are over 96.7% correct using the testing dataset.

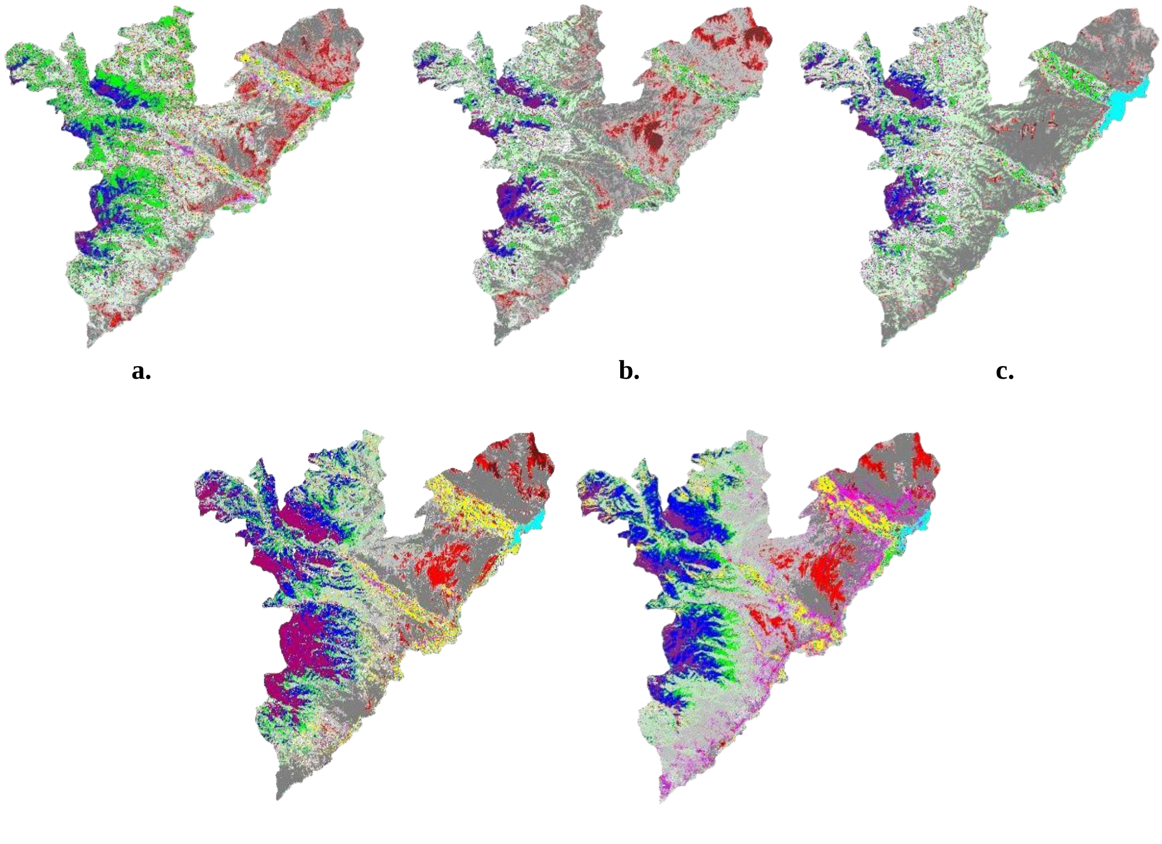
RESULTS

Table 1. Color manipulation of the results

no data	
urbanization	
salinity	
severe salinity	
light bare soil	
dark bare soil	
agricultural vegetation	
shrubland	
sparse forest	
mid-density forest	
higher density forest	
water stream	

According to the color distribution of the classification stated above (Table 1.), between the pre-occupation and 2000 data, the dramatic change observed in urbanization due to the deportation of the local population is evident. In the visualization of the data of the year 2000, we can observe the replacement of agriculture by natural vegetation. However, there is also a rapid decline in natural vegetation in the area.

Given the decline in the urbanization index during that period, massive deforestation by Armenia to use natural wood as an energy source is the only satisfactory explanation (Fig. 5).



a. b. c.

d. e.

Fig. 5. The map represents LULC results of Zangilan a) 1990 b) 2000 c) 2010 d) 2020 e) 2022

After the Khoda Afarin dam, which construction began in 1999, began to inaugurate in 2008 (UNDP/GEF, 2013), a slight positive change in agriculture is noticeable. This can be seen in the controlled distribution of greenery in riverside areas and the observed intra-network trends in greenery.

However, in the period 2010-2020, the degree of salinity in the area increased rapidly. Deforestation and unplanned irrigation / fertilization are considered the main causes of this phenomenon. Although the development of agriculture has increased slightly in the last 10 years, the indicators of urban infrastructure in populated areas remained low due to the vandalism of already-built settlements. On the other hand, we can notice a considerable positive change (from 2% to 6%) in urbanization when we compare the results between the years 2020 and 2022 which was before and after the liberation.

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Şərqi Zəngəzurun Zəngilan rayonu ərazisində torpaqdan istifadə və torpaq örtüyü dəyişiklikləri üzrə məsafədən zondlama məlumatlarının tətbiqi

[1,2] Kərimli Nilufər İrşad qızı, [2,3] Əhədov Bəhruz Qəzənfər oğlu, [3] Qədirov Fəxrəddin Əbülfət oğlu

[1] İstanbul Texniki Universitetinin Aspirantura İnstitutu, İstanbul, Türkiyə
[2]Digital Umbrella MMC-nin Məsafədən Zondlama və CİS Bölməsi, Bakı, Azərbaycan
[3]Azərbaycan Respublikası Elm və Təhsil Nazirliyinin Geologiya və Geofizika İnstitutu, Bakı, Azərbaycan

Təqdim olunan tədqiqatda Zəngilan rayonu ərazisində işğaldan əvvəl, işğal ərzində və işğaldan azad edildikdən sonra 32 illik dövrü əhatə edən Torpaqdan İstifadə / Torpaq Örtüyü dəyişiklikləri siniflәndirilərək analiz edilmişdir. Proses açıq mənbədən əldə edilmiş 10 illik müddətə sahib Landsat 4, 5, 8, 9 və Sentinel 2 məlumatlarından istifadə edilərək müqayisə və təsnif edilmişdir. Bundan əlavə, işğaldan azad edilmə tarixindən sonra bir illik dövrlə iki ilin nəticələri də analiz edilmişdir. Sinifləndirmə prosesinin dəqiqliyini artırmaq məqsədi ilə diskret indeksləmə metodundan istifadə edilmişdir. Bu metod müxtəlif indekslərin hesablanmasına və dəqiqliyi artırmaq üçün onların diskret sinifləndirilmə prosesində tətbiqinə əsaslanır. İstifadə edilmiş indekslərə Normallaşdırılmış Fərq Bitki Örtüyü İndeksi (NDVI), Modifikasiya edilmiş Normallaşdırılmış Fərq Su İndeksi (MNDWI) və Şoranlaşma İndeksi (SI) daxildir. Prosesin etibarlılığı "Java Approximator"-a əsaslanan "SNAP ESA" alqoritmi ilə yoxlanılıb və nəticədə test məlumat dəstindən istifadə etməklə 96,7% etibarlılıq proqnozu əldə edilib.

***Açar sözlər**: Torpaqdan istifadə və torpaq örtüyü, məsafədən zondlama, MNDWI, urbanizasiya, yaşıllıq, kənd təsərrüfatı, şoranlaşma*

Применение усовершенствующей обработки данных дистанционного зондирования земли по землепользованию и изменениям растительного покрова в Зангиланском районе Восточно-Зангезурской области

[1,2] Каримли Нилюфер Иршад кызы, [2,3] Ахадов Бахруз Газанфар оглу, [3] Кадиров Фахраддин Абульфат оглу

[1] Институт высшего образования Стамбульского технического университета, Стамбул, Турция
[2] Подразделение дистанционного зондирования и ГИС ООО «Диджитал Амбрелла», Баку, Азербайджан
[3] Институт геологии и геофизики Министерства науки и образования Азербайджанской Республики, Баку, Азербайджан

В настоящей работе были классифицированы и анализированы изменения в землепользовании и растительном покрове, охватывающие 32-летний период, в течение которого Зангиланский район был оккупирован и освобожден от оккупации. Процесс сравнивался и классифицировался с использованием открытых спутниковых данных, таких как Landsat – 4, 5, 8,9, Sentinel – 2 с десятилетним периодом. Кроме того, к анализу были привлечены результаты однолетних и двухлетних наблюдений после освобождения от оккупации. Для повышения точности процесса классифицирования был разработан и применен метод дискретного индексирования. Используемый нами метод был основан на расчете различных индексов и их применении в процессе классификации для повышения точности. Эти индексы включают нормализованный разностный индекс растительности (NDVI), модифицированный нормализованный разностный водный индекс (MNDWI) и индекс солености (SI). Достоверность процесса была проверена с использованием алгоритма SNAP ESA на основе Java Approximator, в результате чего было получено более 96,7% правильных прогнозов с использованием тестового набора данных.

Ключевые слова: *Использование земель и структура землепользования, дистанционное зондирование, модифицированный нормализованный разностный водный индекс (MNDWI), урбанизация, растительность, сельское хозяйство, соленость*

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Threatened higher plants in Shusha and the surrounding areas

Asgarov Aydin Musa

Institute of Botany, Ministry of Science and Education of the Republic of Azerbaijan, 40 Badamdar Highway, Baku AZ1073, Azerbaijan

For correspondence: *askerov1@mail.ru*

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The paper provides information about the threatened plants in Shusha and the surrounding areas. According to obtained data, 233 rare species of higher plants of various groups found in the Karabakh and Eastern Zangezur economic regions can be included in the future "Red Book of Karabakh". 59 species of them are (28 families and 49 genera) endemic, sub endemic and rare plants found in Shusha and the surrounding areas. 33 of these species (15 families, 27 genera) were first described in Shusha and its surroundings (12 species were first described directly from Shusha (10 families, 11 genera). The article describes the features (priority name, morphological features, nomenclature type, distribution, ecological features and importance) of 12 species, described directly from the surrounding areas of Shusha.

Keywords: *Azerbaijan, Karabakh, Shusha, flora, protection*

INTRODUCTION

Karabakh, as well as Shusha and its surroundings, is considered the richest phytogeographical region of the Republic of Azerbaijan and the Caucasus as a whole. More than 2000 species of higher plants (*Pteridophyta*, *Pinophyta*, *Angiospermae*) are found in these areas, and this is more than 42 percent of the species of higher plants of the flora of Azerbaijan. First of all, this diversity is due to the extreme complexity of natural conditions, and geological and geomorphological structures here. There are many types of medicinal, food, vitamin, tinctorial, fodder and other useful plants among the species here.

The following plant groups are common in Karabakh, Shusha and surrounding areas: forest plants, mixed shrubland, phryganoid and steppe vegetation, rock plants, wetland plants, subalpine and alpine meadows, including restored plant communities in place of forest and steppe vegetation.

The districts around Shusha mean the districts directly bordering Shusha. At the same time, the board territories of Khankendi, Lachin, and Khojavend (Hadrut) districts with Shusha were taken into account.

Unfortunately, the flora of Karabakh and Shusha and surrounding areas were not specially studied. Some data about the flora of the region was obtained from expeditions organized by us to the region before the occupation, multivolume "Flora of Azerbaijan" (Flora of Azerbaijan, 1950-1961), V.Hajiyev et al. "Altitude vegetation of the Less Caucasus" (Hajiyev et al., 1990), "About the nature of Ganjabasar and Karabakh" (Asgarov et al., 2016) from the journal published by ANAS in 3 languages (here the vegetation of Karabakh was written by us), and also from "Plants of Azerbaijan" (Asgarov, 2016). The valuable information on the nature of Karabakh was also given in the materials of the online conference "Biodiversity, land and water resources of Karabakh: past, present and future" (Asgarov, 2021), special issues of the journal "Science of life and biomedicine" (Asgarov, 2021).

MATERIALS AND METHODS

Information on the flora, plant cover and plant resources of the territory was based on

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monitoring data conducted during numerous floristic expeditions to Karabakh under the authority of the author in the pre-occupation years, analysis of collected herbarium and seed materials and published data of obtained results (Asgarov, 2005, 2006, 2008, 2011, 2016, 2019; Asgarov et al., 2016). Furthermore, the materials of the Herbarium Foundation of the Institute of Botany of ANAS were studied in the Herbarium Fund of Botanical Institute of the Russian Academy of Sciences. The books and monographs published on this topic were used (Flora of Azerbaijan, 1950-1961; Прилипко, 1970; Hajiyev et al., 1990).

RESULTS AND DISCUSSION

Among the 266 names listed in both editions of the Red Book of the Azerbaijan Republic (Red Book of the Azerbaijan SSR, 1989; Red Book of the Republic of Azerbaijan, 2013), the majority of rare and endangered higher plants are found in Shusha and adjacent districts: Shusha Gevani, Shusha Khashasi, Kharibulbul and other species of stone orchid, hip, etc.

The number of rare, disappearing, endemic, and sub-endemic plants known to us in the territories liberated from occupation was more than nowadays. Currently, most of them were destroyed during the Armenian occupation. Since more than 54 thousand hectares of forest land were destroyed during the occupation period, valuable species in 2 reserves and 4 reserve zones with a total area of 43 thousand hectares were severely damaged.

223 rare species of higher plants (59 families, 140 genera) from various categories of the Karabakh and East-Zangezur economic regions can be included in the "Red Book of Karabakh".

The number of endemic, sub endemic and rare plant species (28 families and 49 genera) found in Shusha and adjacent districts is 59. 33 species (15 genera, 27 genera) were first described from Shusha and surrounding areas (12 species were first described directly from the Shusha region (10 genera, 11 genera) (Table 1, 2).

Table 1. Endemic, subendemic, and endangered species found in Shusha and surrounding areas

Family	Genus	Species' name
1	2	3
Alliaceae	*Allium*	*A. kunthianum* Vved.
		A. szovitsii Regel
Amarillidaceae	*Sternbergia*	*S. vernalis* (Miller) Gorer & J.H.Harvey *(S. fischerana* (Herb.) M. Roem.)
Apiaceae	*Astrantia*	*A. maxima* Pall.
Asteraceae	*Centaurea*	*C. reflexa subsp. sosnovskyi* (Grossh.) Mikheev *(C. sosnovskyi* Grossh.)
	Cousinia	*C. cynaroides* (Bieb.) C.A.Mey.
	Helichrysum	*H. armenium* DC.
	Podospermum	*P. canum* C.A.Mey.
	Psephellus	*P. karabaghensis* Sosn. in Grossh.
	Tragopogon	*T. coloratus* C. A. Mey.
	Scorzonera	*S. pulchra* Lomak.
Aquifoliaceae	*Ilex*	*I. spinigera* Loes *(I. hyrcana* Pojark.)
Brassicaceae	*Cardamine*	*C. tenera* S. G. Gmel. ex C.A.Mey
Campanulaceae	*Asyneuma*	*A. campanuloides* (Bieb. ex Sims.) Bornm.
	Campanula	*C. karabaghesis* Mikheev.
Caryophyllaceae	*Cerastium*	*C. szowitsii* Boiss.
	Dianthus	*D. capitatus* J.ST-Hil.
		D. raddeanus Vierh.
Celtidaceae	*Celtis*	*C. caucasica* Willd.
Cupressaceae	*Juniperus*	*J. foetidissima* Willd.
Dryopteridaceae	*Dryopteris*	*D. caucasica* (A.Br.) Fr. – Jenk. et Corley
Euphorbiaceae	*Euphorbia*	*E. iberica* Boiss.
		E. ledebourii Boiss.
Fabaceae	*Astragalus*	A. dzhebrailicus Grossh.
		A. karabaghensis Bunge
		A. schuschaensis Grossh.
	Onobrychis	*O. schuschajensis* Agaeva

Table 1 continued

1	2	3
	Trifolium	*T. bobrovii* Chalilov
Hyacinthaceae	*Scilla*	*S. siberica subsp. caucasica* (Miscz.) Mordak *(S. caucasica* Miscz.)
İridaceae	*İris*	*İ. caucasica* Hoffm.
Liliaceae	*Tulipa*	*T. armena* Boiss. *(T. karabachensis* Grossh.)
		T. schmidtii Fomin
Malvaceae	*Alcea*	*A. sachsachanica* Iljin
Moraceae	*Ficus*	*F.carica* L.
Orchidaceae	*Limodorum*	*L. abortivum* (L.) Sw.
	Ophrys	*O. caucasica* Woronow ex Grossh.
		O. oestrifera Bieb.
	Platanthera	*P. chlorantha* (Custer.) Reichenb.
Pinaceae	*Pinus*	*P. sylvestris var. hamata* Steven *(P. kochiana* Klotzch ex C.Koch)
Punicaceae	*Punica*	*P. granatum* L.
Poaceae	*Colpodium*	*C. versicolor* (Stev.) Schmalh.
	Triticum	*T. monococcum* L.
Ranunculaceae	*Aconitum*	*A. nasutum* Fisch.ex Reichenb.
	Delphinium	*D. brunonianum* Royle *(D. foetidum* Lomak.)
		D. sowitsianum Boiss.
	Pulsatilla	*P. violacea* Rupr.
Rosaceae	*Amygdalus*	*Prunus fenzliana* Fritsch *(A. fenzliana* (Fritsch) Lipsky)
	Crataegus	*C. orientalis subsp. szovitsii (*Pojarkova) K.I.Chr. *(C. szovitsii* Pojark.)
	Rosa	*R. komarovii* Sosn.
		R. sachokiana P.Jarosch.
	Padus	*Prunus padus L. (P. avium* Mill.)
Rubiaceae	*Galium*	*G. hyrcanicum* C.A.Mey.
Rutaceae	*Haplophyllum*	*H. villosum* (Bieb.) G. Don fil.
Scrophulariaceae	*Digitalis*	*D. nervosa* Steud. et Hochst. ex Benth.
	Scrophularia	*S. versicolor* Boiss. (*S. grosseimii* Schischk.)
	Verbascum	*V. szovitsianum* Boiss.
	Veronica	*V. telephiiflia* Vahl *(V. minuta* C.A.Mey.)
		V. amoena Stew.
Taxaceae	*Taxus*	*T. cuspidata* Siebold & Zucc. (*T. baccata* L.)
Total: 28	**49**	**59**

Table 2. Higher plant species described from Shusha and surrounding areas
(Species described in surrounding areas of the city of Shusha are highlighted in black font).

Family	Genus	Species' name
1	2	3
Alliaceae	*Allium*	***Allium kunthianum*** **Vved.**
		A. szovitsii Regel
Amaryllidaceae	*Sternbergia*	*S. vernalis* (Miller) Gorer & J.H.Harvey *(S. fischerana* (Herb.) M. Roem.)
Apiaceae	*Ferulago*	*F. setifolia* C. Koch
	Pastinaca	***P. armena*** **Fisch. et C.A.Mey.**
	Pimpinella	*P. peucedanifolia* Fisch. ex Ledeb.
	Szovitsia	*S. callicarpa* Fisch. et C.A.Mey.
Asteraceae	*Cirsium*	*C. aduncum* Fich. etC.A.Mey. ex DC.
		C. szovitsii (C. Koch) Boiss.
	Echinops	*E. pungens Trautv.*
	Hieracium	*H. camkorijense subsp. sericicaule* (Schelk.et Zahn) Juxip *(H. sericicaule* (Schelk.et Zahn) Juxip)
		Renealmia cincinnata (K.Schum.) T. Durand & Schinz *(H. cincinnatum Fries)*
	Jurinea	***J. spectabilis*** **Fisch. et C.A.Mey.** (*J.grossheimii*Sosn.)
Brassicaceae	*Erysimum*	*E. strictisiliquum* N. Busch

Table 2 continued

1	2	3
Caryophyllaceae	*Cerastium*	*C. szowitsii* Boiss.
	Gypsophila	***G. szovitsii* Fisch. et C.A.Mey. ex Fenzl**
Corylaceae	***Carpinus***	***C. schuschaensis* H.Winkl.**
	Corylus	*C. colurna*L.
Crassulaceae	*Rosularia*	*R. sempervivum subsp. persica* (Boiss.) Eggli*(R. radiciflora Steud. ex Boriss.)*
Euphorbiaceae	*Euphorbia*	***E. ledebourii* Boiss.**
Fabaceae	*Astragalus*	*A. brachypetalus*Trautv.
		A. karabaghensis Bunge
		***A. schuschensis* Grossh.**
		***A. dzhebrailicus* Grossh.**
	Onobrychis	***O. schuschajensis*Agaeva**
Lamiaceae	***Nepeta***	***N. racemosa* Lam. *(N. transcaucasica Grossh.)***
Malvaceae	*Alcea*	***A. sachsachanica*Iljin**
Ranunculaceae	*Delphinium*	*D. brunonianum* Royle *(D. foetidum* Lomak.)
Rosaceae	*Amygdalus*	*Prunus fenzliana* Fristsh *(A. fenzliana*(Fritsch) Lipsky)
	Crataegus	***C.orientalis subsp. szovitsii* (Pojarkova) K.I.Chr. *(C. szovitsii*Pojark.)**
Scrophulariaceae	*Euphrasia*	*E. kurdica*Kem.-Nath.
	Linaria	*L. kurdica*Boiss& Hohen.
	Veronica	*V. intercedens*
Total: 15	**27**	**33**

The analyzed endemic, sub-endemic and endangered species described directly from these areas are among the rare species listed in the table and include 15 families, 27 genera, and 33 species. 12 species belonging to 10 families and 11 genera were described from the surrounding areas of Shusha. They were studied in more detail. The botanical data about these 12 species are limited. Some of them were published in foreign sources in 1837-1860. Their scientific names have been transferred into synonyms of other species several times. The nomenclature types of some species are unknown. This does not allow them to determine their status. We studied their fund and herbarium data and tried to specify their botanical descriptions, species, and places of distribution.

New information about the parameters of the occurrence of these species in nature does exist, which does not allow for regional estimating of the degree of their rarity (status). Their occurrence in nature is unknown. The categories (EX, CR, VU, EN, NT, LC, DD), criteria (A, B, C, D, E) and subcriteria (a, b, c, d), features (i, ii, iii, iv, v) of these crops should be specified with additional studies.

After obtaining this information, their position in natural conditions will be clarified, and measures for their protection will be developed. According to the requirements of the International Union for Conservation of Nature (IUCN, 2011), rare plants found in Shusha and surrounding areas are mainly classified as **CR-Critically endangered (CR-Critically endangered), EN-Endangered and susceptible to environmental factors (VU-vulnerable) categories**.

Data about 12 species described in Shusha are followings:

***Alliaceae* J.Agardh**

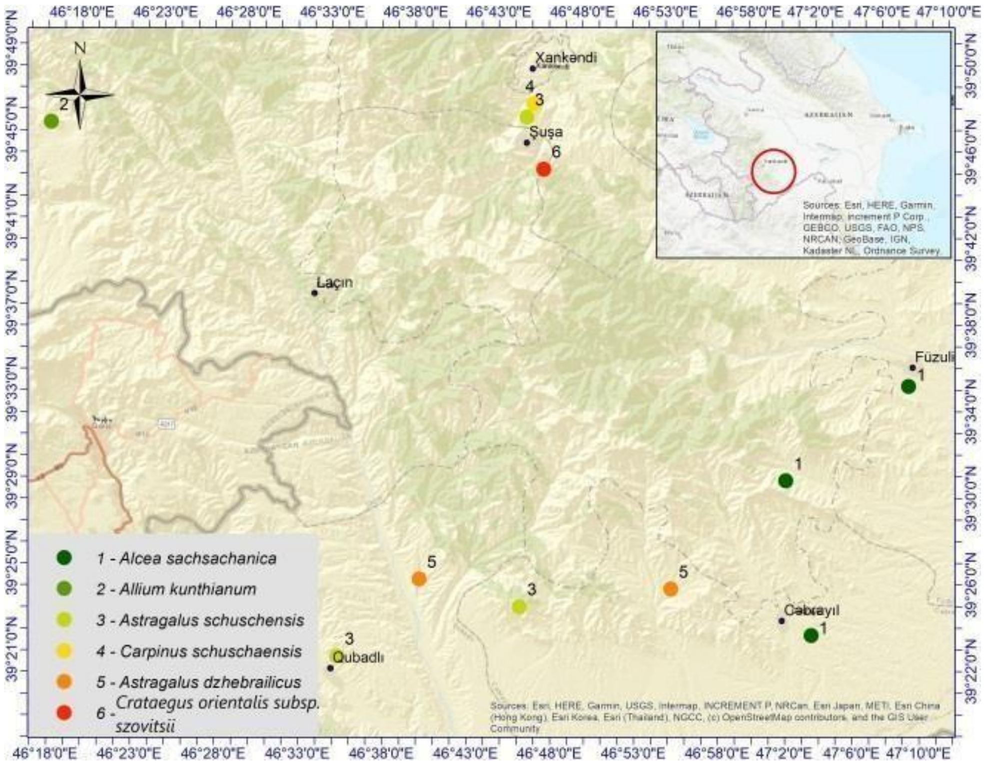
1. Kunt soğanı - *Allium kunthianum* Vved.

Bulb ovoid, 0.75-1.5 (2) cm thick. The stem is 5(10)-20(25) cm high, 1/2-1/3 is covered with leaves. Leaves 0.5-1 mm wide, semi-cylindrical in shape. The peduncle is unequal, shorter or 2-3 times longer than the flower.

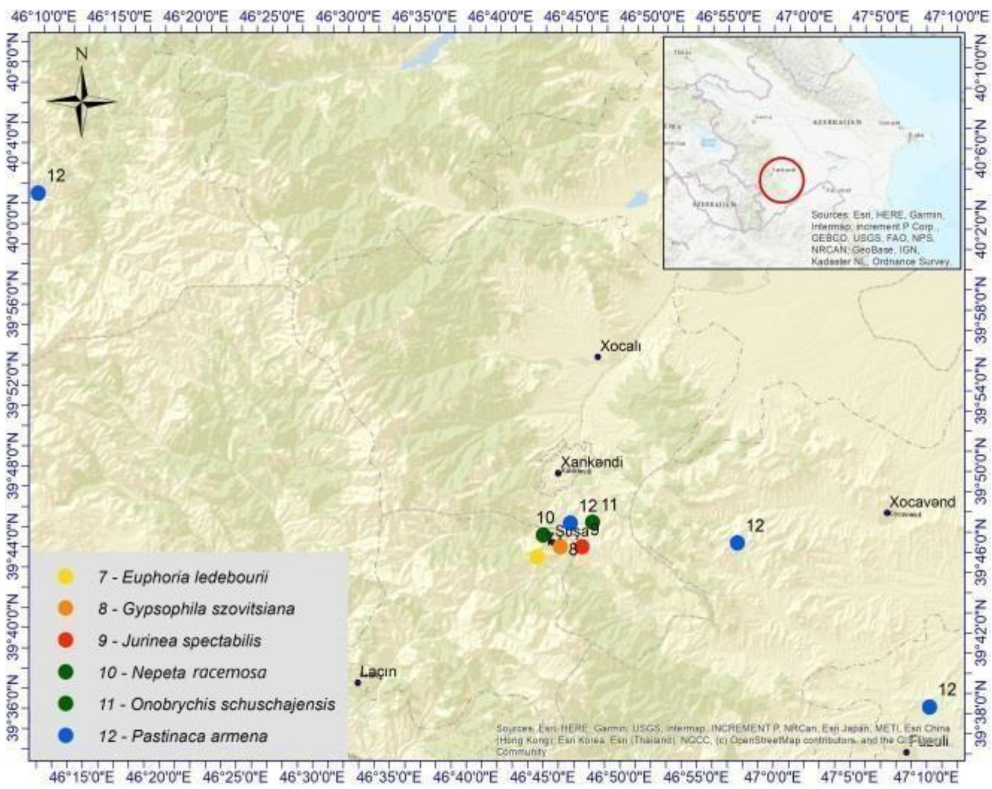
The herbarium specimen, on which basis the described species was collected in 1843 from the Sakhsaghan mountain near Shusha city. Lectotypus (Kudrjaschova, hoc loco, Кудряшова, 2001:128: «тип»): «Caucasus. Dipsui Schusch. Hohenacker» (LE! Cum 3 isolectotypi).

Herbarium specimens collected from Shusha and Kalbajar also exist (BAK). The local populations are known from some regions of the Caucasus and Turkiye, Iran (https://powo.science.kew.org/taxon/urn:lsid:ipni.org:names:528267-1), it is a rare species.

It is found in subalpine and alpine zones, mountain meadows and rocks. The blooming period is in August, and the bearing period is in September.



Map 1. Areas where endangered species are found in Shusha and surrounding areas



Map 2. Areas where endangered species are found in Shusha and surrounding areas

It is a sub-endemic plant in Azerbaijan. It is considered one of the wild ancestors of cultivated onions (Fig. 1, Map 1).

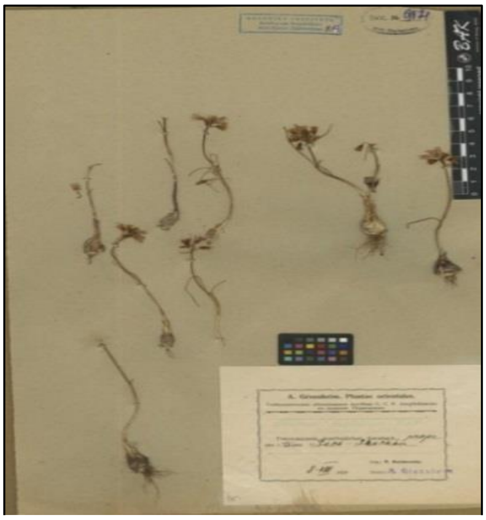


Fig. 1. *Allium kunthianum* Vved.

***Apiaceae* Lindl.**

2. Cənubi Qafqaz xımısı - *Pastinaca armena* Fisch. et C.A.Mey. ex Hohen.

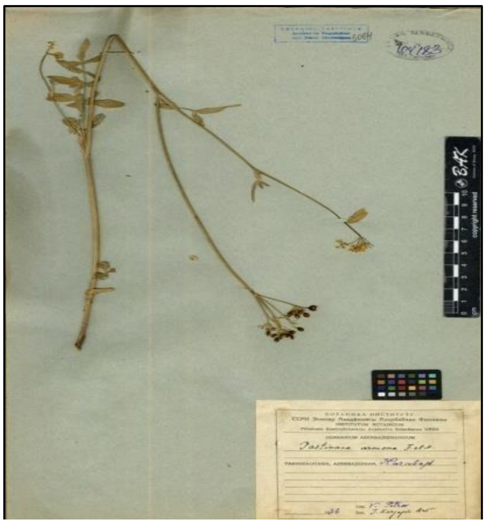


Fig. 2. *Pastinaca armena* Fisch. et C.A.Mey.

It is a perennial herb. The stem is erect, soft-hairy, branching, and culms (14) 30-50 (70) cm high. Root and lower stem leaves are petiolate, with 4-7 pairs of lateral segments; upper leaves are sessile. Petals are yellow, fruits are glabrous or slightly hairy, wide oval, (4)5-6 mm long, 4-5 mm wide.

Described from Shusha. (Sarial mountain) ("in pratis subalpinis montis Sarial"). It is found in subalpine and alpine meadows. Its isolated and small populations are found in Khojavand, Kalbajar and Fuzuli regions.

It is a valuable wild vegetable, spice, and medicinal sub-endemic plant of Azerbaijan (Fig. 2, Map 2). Also its found in Turkiye.

It is a perennial plant with a height of 20-40 cm. The leaves are toothed, and oval-shaped and have petioles. The inflorescence is a type of calathium, large, globular. The flowers are pink.

Described from Azerbaijan on the basis of Shusha and Ganja herbarium specimens. Lectotypus (Tscherneva, hoc loco): "In locis saxosis provinciae Karabagh, circa munimentum Schuscha, R. Hohenacker" (LE).

***Asteraceae* Dumort**

3. Gözəl yastıbaş - *Jurinea spectabilis* Fisch. et C.A.Mey. (*J.grossheimii* Sosn. 1934, in schedis)

Fig. 3. *Jurinea spectabilis* Fisch. et C.A.Mey.

The data about the existence of small populations of this species in other areas of the Lesser Caucasus, Asia, Iran (https://powo.science.kew.org/taxon/urn:lsid:ipni.org:names:845654-1) and in Nakhchivan were recorded.

It grows on rocky slopes in the middle mountain zone, blooms in July-August, bearing occurs in August.

It is a subendemic ornamental plant (Fig. 3, Map 2).

***Caryophyllaceae* Juss.**

4. Şovis çoğanı - *Gypsophila szovitsii* Fisch. et C.A.Mey. ex Fenzl, 1842, nom. illeg.

It is a perennial herb. The leaves are linear; the tip is needle-shaped. Petals are pink, oblong, and 1-2 times longer than the calyx. The pod is egg-shaped.

Lectotypus (Barkoudah, 1962:132): "In prov. Karabagh legit... Hohenacker (LE)."

The main areas of distribution are in Shusha and Ganja, there are also some small populations in Kura plain and Nakhchivan (Asgarov, 2016).

It grows on sandy, clayey slopes and rocks in plains and lower mountain belts.

It is a subendemic ornamental plant of Azerbaijan. (Fig. 4, Map 2).

It is not a short tree. Winged fruits are 5 cm long, sharp.

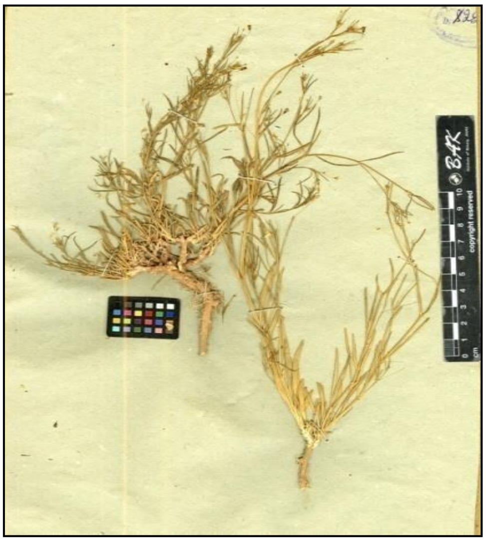


Fig. 4. *Gypsophila szovitsii* Fisch. et C.A.Mey. ex Fenzl

***Corylaceae* Mirb.**

5. Şuşa vələsi – *Carpinus schuschaensis* (*C. oxycarpa* H.J.P.Winkl.; *C. geokczaica* Radde-Fom.)

Lectotypus (Menitsky, hoc loco): "Prope castellum Schuscha, № 3462, Herb. K.Fr.Hohenacker" (LE; syntpi: B, LE (№№3443, 3455), G-BOIS, W).

In addition to Karabakh, the presence of small populations of the plant in the Greater Caucasus and the Lankaran district is recorded (Конспект флоры Кавказа, 2012).

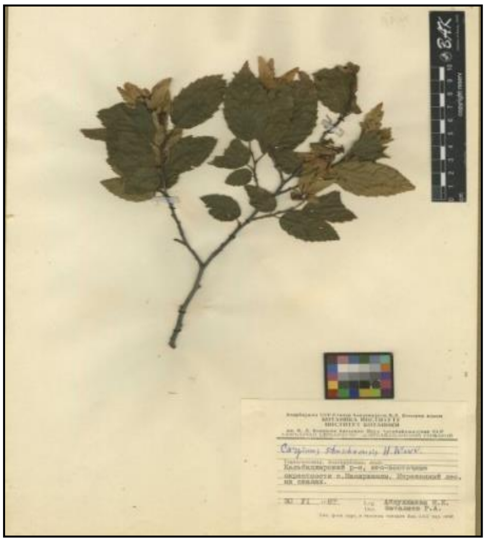


Fig. 5. *Carpinus schuschaensis* H. Winkl.

It is found in the forests of the lower-middle mountain belt.

This is an endemic and main forest-forming tree genus of Azerbaijan. (Figure 5, Map 1).

***Euphorbiaceae* Juss.**

6. Ledebur südləyən - *Euphorbia ledebourii* Boiss.

The plant is annual, glabrous, the leaf is linear, 2-4 cm long. The pod is ovoid, the seed is flat and eggshaped.

Described from Shusha. However, since there are no samples of this plant in the Azerbaijan herbarium, its lectotype was selected from samples of Ganja. Lectotypus (Гельтман, 2000:104): «In planitie territorii Elisabethopoleos, Flora Transcauc., 21 V 1844, No. 1445, Kolenati» (LE).

It grows on stony slopes of the lower mountain belt.

It is found around Shusha and Ganja.

This is a subendemic plant of Azerbaijan. It is rich in biologically active substances. There is little information about the state of its natural population (map 2). It is also found in Crimea and Turkey (Конспект флоры Кавказа (2012)).

***Fabaceae* Lindl.**

***7.* Şuşa gəvəni - *Astragalus schuschaensis* Grossh.**

It is a perennial grey hairy plant. The stem is 8-20 cm tall, the stalk is gray, sometimes with black hairs. Calyx toothed. The corolla is light yellow, and the upper part of the vexillum is slightly concave. Beans are white or black hairy (Grossheim, 1952).

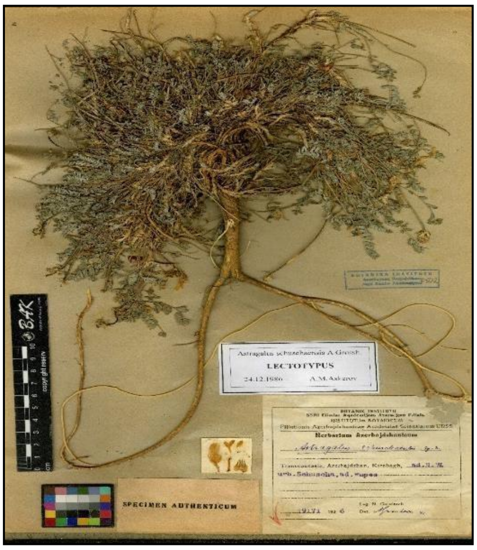


Fig. 6. *Astragalus schuschaensis* Grossh.

Typus: "Karabagh, ad N. W.urb. Schuscha, ad rupes, 19 VI 1936, N. Curvitsh" (BAK)

It was collected in the vicinity of Shusha - Sary-baba and Saksagan mountains.

It is found in the lower and middle belts of the mountains, on stony and gravelly slopes. Information about the places of natural distribution and the dynamics of the number of plants is limited. It is endemic to Azerbaijan. Its significance has been poorly studied. Close species have many biologically active substances, they are valuable fodder plants (Fig. 6, map 1).

8. Cəbrayıl gəvəni - *Astragalus dzhebrailicus* Grossh.

This is a perennial densely soft-hairy plant 10-20 cm high. The leaves consist of 12-16 leaflets. The corolla is light violet, and the upper part of the vexillum is round (Grossheim, 1952).

Typus: АзССР, «Южный Карабах, г. Тумаслу, 31 V 1935, Я. Исаев» (BAK).

In addition to Tumaslu mountain, it was also collected from the territory of Gubadli district ("promontorio m-tis Top - Agatsh").

It is found on gravel slopes of the lower belt of mountains, among xerophytic bushes. It is subendemic to Azerbaijan.

It is also found in East Turkiye and N.W.Iran (https://powo.science.kew.org/taxon/urn:lsid:ipni.org:names:477241-1). Its significance has been poorly studied. Close species have many biologically active substances, they are valuable fodder plants (Fig. 7, map 1).

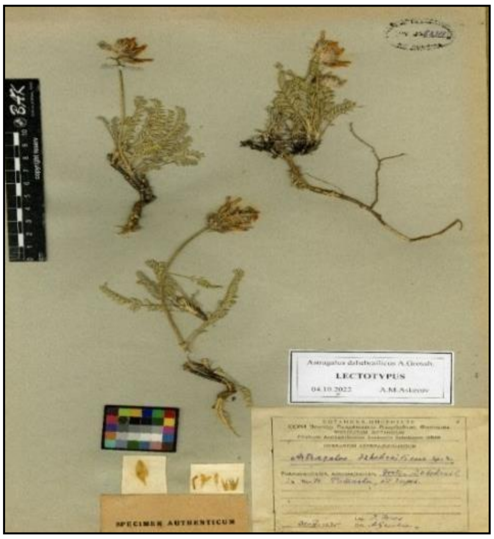


Fig. 7. *Astragalus dzhebrailicus* Grossh.

***9.* Şuşa xaşası - *Onobrychis schuschajensis* Agaeva 1967.**

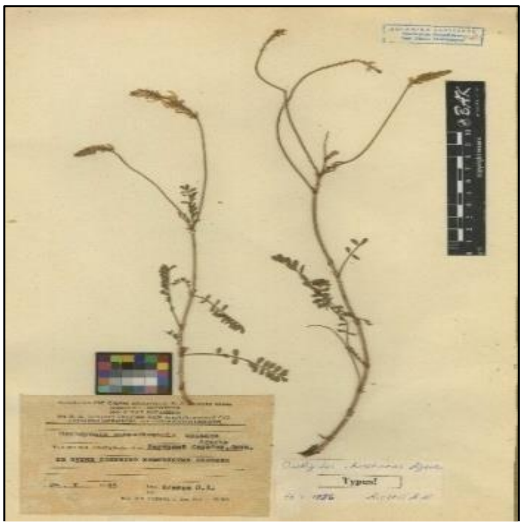


Fig. 8. *Onobrychis schuschajensis* Agaeva

Perennial 20-50 cm tall, corollais white, densely hairy.

Described from the surroundings of Shusha Type: (А.М.Аскеров). Karabakh, Shusha, on dry clayey and stony slopes. 24.05.1965 Leg. Агаева О.Д. (BAK!); Isotypus (А.М.Аскеров, 16.12.1986). Karabakh, Shusha, on dry clayey and stony slopes. 24.05.1965 Leg. Агаева О.Д. (BAK!).

It has not been collected since 1965, when the plant was described. The type was collected by the author only from one place; Shusha, suburb of Karabakh (2 samples).

It is found on dry gravel slopes.

It is endemic to Azerbaijan and is considered the ancestor of cultivated varieties of sainfoin (Fig. 8, map 2).

***Lamiaceae* Lindl.**

10. Cənubi Qafqaz pişiknanəsi - *Nepeta racemosa* Lam. (*N. mussinii* Spreng.; N. *transcaucasica* Grossh.)

Described from the surroundings of Shusha, the type is unknown.

Small populations are available in Khojavend, Kelbajar, Lachin and Zangilan districts.

It is found on arid slopes and arid, stony and gravelly slopes from the subalpine belt to the mountain belt.

Fig. 9. *Nepeta racemosa*Lam.

This is a subendemic and valuable medicinal plant of Azerbaijan. This species was also found in Turkiye and N.W.Iran (https://powo.science.kew.org/taxon/urn:lsid:ipni.org:names:452683-1).

The status of this species needs clarification. This species is considered a synonym of *N. racemosa* Lam. species in some sources (WFO). the Caucasian researcher of this genus Yu.L. Menitsky recognized this species as independent (1992) (Fig. 9, Map 2).

***Malvaceae* Juss.**

11. Saxsağan gülxətmisi – *Alcea sachsachanica* Iljin.

This is a perennial herbal plant. The stems are 50-70 cm high. The leaves are star-shaped and short-hairy. The leaf blade is similar to the leaf blade of a fig, heart-shaped at the base. The flowers are densely hairy; the epicalyx is shorter than the calyx by almost twice. The corolla is yellow.

Typus: Transcaucasia, Azerbajdzhan, Karabach, propemontem Sach-Sachan. 8 VIII 1929, legit A.Kolakovsky (LE).

Distribution areas are Shusha surroundings - Sakhsagan mountain, Cidir plain, Khankendi, it is uncommon in Domu village of Khojavand district and East Zangezur.

It is found on dry stony slopes, in various grass and cereal, and mountain-xerophyte groups of the middle mountain belt. It is a drought-resistant heliophyte plant.

It is endemic to Azerbaijan, a valuable medicinal and ornamental plant (Fig. 10, Map 1).

Fig. 10. *Alcea sachsachanica* Iljin.

Rosaceae **Juss.**

12. Şovits yemişanı – *Crataegus orientalis subsp. szovitsii (*Pojarkova) K.I.Chr. *(Crataegus szovitsii* Pojark.)

It is a small tree or shrub. The cortex is brown-grey. The leaves are five-lobed, and the petiole is short. The corolla is white; the fruit is 12-15 mm in diameter.

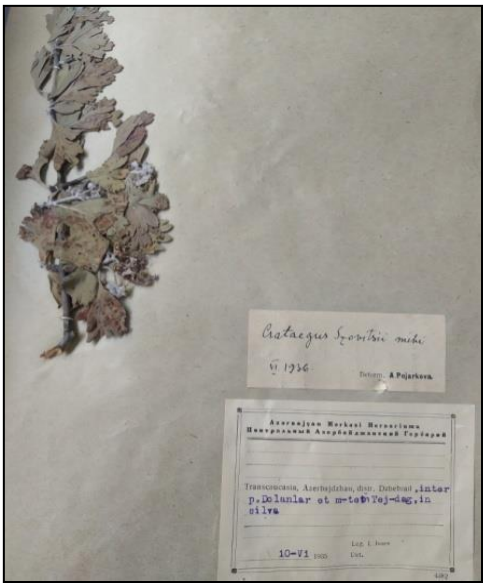


Fig.11. *Crataegus orientalis subsp. szovitsii (*Pojarkova) K.I.Chr.

Lectotypus: Karabagh orientalis, in collibus prope Schuscha, Hohenacker, n^0 3423, fl.; (LE).

It is also found in Khojavend, Hadrut, Shusha, Jabrail and Turkiye, Iran (https://powo.science.kew.org/taxon/urn:lsid:ipni.org:names:967723-1).

It is found in the mid-mountain zone, rocky slopes, and bushes. This is a subendemic, valuable medicinal and food plant of Azerbaijan (Fig. 11, map 1).

At present, large-scale restoration and construction work is conducted in Shusha and its surroundings. We hope that in the near future, along with these works, security measures will be completed, we will be able to organize long-term floristic expeditions to Karabakh, and will study in detail the rare plants in this area and start compiling the Red Book of Karabakh.

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https://powo.science.kew.org/taxon/urn:lsid:ipni.org:names:477241-1

https://powo.science.kew.org/taxon/urn:lsid:ip

ni.org:names:452683-1 **ni.org:names:967723-1**
https://powo.science.kew.org/taxon/urn:lsid:ip

Şuşa və Şuşaətrafı ərazilərdə itmək təhlükəsində olan ali bitkilər

Əsgərov Aydın Musa oğlu

Azərbaycan Respublikası Elm və Təhsil Nazirliyinin Botanika İnstitutu, Bakı, Azərbaycan

Məqalədə Şuşa və Şuşaətrafı ərazilərdə itmək təhlükəsində olan ali bitkilər haqqında məlumat verilir. Müəyyən edilir ki, Qarabağ və Şərqi Zəngəzur iqtisadi rayonlarında müxtəlif kateqoriyalardan olan 233 nadir ali bitki növünə rast gəlinir, bunlar da yaxın gələcəkdə yazılacaq "Qarabağın Qırmızı kitabı"na daxil edilə bilər. Bunlardan Şuşa və Şuşaətrafı ərazilərdə rast gəlinən endem, subendem və nadir bitkilər 59 növdür (28 fəsilə və 49 cins). Bu növlərdən də 33-ü (15 fəsilə, 27 cins) Şuşa və Şuşa ətrafından təsvir olunmuşdur (bilavasitə Şuşa şəhəri ərazisindən təsvir olunanlar 12 növdür (10 fəsilə, 11 cins)). Məqalədə həmin 12 növün xarakteristikası (prioritet adı, morfoloji səciyyəsi, nomenklatur tipi, yayılması, ekoloji xüsusiyyətləri və əhəmiyyəti) verilir.

Açar sözlər: *Azərbaycan, Qarabağ, Şuşa, flora, mühafizə*

Высшие растения Шушы и ее окрестностей, находящиеся под угрозой исчезновения

Аскеров Айдын Муса оглу

Институт ботаники Министерства науки и образования Азербайджанской Республики, Баку, Азербайджан

В статье сообщается о видах высших растений города Шуша и ее окрестностей, находящихся на грани исчезновения. Было установлено, что на территории Карабахского и Восточно-Зангезурского экономических районов встречаются 233 редких вида высших растений различной категории редкости. Рекомендуется включить их в «Красную книгу Карабаха», составление которой намечается в ближайшее время. Из указанных 233 видов 56 (28 семейств и 49 родов) находятся на территории Шушы и ее окрестностях. Они также являются эндемами, субэндемами и редкими видами. Из числа этих же видов 33 вида (15 семейств из 27 родов) были описаны, как новые для науки. 12 из этих видов (10 семейств и 11 родов) произрастают непосредственно в Шуше. В статье приведены данные по морфологии, экологических особенностях, номенклатурному типу и значению этих видов.

Ключевые слова: *Азербайджан, Карабах, Шуша, флора, охрана*

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About the reptiles of the Karabakh territories liberated from occupation and their habitats

Eyvazov Aladdin Ismet, *Iskenderov Tavakkul Mukhtar, Gasimova Gulbeniz Hafiz

Institute of Zoology, Ministry of Science and Education of the Republic of Azerbaijan,
115 A.Abbaszade Str., 1128 Pass., 504 Quar., Baku AZ 1004, Azerbaijan

***For correspondence:** iskenderov52m@mail.ru*

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The presented article provides information about the reptiles (Reptilia) of Karabakh and the ecological changes that occurred in their habitats during the occupation. 37 species of reptiles are distributed in Karabakh. Of the reptiles, there are 3 species of turtles (Testudines), 19 species of lizards (Sauria) and 15 species of snakes (Serpentes). In Karabakh, reptiles are mainly distributed in the semi-desert, dry-steppe, xerophyte-steppe, forest-shrub landscapes (200-1500 m above sea level) of the plains, low and medium highlands. Reptiles are rarely found in subalpine and alpine meadows of the highlands (1900-3000 m above sea level), and in forest and meadow-shrub landscapes of the middle highlands (700-1500 m above sea level). In the Karabakh territories, which were subjected to looting and the destructive effects of war factors (I and II Karabakh wars) for a long time, fauna species, including the habitats of reptiles, have undergone quality changes. Densely populated settlements with intensive human activity (city, village, settlement, etc.), which are anthropogenic biotopes, are unfavorable for most reptile species. However, the natural landscape was restored in the ruins of uninhabited and destroyed cities and villages during the occupation period, and natural biotopes suitable for reptiles were created. In these biotopes, where there is no human presence, there are food resources that are important for the settlement of reptiles and shelters (ruins) suitable for hiding, laying eggs, and wintering. The creation of suitable habitat for reptiles in the ruined areas of the liberated Agdam, Fuzuli, Jabrayil, Zangilan and Gubadli regions of Karabakh has led to the dense settlement of reptiles in these areas. The widespread reptile species of these areas are dominated by snakes, especially the Levantine viper, which is a venomous species of snake. In the periods of high activity of reptiles (spring-summer months), there are more cases of encounters with these snakes, and it is appropriate to consider this factor from the point of view of the safety of people working in the areas.

***Keywords**: Occupation, reptiles, habitats, ruins, settlement*

INTRODUCTION

Karabakh is one of the geographical areas of Azerbaijan rich in reptiles (Reptilia). The role of reptiles is important for the stability of fauna diversity in ecosystems. They are included in the feed ration of birds of prey and mammals, and at the same time, they participate in the regulation of the number balance of these species by feeding on small mammals (rodents), birds and chicks, and various invertebrates. Reptiles also benefit crops and agriculture by eating and destroying pests and rodents. In this respect, they are also useful for forest protection, agriculture and horticulture. Therefore, the complications that occur in the reptile fauna do not go unnoticed for both nature and the population.

The territories of Karabakh were subjected to Armenian occupation for nearly 30 years, cities and villages were looted and turned into ruins, and were subjected to the destructive effects of war factors (I and II Karabakh wars).

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Undoubtedly, all this has led to the diversity of fauna, including species of reptiles, qualitative changes in their habitats (vegetation, fauna composition, relief, calmness factors, etc.). Considering that reptiles are more sensitive representatives of the fauna to changes in the quality of their habitat, occupation factors are expected to have a greater impact on this fauna.

RESULTS AND DISCUSSION

The study of the available literature shows that 37 species of reptiles are distributed in the plains, foothills, mountainous areas and forests of Karabakh (Alekperov, 1978; Alekperov, 1982; Jafarova, 1984; Jafarova et al., 2014; Taxonomic spectrum of Azerbaijani fauna (Vertebrates, 2020). This is 58.7% of the reptile fauna of Azerbaijan (63 species). Among the reptiles, 3 species of turtles, 19 species of lizards and 15 species of snakes are common. In Karabakh, reptiles are mainly distributed in the semi-desert, dry-steppe, xerophyte-steppe, forest-shrub landscapes (200-1500 m above sea level) of the plains, low and medium highlands. In the subalpine and alpine meadows of the high highlands (1900-3000 m above sea level), in the forest and meadow-shrub landscapes of the middle highlands (700-1500 m above sea level), reptiles are rarely found (striped lizard - *Lacerta strigata*, true grass-snake - *Natrix tessellata*, *Natrix natrix* - ordinary grass snake, *Coronella austriaca* - common brown snake, South Caucasian rattlesnake - *Zamenis hohenackeri*).

3 species of reptiles (*Lacerta strigata, Natrix tessellata, Natrix natrix*) are found in all landscapes. Levantine viper (*Macrovipera lebetina obtusa* Dwigubsky, 1832), a poisonous snake dangerous for human life and agricultural animals, is widespread in the plains, foothills and mountainous arid areas of Karabakh (Aghdam, Fuzuli, Jabrayil, Zangilan, Gubadli). In the steppe-xerophytic and xerophytic mountainous areas of Karabakh (Kalbajar plains), another poisonous snake species belonging to the shield viper (*Vipera/Pelias*) - the Yerevan viper (V.*eriwanensis* Reuss, 1933) is also likely to spread (Alekperov, 1982). During the Soviet period, hundreds of Levantine vipers were hunted every year from the arid areas of the plains and foothills of Karabakh and used for the production of snake venom (Isgandarov, 2013, 2016). This supply was important for density regulation in viper snake populations in those areas.

6 species from the reptile fauna of Karabakh (Mediterranean tortoise - *Testudo graeca*, desert agama - *Trapelus ruderatus*, Asian naked eye - *Ablepharus pannonicus*, common brown snake - *Coronella austriaca*, Urartian elaphe - *Elaphe urartica* (=*Elaphe sauromates*) and South Caucasian elaphe - *Zamenis hohenac*keri) Included in the "Red Book" of the Republic of Azerbaijan (2013). Mediterranean turtle - *Testudo graeca* vulnerable (VU), Rostombeyov's lizard - *Darevskia rostmbekovi* are included in the "Red List" of the International Union for Conservation of Nature (IUCN) with the status of critically endangered (CR) species. Testudo graeca is also included in the list of species prohibited from international trade (CITES). Among the snakes, *Zamenis hohenackeri* and *Elaphe urartica* are endemic species of the Caucasus.

Reptiles are representatives of the fauna that are more sensitive to quality changes and pollution of the habitat. Degradation of habitat quality (disruption of natural vegetation, reduction of fauna composition, influence of anthropogenic factors, etc.) weakens and gradually destroys reptile populations. The elimination of anthropogenic impacts on the habitat and the restoration of a natural landscape favorable for reptiles strengthens the reptile population.

The monitoring carried out in the liberated areas of Eastern Zangezur (Fuzuli, Zangilan, Jabrayil and Gubadli) showed that biotopes suitable for reptiles were created in the place of ruined settlements (Figure).

Deterioration of the quality of habitats is mainly related to the human factor and occurs as a result of the transformation of natural areas into agrocenoses and anthropogenic biotopes (residences, fields and gardens). In agrocenoses and anthropogenic biotopes, the habitat conditions of reptiles only deteriorate, they are destroyed by people because of negative attitudes. Therefore, reptiles move away from such biotopes (cities, settlements, villages, gardens, fields, etc.) and settle more in areas with less anthropogenic load and human presence. Although the species of reptiles were mainly distributed in natural landscapes in the pre-occupation period, the biotope landscape was different in the post-occupation period, and the transformation of anthropogenic biotopes (city, town, village, etc.) into "natural" biotopes (ruins) during the occupation period changed the nature and range of the habitat of reptiles, including snakes.

Fig. Ruined settlements and restored natural landscape (grassy thickets) in liberated Fuzuli region, September 2022. Photo: G. Gasimova; *Levantine viper* (*Macrovipera lebetina obtusa* Dw.,1832). Photo: T.Iskenderov

During the period of occupation, information on Armenians' hostile attitude towards natural ecosystems, especially forests and rivers (deforestation, pollution of rivers, looting of natural resources, etc.), serious damage to nature, diversity of flora and fauna, destruction of territories and turning them into ruins were widely reported in the local press. It is known that in the absence of human presence and activity, a disturbed natural landscape or biotope (vegetation and fauna) gradually recovers itself. Therefore, during the occupation of Karabakh, natural biotopes recovered in these ruins without human presence and activity. In the areas of Agdam, Fuzuli, Jabrayil, Zangilan and Gubadli regions that were freed from occupation, over time, densely populated areas and intensive economic activity, the characteristic vegetation (grass and bushes) of the natural landscape (semi-desert and steppe) has been restored, followed by the characteristic fauna composition (small mammals, birds, lizards, etc.) formed, endless ruins turned into "snakes crawling" deserts. In these restored natural biotopes, small mammal fauna (Mammalia) belonging to the groups *Insectivora* and Rodents - *Rodentia*, which are the feeding objects of reptiles, ground feeders belonging to the groups *Galliformes*, *Columbiformes* and *Passeriformes* of the bird fauna (*Aves*) and species that nest on the ground, in bushes, on rocks, and on roofs are settled. Countless building ruins in the area are convenient shelters for reptiles to hide, lay eggs and hibernate. All these are biotic and abiotic factors that determine the dense settlement of reptiles in areas freed from invasion. Therefore, in the liberated territories of Karabakh (ruins and adjacent territories), a high density of reptiles, including snakes, is observed.

On the other hand, the influence of war factors (I and II Karabakh wars) on the nature of the distribution of reptiles in the territories freed from occupation should also be taken into account. During the active periods of the wars, the destruction caused by artillery, aviation and tank fires on the ground, and countless large and small defense fortifications and trenches, which were built, damaged the relief of the area. This type of terrain damage has a negative impact on populations by making it difficult for reptiles with limited mobility to move biotopes during feeding, breeding and wintering periods. As a result of the impact of such disturbing war factors, the reptiles were forced into the areas where these effects are less - the ruined areas, and the settlement in the ruined areas increased.

Thus, a dense population of reptiles can be observed in the liberated areas of Karabakh, especially in the ruined areas of Agdam, Fuzuli, Jabrayil, Zangilan and Gubadli regions. Among the widespread reptiles of these areas, snakes predominate, especially the Levantine viper, a species of venomous snake. During the periods when reptiles are more active (spring-summer months), there are more cases of encounters with snakes, and it is reasonable to consider this factor in terms of the safety of people working in the areas.

INNOVATIONS

In the studies, the species diversity of the reptile fauna in the Karabakh territories freed from occupation, the influence of biotic and abiotic factors related to occupation and war factors on the habitat of reptiles, the nature of distribution and settlement in the area were analyzed from an ecological aspect. Self-restoration of natural biotopes in settlements that were freed from occupation and turned into ruins, the absence of the human factor created conditions for the dense population of reptiles, including snakes, in these areas. It is appropriate to consider the results of this study from the point of view of the safety of the people working in the construction stage in the occupied territories and the population during the "great return"

CONCLUSION

1. There are 37 species of reptiles in the liberated territories of Karabakh. 3 species of them are turtles, 19 species of lizards and 15 species of snakes. 6 species of reptiles common in the territories of Karabakh were included in the "Red Book" of the Republic of Azerbaijan (2013).
2. In Karabakh, reptiles are mainly distributed in lowland, semi-desert, dry steppes, as well as xerophyte-steppe, forest-shrub landscapes(200-1500 m above sea level). Reptile species are mostly settled in the territories of Agdam, Fuzuli, Jabrayil, Zangilan and Gubadli regions.
3. The lack of human presence and activity in the territories of Karabakh, which were reduced to ruins as a result of the occupation for many years led to the restoration of natural steppe and semi-desert biotopes (characteristic plant cover - grass and bushes, characteristic fauna - small mammals, birds, lizards, etc.) and so caused the dense population of reptiles in those areas.

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İşğaldan azad edilmiş qarabağ ərazilərinin sürünənləri (*Reptilia*) və onların yaşayış yerləri barədə

Eyvazov Ələddin İsmət oğlu, İsgəndərov Təvəkkül Muxtar oğlu, Qasımova Gülbəniz Hafiz qızı

Azərbaycan Respublikası Elm və Təhsil Nazirliyinin Zoologiya İnstitutu, Bakı, Azərbaycan

Təqdim olunan məqalədə Qarabağın sürünənləri (*Reptilia*) və işğal dövründə onların yaşayış yerlərində baş verən ekoloji dəyişiliklər barədə məlumat verilir. Qarabağ ərazilərində 37 növ sürünən yayılmışdır. Sürünənlərdən 3 növ tısbağalar (Testudines), 19 növ kərtənkələlər (*Sauria*) və 15 növ ilanlardır (*Serpentes*). Qarabağda reptililər əsasən düzənliklərin, alçaq və orta dağlığın yarımsəhra, quru-bozqır, kserofit-bozqır, meşə-kol landşaftlarında (d.s.h. 200-1500 m) yayılıb. Yüksək dağlığın subalp və alp çəmənliklərində (d.s.h. 1900-3000 m), orta dağlığın meşə və çəmən-kol landşaftlarında (d.s.h. 700-1500 m) sürünənlərə az rast gəlinir. Uzun müddət işğal altında qalaraq talançılığa və müharibə amillərinin (I və II Qarabağ müharibələri) dağıdıcı təsirlərinə məruz qalmış Qarabağ ərazilərində fauna növlərinin, o cümlədən sürünənlərin yaşayış yerlərinin keyfiyyət dəyişilmələri baş vermişdir. İşğal dövründə insan yaşamayan, viran edilmiş şəhər və kəndlərin xarabalıqlarında təbii landşaft bərpa olmuş, sürünənlər üçün əlverişli təbii biotoplar yaranmışdır. İnsan iştirakı olmayan bu biotoplarda, sürünənlərin məskunlaşması üçün vacib olan yem resursları və gizlənmək, yumurta qoymaq, qışlamaq üçün yararlı sığınacaqlar (xarabalıqlar) vardır. Qarabağın işğaldan azad edlmiş Ağdam, Füzuli, Cəbrayıl, Zəngilan və Qubadlı rayonlarının xarabalığa çevrilmiş ərazilərində sürünənlər üçün əlverişli yaşayış mühitinin yaranması bu ərazilərdə sürünənlərin sıx məskunlaşmasına səbəb olmuşdur. Geniş yayılmış sürünən növləri arasında ilanlar, xüsusən zəhərli ilan növü olan Levantin gürzəsi üstünlük təşkil edir. Sürünənlərin yüksək fəallıq dövrlərində (yaz-yay ayları) ilanlarla rastlaşma hallarına daha çox rast gəlinir və bu amilin ərazilərdə çalışan insanların təhlükəsizliyi baxımından nəzərə alınması məqsədəuyğundur.

Açar sözlər*: İşğal, sürünənlər, yaşayış yerləri, xarabalıqlar, məskunlaşma*

О рептилиях (*Reptilia*) и их местообитаниях на освобожденных от оккупации территориях Карабаха

Эйвазов Аладдин Гисмет оглу, Искендеров Таваккюл Мухтар оглу, Гасимова Гюлбениз Афиз гызы

Институт зологии Министерства науки и образования Азербайджанской Республики, Баку, Азербайджан

В статье представлена информация о пресмыкающихся (*Reptilia*) Карабаха и экологических изменениях, произошедших в местах их обитания во время оккупации. На территории Карабаха распространено 37 видов пресмыкающихся: 3 вида черепах (*Testudines*), 19 видов ящериц (*Sauria*) и 15 видов змей (*Serpentes*). В Карабахе рептилии в основном, распространены в полупустынных, сухостепных, ксерофитно-степных, лесокустарниковых ландшафтах (200-1500 м над ур. м.) равнин, низких, средних и высоких гор. Рептилии редко встречаются на субальпийских и альпийских лугах высокогорий (1900-3000 м над уровнем моря), а также в лесных и лугово-кустарниковых ландшафтах среднегорья (700-1500 м над уровнем моря). На карабахских территориях, подвергшихся разграблению и разрушительному воздействию военных факторов (I и II Карабахские войны), в течение длительного времени местообитания видов фауны, в том числе рептилий, претерпели качественные изменения. Населенные пункты с большой плотностью населения и интенсивной деятельностью человека (город, деревня, поселок и др.) являются антропогенными биотопами, и неблагоприятны для большинства видов рептилий. Однако на руинах необитаемых и разрушенных в период оккупации городов и сел в настоящее время восстановлен природный ландшафт, созданы естественные биотопы, пригодные для рептилий. В этих биотопах, где нет человека, есть пищевые ресурсы, важные для расселения рептилий, и убежища (руины), пригодные для укрытия, откладывания яиц и зимовки. Создание подходящей среды обитания для рептилий на разрушенных территориях освобожденных Агдамского, Физулинского, Джебраильского, Зангиланского и Губадлинского районов Карабаха привело к плотному их расселению в этих районах. Среди широко распространенных видов рептилий в этих районах преобладают змеи, особенно левантийская гадюка, которая относится к ядовитым видам змей. В периоды высокой активности пресмыкающихся (весенне-летние месяцы) случаев встреч с этими змеями больше, и этот фактор целесообразно учитывать с точки зрения безопасности людей, работающих на участках.

Ключевые слова: *Оккупация, рептилии, местообитание, руины, поселение*

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Assessment of modern radioecological situation in Aghdam, Lachin and Kalbajar districts

[1*] Aliyev Chingiz Said, [2] Humbatov Famil Yusif, [1] Mahmudova Farah Fuad, [1] Aliyeva Aziza Rafik, [1] Karimli Khayal Mardan

[1] Institute of Geology and Geophysics, Ministry of Science and Educataion of the Republic of Azerbaijan, 119 Huseyn Javid Ave., Baku AZ1143, Azerbaijan
[2] Institute of Radiation Problems, Ministry of Science and Educataion of the Republic of Azerbaijan, 9 BakhtiyarVahabzadeh Str., Baku AZ1143, Azerbaijan

***For correspondence:** aliyev.chingiz47@gmail.com*

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The article presents the typical results of investigations carried out for assessment of the modern radioecological situation in liberated territories of the Aghdam, Lachin and Kalbajar districts. Earlier studies have shown that the radioactivity of rocks in Karabakh varies depending on the composition and age of lithological-stratigraphic intervals. In general, the gamma activity of rocks in this area does not exceed the background significance characteristic of structural complexes of different ages of the Lesser Caucasus. During radioecological monitoring in the studied area, the measurement of the strength of the exposure dose of gamma radiation was carried out by the IndetiFINDER-2 dosimeter-spectrometer, and the strength of the ambient equivalent dose was carried out by the portable dosimeter-radiometer of МКС-АТ1125. As a result of the conducted studies, it was found that the radiation background in Aghdam and Lachin regions is within the norm, and only in soil samples taken from Istisu settlement of the Kalbajar region, the average value of the dose absorbed in the air (D), external hazard index (Hex) and the annual effective dose equivalent (AEDE) were higher than the limit values.

Keywords: *Karabakh, natural radioactivity, gamma radiation, liberated territories, radioecological pollution, strength of exposure dose of radiation*

INTRODUCTION

Maintaining a balanced ecosystem is one of the most important and urgent problems of the XXI century, which includes the problems of reducing the anthropogenic impact on ecosystems as much as possible and protecting the environment against global environmental disasters. Studying radioactive areas in the Earth's crust has particular importance in solving these problems.

As it is known, as a result of the occupation of Azerbaijani lands by Armenia for 30 years, various man-made activities and combat operations in these territories have caused serious damage to the environment. Also during those years, in the investigations devoted to the study of the radiation background in the territory of the republic, the occupied territories were left out for obvious reasons, and old data were used on the compiled maps, which creates the need for new radiometric studies in these territories.

Earlier studies have shown that the radioactivity of rocks in Karabakh varies depending on the composition and age of lithological-stratigraphic intervals. In general, the gamma activity of rocks in this area does not exceed the background significance characteristic of structural complexes of different ages of the Lesser Caucasus (Алиев и др., 2004; Алиев, 2005). The Jurassic structural complex, which forms the main part of the geological section in the Lokh-Karabakh zone, is represented by

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terrigenous-tufogenic sections in the lower part of the section, volcanogenic - sedimentary sections in the middle part, and volcanogenic-sedimentary and carbonate facies in the upper part.

Various structural and material complexes of chalk are also widely represented in the lower mountainous and north-eastern slopes of the Murovdag and Karabakh ranges (Lok-Karabakh zone, Gazakh-Agburun and Khachinchay-Khojavand structure), as well as in the basins of Hakari and other left tributaries of the Araz River (Gafan zone). In general, for Cretaceous rocks, indicators of natural radioactivity vary within the limits of 4,5-7,5 μR/h. In the Eocene-Miocene-Golocene volcanogenic complex of the Kalbajar zone, natural radioactivity varies within 5-7 μR/h, and in some areas of Eocene rocks, it reaches 8-9 μR/h or more.

The main purpose of the research work was the assessment of the modern radioecological situation in the liberated Karabakh territories, the identification of sources of danger and the determination of radionuclide content of samples taken from the areas with high levels of radioactivity.

METHODS AND DEVICES

During radioecological monitoring in the studied area, the measurement of the strength of the exposure dose of gamma radiation was carried out by the IndetiFINDER-2 dosimeter-spectrometer, and the strength of the ambient equivalent dose was carried out by the portable dosimeter-radiometer of МКС-АТ1125 (Fig. 1).

The measurement works were carried out taking into account the requirements of the standard operating theory. Gamma spectrometric analysis of the taken soil samples was carried out in the laboratory. Gamma spectrometer complex with sensitive semiconductor detector based on high - purity Ge-crystal manufactured by “CANBERRA” company and scintillation spectrometer СЕГ-001 “АКП-С”-150 were used during the research works in the laboratory. Samples were prepared for measurement using standard operating procedures based on the ASTM c1402-04 (2009) method and the determination of radionuclides in soil samples was carried out. During preparation, after removing stone and plant residues, soil samples were dried at room temperature, ground and passed through a 1 mm sieve and homogenized.

Fig. 1. Measurement devices

Samples were placed in 100 cm^3 plastic containers, sealed with silicone glue and stored for four weeks to achieve radioactive equilibrium.

Before the analysis of the samples, quality assurance and quality control procedures were carried out. For this, the spectrum of the standard source (Na22, Eu155mix) and the background spectrum of the measuring camera were used.

The spectra were analyzed by using the GENIE 2000 program. The specific activity of ^{226}Ra and ^{232}Th was determined from their decomposition products on the basis of ^{214}Bi (609 keV) and ^{228}Ac (911 keV), respectively. The measurement time of samples was 86400 seconds (24 hours) (Humbatov et al, 2016; Humbatov et al, 2017).

RESULTS AND DISCUSSION

During the studies in Aghdam Region, in 18 points measurements were made, samples were selected and taken from 10 points (Table 1). Samples were taken mainly from arable land and near water sources.

Table 1. Preliminary results of radio ecological research conducted in the Aghdam region

Region	R (nSv/h)	A_{eff} (Bq/kg)	U (Bq/kg)	Th (Bq/kg)	K (Bq/kg)
Sarıjali	53	68.6	14.2	19.8	335
Giyasli	66	82.5	20	24.3	362
Temoyut	60	98.8	22.3	28.9	455
Kengerli	44	85.4	16.7	25.6	414
Papravend	36	79.6	17.7	18.7	441
Boyehvendli	70	93.8	20.8	29.4	406
Magsudlu	63	84.5	18.3	25.3	390
Gervend	60	64.4	12.3	19.8	309
Eyvazchanbeyli	70	95.6	23.9	28.2	410
Khidirli	61	81.2	14.1	20	481

Table 2. Preliminary results of radio ecological research conducted in the Lachin region

Region	R (nSv/h)	A_{eff} (Bq/kg)	U (Bq/kg)	Th (Bq/kg)	K (Bq/kg)
Dashlı №5	50	87.8	19.4	23.3	446
Lachın №3	40	39.7	6.3	11	224
Lachın №6	54	64.2	12.3	19.3	313
Lachin №7	60	70.2	14.7	17.5	383
Lachin №2	40	32.2	4.6	6.51	224
Lachin №8	56	58.9	9.18	17.2	320
Lachin Erdeshevi	30	25.3	6.97	6.46	116
Lolabaghırlı	50	10.7	3.44	2.63	45.5
Lachin №9	60	65.6	10.8	16.2	395

Table 3. Preliminary results of radioecological research conducted in the Kalbajar region

Region	R (nSv/h)	A_{eff} (Bq/kg)	U (Bq/kg)	Th (Bq/kg)	K (Bq/kg)
Istisu	500-530	927	845	38	376
Istisu 2	115	176	77.22	33.3	651
Zallar	55	35.9	9.41	9.48	165
Chopurlu	42	34.2	8.41	8.54	171
Kalbajar	65	121	26.1	35.1	581
Zulfugarli	27	24.4	5.62	6.89	114
Kalbajar №3	38	80	19.4	24.6	335
Kalbajar №4	114	58.8	12.6	12.1	357
Kalbajar №5	79	106	26.6	26.5	527

Table 4. Parameters for assessment of r diological risk in Istisu

	Cra, Bq/kg	CTh, Bq/kg	Ck, Bq/kg	Raeq, Bq/kg	D, nGy/h	Hex	AEDE, SV	AGDE, µSv/year
Istisu 1	511	44	398	601.78	279.374	1.63371	342624.3	1887.882
Istisu 2	64.8	27.5	546	142.345	69.4796	0.394826	85209.78	486.626
Average value				370	55	<1	70	

According to the results of the conducted research, in this region the integral radioactivity (R) indicators vary within 30-70 nSv/h, effective specific activity (A_{eff}) 64-99 Bq/kg, the specific activity of uranium-238 isotope (U) 12-24 Bq/kg, the specific activity of Thorium-232 isotope (Th) 19-29 Bq/kg, the specific activity of potassium-40 isotope (K) 309-481 Bq/kg, which can be considered as normal values.

During the studies in Lachin district, measurements were made at 22 points, samples were selected and taken from 12 points (Table 2). Samples were taken mainly from arable land and near water sources.

According to the results of the conducted studies, in this region the integral radioactivity (R) indicators vary within 30-60 nSv/h, effective specific activity (A_{eff}) 11-88 Bq/kg, the specific activity of uranium-238 isotope (U) 5-19 Bq/kg, the specific activity of Thorium-232 isotope (Th) 3-23 Bq/kg, the specific activity of potassium-40 isotope (K) 46-446 Bq/kg, which also can be considered as normal values.

Measurements in Kalbajar were carried out at 35 points, samples were selected and taken from 15 points (Table 3). Samples were taken mainly from arable land and near water sources.

During radioecological monitoring in the territory of Kalbajar region, measurement of the exposure dose of gamma radiation was carried out using IndetiFINDER-2 dosimeter-spectrometer. Measurements were carried out taking into account the requirements of the standard operating procedure, and for 80 stations where measurements were made based on observed radiation background values.

It should be noted that during radioecological monitoring, a relatively high radiation background (50.4 µR/h) was observed in Istisu settlement of Kalbajar region, in the area of Istisu.

According to the recommendations of the "International Atomic Energy Agency", the following parameters should be calculated to assess radiation risks and hazards in the territories, and the prices obtained should be compared with the recommended limits [UNSCEAR, 2000].

• The average value of the dose absorbed in the air (D),

D (nGy/h)=0.462CRa + 0.0604CTh + 0.042CK

• Equivalent activity to radium (Raeq),

Raeq (Bq/kg) = CRa + 1.43CTh + 0.07CK

• External hazard index (Hex),

Hex = CRa/370+ CTh/259+ CK /4810

• Annual dose equivalent of internal organs (AGDE)

AGDE (µSv/year) = 3.09 CRa + 4.18CTh + 0.314 CK

• Annual effective dose equivalent (AEDE)

AEDE (Sv) = D x 24 x 365 x 0.7 x 0.2

The parameters calculated on the basis of the established prices are presented in Table 4.

CONCLUSION

As a result of the conducted studies, it was found that the radiation background in Aghdam and Lachin regions is within the norm, and only in soil samples taken from Istisu settlement of Kalbajar region, the average value of the dose absorbed in the air (D), external hazard index (Hex) and the annual effective dose equivalent (AEDE) were higher than the limit values. It should be noted that for a sample taken from Istisu settlement, near a hot water source, radium equivalent activity also exceeds the limit value. For this reason, there is a need for continuous implementation and control of radioecological monitoring in the mentioned areas. It should be noted that the results obtained are preliminary and currently it is planned to carry out large-scale studies in accordance with the mine action plan.

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Ağdam, Laçın və Kəlbəcər rayonlarında müasir radioekoloji vəzıyyətin qiymətləndirilməsi

[1] Əliyev Çingiz Səid oğlu, [2] Hümbətov Famil Yusif oğlu, [1] Mahmudova Fərəh Fuad qızı, [1] Əliyeva Əzizə Rafiq qızı, [1] Kərimli Xəyal Mərdan oğlu

[1] *Azərbaycan Respublikası Elm və Təhsil Nazirliyinin Geologiya və Geofizika İnstitutu, Bakı, Azərbaycan*
[2] *Azərbaycan Respublikası Elm və Təhsil Nazirliyinin Radiasiya Problemləri İnstitutu, Bakı, Azərbaycan*

Məqalədə Azərbaycanın işğaldan azad edilmiş ərazilərində ətraf mühitdə radioekoloji vəziyyətin ilkin qiymətləndirilməsi, təhlükə mənbələrinin müəyyənləşdirilməsi və anomaliya aşkar olunmuş ərazilərdən götürülmüş nümunələrin laborator şəraitdə radionuklid tərkibinin müəyyən edilməsindən bəhs edilir. Əvvəllər aparılan tədqiqatlar göstərmişdir ki, Qarabağ ərazisində süxurların radioaktivliyi litoloji-stratiqrafik intervalların tərkibindən və yaşından asılı olaraq dəyişir. Ümumiyyətlə, bu ərazidə süxurların qamma fəallığı Kiçik Qafqazın müxtəlif yaşlı struktur kompleksləri üçün xarakterik olan fon əhəmiyyətini aşmır. Aparılmış tədqiqatlar nəticəsində Ağdam və Laçın rayonlarında radiasiya fonunun norma daxilində olduğu, yalnız Kəlbəcər rayonu İstisu qəsəbəsindən götürülmüş torpaq nümunələrində havada udulan dozanın orta qiymətinin (D), Xarici təhlükəlilik indeksi (Hex) və illik effektiv doza ekvivalentinin (AEDE) limit qiymətindən yüksək olduğu müəyyən olunmuşdur. Radiuma ekvivalent aktivlik də limit qiymətini keçir. Bu səbəbdən qeyd olunan ərazilərdə radioekoloji monitorinqin davamlı şəkildə həyata keçirilməsinə və nəzarətdə saxlanmasına ehtiyac vardır. Qeyd etmək lazımdır ki, alınan nəticələr ilkindir və hal-hazırda ərazilərin minadan təmizləmə planına uyğun olaraq genişmiqyaslı tədqiqatların aparılması planlaşdırırlır.

Açar sözlər: *Qarabağ, təbii radioaktivlik, qamma şüalanma, işğaldan azad edilmiş ərazilər, radioekoloji vəziyyət, şüalanmanın ekspozisiya dozasının gücü*

Современное радиоэкологическое состояние в Агдамском, Лачинском и Келбаджарском районах

[1] Алиев Чингиз Саид оглу, [2] Гумбатов Фамиль Юсиф оглу, [1] Махмудова Фарах Фуад гызы, [1] Алиева Азиза Рафик гызы, [1] Керимли Хаял Мардан оглу

[1] Институт геологии и геофизики Министерства науки и образования Азербайджанской Республики, Баку, Азербайджан
[2] Институт радиационных проблем Министерства науки и образования Азербайджанской Республики, Баку, Азербайджан

В статье проведена оценка радиоэкологического состояния окружающей среды на освобожденной от оккупации территории Карабаха. Исследования, проведенные ранее, показали, что на территории Карабаха радиоактивность пород меняется в зависимости от состава и возраста литолого-стратиграфических интервалов. В целом гамма-активность пород не превышает фоновые значения для разновозрастных структурно-вещественных комплексов Малого Кавказа. В результате проведенных исследований было установлено, что радиационный фон в Агдамском и Лачинском районах находится в пределах нормы, только в образцах почвы, взятых из поселка Истису Кельбаджарского района, средняя величины поглощенной дозы в воздухе и годовой эффективной дозы были выше предельной нормы. По этой причине существует необходимость в постоянном контроле и проведении радиоэкологического мониторинга на указанных территориях. Следует отметить, что полученные результаты являются предварительными и в настоящее время планируется проведение масштабных исследований в соответствии с планом разминирования территорий.

Ключевые слова: *Карабах, естественная радиоактивность, гамма-излучение, освобожденные территории, радиоэкологическое загрязнение, мощность экспозиционной дозы радиации*

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Use of medicinal plants distributed in lowland Karabakh in ethnoveterinary medicine

Movsumova Nuri Vagif, *Ibadullayeva Sayyara Jamshid

Department of Ethnobotany, Institute of Botany, Ministry of Science and Education of the Republic of Azerbaijan, 40 Badamdar Highway, Baku AZ 1004, Azerbaijan

***For correspondence:** *ibadullayeva.sayyara@mail.ru*

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The research work was conducted in the territory of lowland Karabakh during 2020-2022. The main goal of the work was to reveal medicinal plants used in ethnoveterinary and their effectiveness in terms of the development of animal husbandry, which has an ancient history in the region. During the research, ethnobotanical survey methods were used, statistical analyzes were carried out, plant samples were collected and determined according to classical and modern methods. Interviews were conducted with 123 local residents aged 40 and over living in 56 villages of the study area. Of those who took part in the interviews, 78 were women, 45-men, 67 were engaged in agriculture, 56-doctors. As a result of surveys, it was found that out of 1100 species distributed in the territory, 39 species belonging to 15 families are used in the treatment of various diseases in ethnoveterinary medicine. The effectiveness of the species in diseases, the degree of reliability and the value of use were also evaluated. The consensus factor was high for skin diseases (ICF 0.91), fever (ICF 0.98) and eye diseases (ICF 0.88). The value of the use of *Artemisia absinthium* (0.70) and *Mentha longifolia* (0.69) was the highest according to the number of references obtained. The reliability rate of *Salvia verticillata, Urtica urens, Urtica dioica, Plantago lanceolata, Artemisia absinthium, Achillea filipendulina and Glycyrrhiza glabra* was the highest (100%). Since 16 of the species used as medicine are fodder plants, they directly affect the health of animals in grazing areas.

Keywords: *Ethnoveterinary, lowland Karabakh territory, medicinal plants and methods of their use*

INTRODUCTION

As it is known, folk medicine was formed on the basis of the customs and traditions and the millennial experience of various peoples and cultures. Different nations have different ways of using and taking medicinal plants, and there are treatment methods based on these national traditions. These treatment methods are widely used among the local population as pearls of folk medicine to this day (Muin, 1347; Abu Ali Ibn Sina, 1982). However, some methods of application of the doctors who developed various methods of treatment have remained unknown until now. The reason for this is that ethnobotanical knowledge is transmitted orally from one generation to another, and this information has not yet been fully documented. Existing publications rely on previous literature, thus, the possibilities of using plants are limited in terms of scope. As a result, this has led to the creation of gaps in the documentation of medicinal plants distributed in the territory of the republic. Ethnobiological studies conducted in the regions of Azerbaijan in the last decade (Aghayeva, Ibadullayeva, 2012, 2013; Ibadullayeva, 2013; Ibadullayeva et al., 2015, 2022) is aimed at updating and scientific justification of existing knowledge. However, the mechanism of medicinal plants used in non-traditional medicine in the flora of Azerbaijan as a whole has not been fully determined.

Ethnoveterinary, a branch of ethnobotany, has

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an ancient history. Because the primary occupations of people were animal husbandry - horse breeding, poultry farming, cattle breeding, beekeeping and other special care for animals. As a result of this, developed, individual and private farms were created. Animal husbandry is one of the main occupations of the people living in the Karabakh region of Azerbaijan. The people who are engaged in this work turn to medicinal plants because they are available more quickly during the treatment of animals, especially in the area of lowland Karabakh. In modern times, ethnoveterinary, as a separate field of research, is being investigated in many ways in the countries of the world (Münir et al., 2019; Sõukand and Pieroni, 2016; Brekhna et al., 2019).

The main purpose of the research is to scientifically substantiate and document oral knowledge during the return of the displaced population to the liberated Karabakh region, as well as to contribute to the development of animal husbandry, which is the main occupation of the population in the research area.

MATERIALS AND METHODS

Study area: The research work was carried out in the southwestern part of the Lesser Caucasus, in the territory of lowland Karabakh. It includes the northeast of Tartar district (a.s.l. 227 m, E 40º21`04`` və N 4º55`55``), Agjabadi district (a.s.l. 34 m, E 40º02`46`` and N 47º25`37``), Barda district (a.s.l. 87m, E 40º22`25`` and N 47º07`30``), Aghdam district (a.s.l. 350 m, E 40º03`02`` and N 46º55`09``) (Fig. 1). The low-sloping, undulating plain surface areas of the district are composed of continental and marine sediments of the anthropogenic system. Chestnut, gray and meadow-gray, salty soil types are typical for the soil cover of the area. The climate is semi-desert and dry-arid with hot-dry summers and mild-cold winters. The amount of annual pre-cipitation varies between 250-500 mm. The average maximum annual temperature is 14-27ºC (July-August), min. 1-7ºC (January-February) (The World Weather). The water supply of the study area is mainly through channels, springs and rivers. Among the rivers here are Tartar river, Kura river, Incechay, Khachinchay, Gargarchay. The biggest rivers and their tributaries pass through the area. A sparse Tugai forest is spread on the banks of the Kura River.

Method of survey: Surveys were taken from 123 local residents aged 40 and over living in the study area during 2020-2022. During the interviews, ethnobotanical methods were used (Martin, 2004; Chursin, 1929; Cotton, 1996). Interviews were conducted in 56 villages in the study area. Of those who took part in the interviews, 78 were women, 45-men, 67 were engaged in farming, 56 - doctors (Fig. 2).

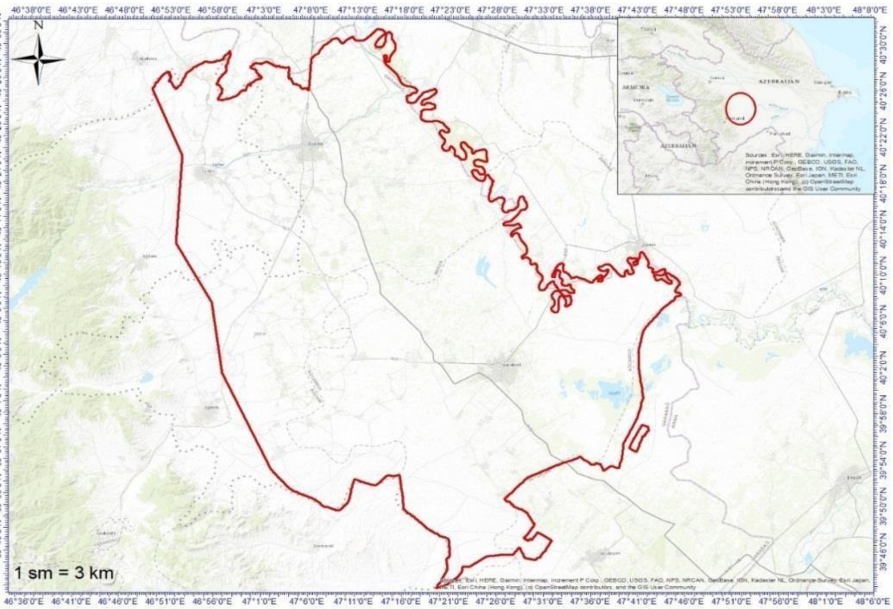

Fig. 1. Map of the studied lowland Karabakh area

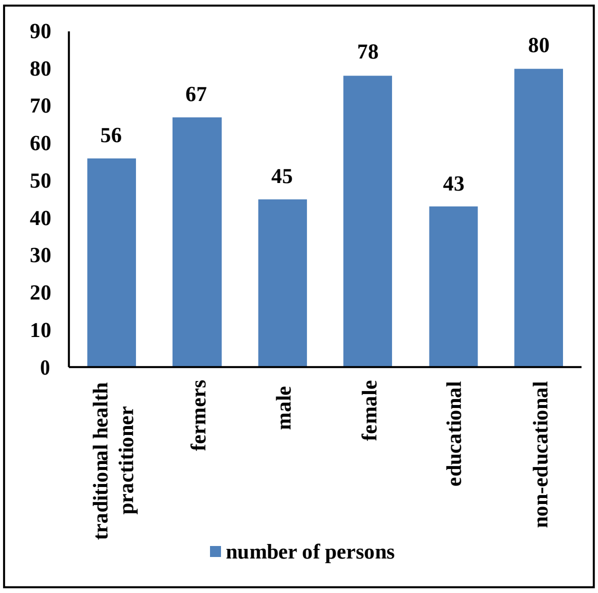

Fig. 2. Classification of respondents on different categories

First, to treat common and widespread diseases, information on local names of plants, their usage, distribution areas, collection and drying was collected, and special forms prepared for questionnaires were filled out. At this time, the informants' knowledge about medicinal plants was registered and they were given information about medicinal plants that are common in the area, but whose use is unknown.

More than 20 ethnic groups live in the region: Turks, Russians, Ukrainians, Tatars, Kurds, Jews, Lezgis and others. Data from different ethnic groups are also summarized. Surveys were also conducted among the population group engaged in farming. The results of the conducted surveys were analyzed comparatively, the parts of medicinal plants used in ethnoveterinary, the method of preparing mixtures and their application were investigated.

Collection and determination of plant samples: During numerous expeditions to the research areas, plant samples were collected and information about the effect properties was obtained. They were identified according to the "Flora of Azerbaijan" and handed over to the Herbarium fund of the Institute of Botany (BAK). "International Code of Botanical Nomenclature" was used in the nomenclature of the species, "Key to plant of the Caucasus" in the determination of the species. The names of families are based on the angiosperm phylogenetic group (APG III, 2009), and the naming by A.Asgarov (2016) and "The World Flora Online".

***Statistical* analyses:** On the basis of surveys, the signs of the disease identified in animals and the organs of occurrence were grouped into 8 categories. Informant consensus factor (ICF) was estimated as follows (Trotter and Logan, 1986):

$$\mathbf{ICF = (N_{uc} - N_s)/(N_{uc} - 1),}$$

where N_{uc} is the number of references to usage, N_s is the number of species based on each reference.

The fidelity level (FL) of the use of each species in different diseases was also calculated (Begossi A., 1996). In terms of this bioactivity, it allows determining how effective medicinal plant raw materials are in the treatment of diseases.

$$\mathbf{FL = S_f/T_f\,(\%)}$$

where S_f is the frequency of references to one species in any disease, T_f is the number of total references to that species.

The degree of suitability of each plant in the treatment of various diseases by the local population is determined by data use value (UV) (Philips et al., 1994).

$$\mathbf{UV = \sum U/n}$$

where U is the number of references given by each informant about the use of the plant species, n is the number of respondents.

RESULTS AND DISCUSSION

As a result of surveys conducted among the local population in the study area, it was determined that out of 1098 species distributed in the area, 39 species belonging to 15 families are used in the treatment of various diseases in ethnoveterinary medicine (Fig. 3). Of these, representatives of the families *Lamiaceae*, *Asteraceae* and *Fabaceae* are widely used in the treatment of animals, both as part of feed mixtures and as separate applications.

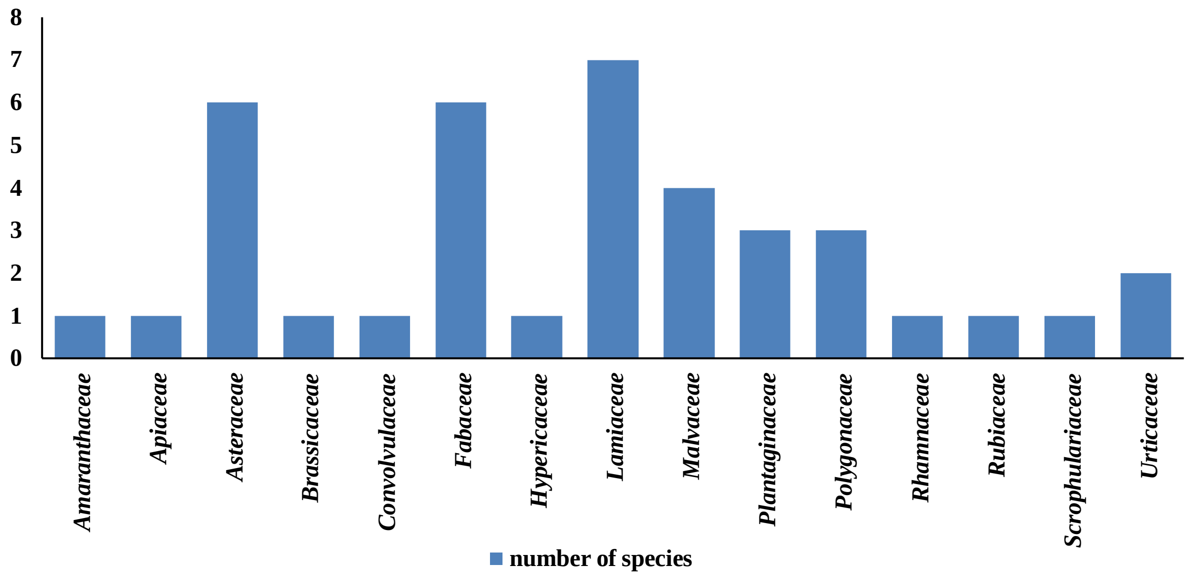

Fig. 3. Distribution of species used in ethnoveterinary by families

Table 1. Informant consensus factor of medicinal plants used in ethnoveterinary

Name of the disease	**Number of references about usage, N_{uc}**	**Number of taxa, N_s**	**Informants consensus factor (ICF)**
Gastrointestinal diseases	36	12	0,69
Skin diseases	45	5	0,91
Eye diseases	27	4	0,88
Fever	46	2	0,98
Worm disease	19	4	0,83
Respiratory diseases	39	9	0,79
Urinary tract diseases	47	9	0,83

Based on the surveys, the effects of treatment with medicinal plants were summarized and the identified diseases were grouped into 7 categories (Table 1). Diseases of the gastrointestinal tract, respiratory tract and urinary tract were the most common in the survey. Worm disease is widespread among animals. The effectiveness of medicinal plants in terms of their effect on diseases was calculated by the data consensus factor, based on the number of references given in the surveys. Skin diseases, fever, and eye disease had a high consensus factor. A large number of references to a small number of species in the same diseases indicates a high bioactive effect of these species.

Among the species used in ethnoveterinary in the study area, the use value of *Artemisia absinthium* (UV 0.70) and *Mentha longifolia* (0.69) species was the highest according to the number of references obtained. The number of references (71-66) made by the population to *Glycyrrhiza glabra* (0.59), *Urtica dioica* (0.58), *Arctium lappa* (0.55), *Plantago lanceolata* (0.55), *Plantago major* (0.54), *Hypericum perforatum* (0.54) species was more than other species (table 2). Thus, the population prefers the use of leaves (30%), aerial parts (25%) and flowers (10%) of medicinal plants in different ways because they are more effective in the treatment of animals (Fig. 4). Brewing, decoctions and extracts prepared from plants are administered orally to animals or in the form of epitheme.

Based on the results we obtained, we can say that most of the plants used for medicinal purposes are herbs. They are spread from the plains to the foothills on dry stony-gravel slopes, crops, and meadows.

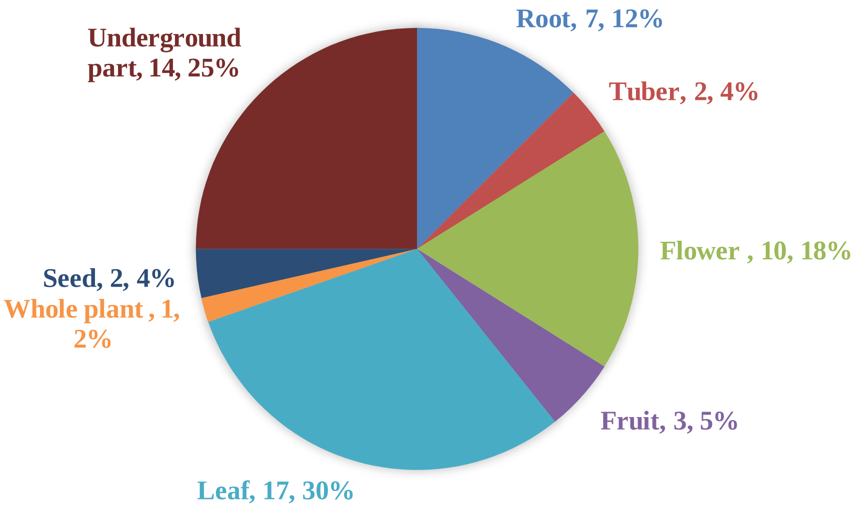

Fig. 4. Parts of plants used for treatment

Table 2. Medicinal plants used in ethnoveterinary in lowland Karabakh, their FL and UV

No.	Names of medicinal plants	Habitat	Life form	Used part	Instructions for use	Use in diseases	FL (%)	UV
1	2	3	4	5	6	7	8	9
1.	*Mentha longifolia* (L.) L. (*Lamiaceae*)	Waterside grassy areas	Perennial herb	Leaves	By oral administration	In gastrointestinal disease	83.00	0.69 (85)
2.	*Rumex obtusifolius* L. (*Polygonaceae*)	In screes	Perennial herb	Roots	In the form of epitheme	Hemostatic	64.21	0.25 (31)
3.	*Rumex crispus* L. (*Polygonaceae*)	Meadow	Perennial herb	Leaf, rhizome	By oral administration, in the form of epitheme	Gastrointestinal, lung diseases, diarrhea, dysentery	56.30	0.29 (36)
4.	*Salvia aethiopis* L. (*Lamiaceae*)	In screes	Perennial herb	Roots, fruits	By oral administration	In cleaning the urinary and biliary tract	82.11	0.14 (17)
5.	*Salvia verticillata* L. (*Lamiaceae*)	On clayey slopes	Perennial herb	Aerial part	By oral administration, in the form of epitheme	In inflammatory diseases, in the treatment of wounds	100.0	0.20 (24)
6.	*Rhamnus cathartica* L. (*Rhamnaceae*)	In dry meadows, bushes	Bush	Fruits	By oral administration	As an anthelmintic due to its laxative effect	96.70	0.38 (47)
7.	*Lamium album* L. (*Lamiaceae*)	In the meadows and crops	Perennial herb	Aerial grassy part, flowers	By oral administration	Wound healing, gastrointestinal, skin and lung diseases, etc.	67.30	0.42 (52)
8.	*Stachys pubescens* Ten. (*Lamiaceae*)	In dry steppes	Perennial herb	Aerial part	By oral administration	In respiratory disease, as a laxative for constipation	60.03	0.32 (39)
9.	*Hypericum perforatum* L. (*Hypericaceae*)	In bushes, on grassy slopes	Perennial herb	Aerial part	By oral administration and in the form of epitheme	Gastrointestinal inflammation, in the treatment of eye ulcers	100.00	0.54 (66)
10.	*Verbascum pyramidatum* M.Bieb (*Scrophulariaceae*)	In screes, on rocky and gravelly slopes	Perennial herb	Leaves	By oral administration	Gastrointestinal diseases, diarrhea	56.80	0.11 (13)

Table 2 continued

1	2	3	4	5	6	7	8	9
11.	*Persicaria lapathifolia* (L.) Delarbre (*Polygonaceae*)	At the water's edge	Annual herb	Root and leaves	By oral administration	Gastrointestinal, liver diseases	91.80	0.38 (47)
12.	*Malvella sherardiana* Jaub.et Spach (*Malvaceae*)	On dry clayey slopes, crops	Perennial herb	Aerial part	By oral administration	Urinary tract and kidney inflammation	81.20	0.21 (26)
13.	*Trifolium pratense* L. (*Fabaceae*)	In dry meadows	Perennial herb	Inflorescenc e and leaves	In the form of epitheme	Anti-inflammatory in eye diseases and skin wounds	87.56	0.36 (44)
14.	*Cichorium intybus* L. (*Asteraceae*)	In the crops, along the roadsides	Perennial herb	Roots	By oral administration	Choleretic, in diseases of the liver and kidneys	76.23	0.46 (57)
15.	*Urtica urens* L. (*Urticaceae*)	In the crops	Perennial herb	Inflorescence and leaves	By oral administration	In gastrointestinal diseases, as an antipyretic	100.00	0.33 (40)
16.	*Urtica dioica* L. (*Urticaceae*)	Near residential areas, bushes	Perennial herb	Leaves	By oral administration	In kidney inflammation, intestinal, antitussive, as anthelmintic	100.00	0.58 (71)
17.	*Malva neglecta* Wallr. (*Malvaceae*)	In the crops, near residential areas	Perennial herb	Flower and sepal	By oral administration	In inflammatory diseases of the respiratory tract, gastrointestinal tract	75.00	0.42 (52)
18.	*Medicago minima (* L.) Bartal. (*Fabaceae*)	In dry steppes	Annual herb	Aerial part	By oral administration	As a diuretic, as a analeptic	64.80	0.39 (48)
19.	*Plantago major* L. (*Plantaginaceae)*	In meadows	Perennial herb	Leaves, dried plant	By oral administration	Gastrointestinal diseases, cough	98.00	0.54 (66)
20.	*Plantago media* L. (*Plantaginaceae)*	In bushes, dry slopes	Perennial herb	Leaves	In the form of epitheme	Wound Healing	91.24	0.41 (51)
21.	*Plantago lanceolata* L. (*Plantaginaceae)*	Dry, grassy slopes	Perennial herb	Leaves	In the form of epitheme	Hemostatic, against inflammation of the eyes	100.00	0.55 (66)
22.	*Silybum marianum* (L.) Gaertn. (*Asteraceae*)	In arid areas	Biennial	Young leaves and seeds	By oral administration	In diseases of the liver, as a choleretic agent, when cleansing the intestines	86.70	0.35 (43)
23.	*Cirsium vulgare* (Savi) Ten. (*Asteraceae*)	On roadsides, in arid areas	Biennial	Inflorescence	By oral administration	In cleaning the bile ducts	75.78	0.26 (32)
24.	*Artemisia absinthium* L. (*Asteraceae*)	In dry bushes, screes	Perennial herb	Leaves and flowering tips	By oral administration	Helminthic disease, gallbladder, liver, gastrointestinal diseases, diseases of the upper respiratory tract	99.00	0.70 (86)
25.	*Achillea filipendulina* Lam. (*Asteraceae*)	On the roadsides, in bushes	Perennial herb	Grass, flowers and leaves	By oral administration	For bleeding, analgesic, gastrointestinal cramps carminative	100.00	0.50 (61)
26.	*Laser trilobum* (L.) Borkh. (*Apiaceae*)	On the roadsides, bushes	Perennial herb	Fruit, leaf and root	By oral administration	Antipyretic	60.00	0.17 (21)
27.	*Nepeta racemosa* Lam. (*Lamiaceae*)	Dry stony-gravelly slopes	Perennial herb	Aerial part	In the form of epitheme and by oral administration	Analgesic, hemostatic	54.40	0.15 (18)

Table 2 continued

1	2	3	4	5	6	7	8	9
28.	*Origanum vulgare* L. (*Lamiaceae*)	In meadows	Perennial herb	The aerial part during the flowering period	In the form of epitheme and by oral administration	For diseases of the oral cavity, skin wounds, stomach cramps	91.36	0.36 (44)
29.	*Galium rubioides* L. (*Rubiaceae*)	In meadows	Perennial herb	Whole plant	In the form of epitheme and by oral administration	As an analgesic, wound healing, choleretic, diuretic	56.70	0.12 (15)
30.	*Arctium lappa* L. (*Asteraceae*)	Roadsides, bushes	Biennial	Aerial part, the root	In the form of epitheme and by oral administration	As an astringent, wound healing, diuretic and choleretic agent.	95.43	0.55 (67)
31.	*Glycyrrhiza glabra* L. (*Fabaceae*)	In the plains, on the foothills, on the river banks	Perennial herb	Root and rhizome	By oral administration	Anti-inflammatory in cough	100.00	0.59 (72)
32.	*Lotus caucasicus* Kuprian. (*Fabaceae*)	Stony-gravelly slopes	Perennial	Aerial part	By oral administration	During inflammation of the kidneys and urinary tract	89.54	0.29 (35)
33.	*Galega orientalis* Lam. (*Fabaceae*)	In open fields and around the forest	Perennial herb	Aerial part	By oral administration	Used as anthelmintic and diuretic	67.89	0.20 (24)
34.	*Melilotus officinalis* (L.) Pall. (*Fabaceae*)	In the meadows, in the bushes	Biennial herb	Leaves, flowers	By oral administration and in the form of epitheme	As expectorant for respiratory diseases, carminative, in the treatment of purulent wounds	74.33	0.24 (29)
35.	*Chenopodium album* L (*Amaranthaceae*)	On the roadsides, in the crops	Annual herb	Aerial green part	By oral administration	Used as a diuretic	87.88	0.15 (18)
36.	*Malva nicaeensi* All. (*Malvaceae*)	At the water's edge	Annual herb	Inflorescence and leaves	By oral administration	In purulent sores in the mouth, dry cough	91.06	0.27 (33)
37.	*Malva setigera* K.F. Schimp. & Spenn. (*Malvaceae*)	Screes, on dry slopes	Annual herb	Roots, flowers	By oral administration	Respiratory disease, diarrhea, abdominal cramps	98.37	0.22 (27)
38.	*Brassica campestris* L. (*Brassicaceae*)	On the roadsides, in the crops	Annual herb	Seeds, leaves	In the form of epitheme	For festering wounds	67.80	0.34 (42)
39.	*Convolvulus arvensis* L. (*Convolvulaceae*)	In screes, in the crops	Perennial herb	Aerial green part	By oral administration	As laxative	56.70	0.21 (26)

In general, animal diseases appear during seasonal changes. Changes in vegetation cover and reduction in nutrition, or epidemiologically, the spread of diseases among animals are observed. Since 16 of the 39 species used as medicine are fodder plants, they directly affect the health of animals in pastures. But the change of season has a negative effect on it, doctors and farmers only apply mixtures made from medicinal plants in different ways in treatments.

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Aran Qarabağ ərazisində yayılmış dərman bitkilərinin etnobaytarlıqda istifadəsi

Mövsümova Nuri Vaqif qızı, İbadullayeva Səyyarə Cəmşid qızı

Azərbaycan Respublikası Elm və Təhsil Nazirliyinin Botanika İnstitutu, Bakı, Azərbaycan

Tədqiqat işi 2020-2022-ci illər ərzində Aran Qarabağ ərazisində aparılmışdır. İşin əsas məqsədi bölgədə qədim tarixə malik olan heyvandarlıq təsərrüfatının inkişafı baxımından etnobaytarlıqda istifadə olunan dərman bitkilərinin və onların təsir effektivliyinin aşkarlanması olmuşdur. Tədqiqatlar zamanı etnobotaniki sorğu üsullarından istifadə edilmiş, statistik təhlillər aparılmış, bitki nümunələri toplanaraq, klassik və müasir metodlara uyğun təyin edilmişdir. Müsahibələr tədqiqat ərazisinin 56 kəndində yaşayan yaşı 40 və yuxarı olan, 123 yerli sakindən götürülmüşdür. Müsahibələrdə iştirak edənlərin 78-i qadın, 45-i kişi, 67-si fermer təsərrüfatı ilə məşqul olan, 56-sı isə təbiblər olmuşdur. Sorğular nəticəsində müəyyən edilmişdir ki, ərazidə yayılmış 1100 növdən 15 fəsiləyə daxil olan 39 növ etnobaytarlıqda müxtəlif xəstəliklərin müalicəsində istifadə olunur. Növlərin xəstəliklərdə effektivliyi, etibarlılıq dərəcəsi və istifadə dəyəri də qiymətləndirilmişdir. Dəri xəstəliklərində (ICF 0.91), qızdırmada (ICF 0.98) və göz xəstəliklərində (ICF 0.88) konsensuns faktoru yüksək olmuşdur. *Artemisia absinthium* (0.70) və *Mentha longifolia* (0.69) növlərinin istifadə dəyəri əldə olunmuş istinadların sayına görə ən yüksək olmuşdur. *Salvia verticillata, Urtica urens, Urtica dioica*, *Plantago lanceolata, Artemisia absinthium*, *Achillea filipendulina və Glycyrrhiza glabra* növlərinin etibarlılıq dərəcəsi ən yüksək olmuşdur (100%). Dərman kimi istifadə olunan növlərdən 16-sı yem bitkisi olduğundan otlaq sahələrində heyvanların sağlamlığına birbaşa da təsir göstərir.

Açar sözlər: *Etnobaytarlıq, Aran Qarabağ ərazisi, dərman bitkiləri və onların istifadə üsulları.*

Этноветеринарное использование лекарственных растений, распространенных в Аранско-Карабахском регионе

Мовсумова Нури Вагиф гызы, Ибадуллаева Сайяра Джамшид гызы

Институт ботаники Министерства науки и образования Азербайджанской Республики, Баку, Азербайджан

Исследовательская работа проводилась на территории Аранского Карабаха в течение 2020-2022 гг. Основная цель работы заключалась в выявлении лекарственных свойств растений, используемых в этноветеринарии и эффективности их действия в условиях развития животноводства, имеющего в регионе древнюю историю. В ходе исследований применялись методы этноботанического обследования, проводились статистические анализы, собирались и определялись образцы растений по классическим и современным методам. Опрошено 123 местных жителя в возрасте 40 лет и старше, проживающих в 56 селах исследуемой территории. Из принявших участие в опросе 78 женщин и 45 мужчин, 67 занимались сельским хозяйством, 56 врачей. В результате обследований установлено, что из 1100 видов растений, распространенных на территории, 39 видов, входящих в 15 семейств, используются при лечении различных заболеваний в этноветеринарной медицине. Также оценивались эффективность вида при заболеваниях, степень надежности и стоимость использования. Фактор консенсуса(ICF) был высоким при кожных заболеваниях (ICF 0,91), лихорадке (ICF 0,98) и заболеваниях глаз (ICF 0,88). Ценность использования Artemisia absinthium (0,70) и Mentha longifolia (0,69) была самой высокой по количеству полученных ссылок. Виды *Salvia verticillata, Urtica urens, Urtica dioica, Plantago lanceolata, Artemisia absinthium, Achillea filipendulina* и *Glycyrrhiza glabra* имели наивысшую степень достоверности (100%). Поскольку 16 видов, используемых в качестве лекарственных средств, являются кормовыми растениями, они напрямую влияют на здоровье животных на пастбищах.

Ключевые слова: *Этноветеринария, Аранский Карабах, лекарственные растения и способы их применения*

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Eastern Zangezur economic districts Longhorn beetles (*Coleoptera, Cerambycıdae*) of Karabakh

***Eyvazov Aladdin Gismat, Kerimova Ilhama Gudrat**

Institute of Zoology, Ministry of Science and Education of the Republic of Azerbaijan, 115 A.Abbaszade Str., 1128 Pass., 504 Block, Baku AZ1004, Azerbaijan

****For correspondence:** info@zoology.science.az*

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Before the occupation, 53 of 280 species belonging to the fauna of longhorn beetles of Azerbaijan were recorded in the territory of Karabakh. These species belong to the following genera: *Aegomorphus, Agapanthia, Asemum, Cerambyx, Certallum, Chlorophorus, Dinoptera, Dorcadion, Echinocerus, Enoploderes, Gracilia, Hesperophanes, Isotomus, Judolia, Leiopus, Mallosia, Molorchus, Necydalis, Oberea, Pachytodes, Penichroa, Phymatodes, Phytoecia, Plagionotus, Prionus, Purpuricenus, Ropalopus, Rosalia, Rutpela, Saperda, Spondylis, Stenurella, Stictoleptura, Strangalia, Stromatium, Trichopherus*. Of these species, *Rosalia alpina* (Linnaeus, 1758), *Prionus asiaticus* Faldermann, 1837, *Necydalis (Necydalis) ulmi* Chevrolat, 1838, *Mallosia (Eumallosia) herminae* Reitter, 1890, *Cerambyx* (*Cerambyx*) *dux* (Faldermann, 1837), *C.* (*Cerambyx*) *cerdo acuminatus* Motschulsky, 1853 are few. *R. alpina* is included in the IUCN Red List and the Red Book of Azerbaijan under the VU category. Species of the genera *Purpuricenus, Cerambyx, Enoploderes, Molorchus, Necydalis, Prionus, Ropalopus, Rosalia, Saperda, Spondylis, Isotomus, Judolia, Leiopus, Pachytodes, Penichroa, Chlorophorus, Dinoptera, Stictoleptura, Aegomorphus, Gracilia, Asemum, Hesperophanes, Phymatodes, Rutpela, Stenurella, Strangalia* feed on the trunks of trees and shrubs, *Agapanthia, Certallum, Dorcadion, Echinocerus, Mallosia, Phytoecia* on herbaceous plants. Some species of *Oberea* and *Plagionotus* feed on the trunks of deciduous trees, and some on grasses. *Stromatium* and *Trichopherus* damage wooden structures. The liberation of the Karabakh lands from occupation opens up new prospects for Azerbaijani scientists to conduct research in these areas. The re-study of the entomofauna of Karabakh will create conditions for the discovery of rare and endangered species in this area.

Keywords: *Fauna, longhorn beetles, species composition, Red Book, rare species, endangered species*

INTRODUCTION

Located in the southeastern part of the Lesser Caucasus Karabakh, with its charming nature, occupies a key place among the charming places in Azerbaijan. The relief and climate of Karabakh determined the formation of rich fauna and flora here. Like the Lankaran and Nakhchivan regions of Azerbaijan, Karabakh has always attracted the attention of scientists and researchers. The existence of desert, semi-desert, steppe, dry steppe, mountain xerophyte, alpine, subalpine, low-mountain, plain landscapes created conditions for the formation of a rich entomofauna, including rare and endangered species (Constructive geography of the Azerbaijan Republic, 1996). However, due to the fact that this rich territory was under Armenian occupation for a long time, Azerbaijani scientists could not conduct new scientific research. In the post-occupation period, the rich nature of Karabakh creates a reliable basis for active research and the discovery of new species.

The eggs and larvae of the longhorn beetles may not have suffered from the destruction that occurred during the Karabakh war, as they live a rather secretive life inside the trees. During the

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new monitoring, it will be possible to record most of these insects again in the same habitats.

RESULTS AND DISCUSSION

The article is written on the basis of the materials of the entomological collection of the Institute of Zoology of the Ministry of Science and Education of the Republic of Azerbaijan and the literary data of entomologists who conducted research in Karabakh in the pre-occupation period. Available information in this area is summarized. It has been established that 59 species of longhorn beetles inhabit the territory of Karabakh (Table).

Table. Species of longhorn beetles recorded on the territor y of Karabakh

1	2
Tribes and species	**Place of finding**
PRIONINI Latreille, 1802	
Prionus asiaticus Faldermann, 1837	Terter
ENOPOLODERINI Danilevsky in Althoff & Danilevsky, 1997	
Enoploderes (Enoploderes) sanguineum Faldermann, 1837	Kalbajar -Lachin
RHAMNUSIINI Danilevsky in Althoff & Danilevsky, 1997	
Rhamnusium graecum Schaufuss, 1862	Khojali, Khojavend, Khankendi, Shusha, Aghdere
RHAGIINI Kirby, 1837	
Rhagium (Megarhagium) fasciculatum Faldermann, 1837	Kalbajar -Lachin
Dinoptera (Dinoptera) collaris Linnaeus, 1758	Khojali, Khojavend, Khankendi, Shusha, Aghdere
Cortoderaq pseudomophlus Reitter, 1889	Khojali, Khojavend, Khankendi, Shusha, Aghdere
LEPTURINI Latreille, 1804	
Vadonia unipunctata unipunctata Fabricius, 1787	Khankendi, Shusha
Judolia erratica erratica var. erythrura (Küster, 1848)	Khankendi, Shusha
Stictoleptura Stictoleptura) cordigera cordigera Fuessly, 1775	Khojali, Khojavend, Khankendi, Shusha, Aghdere
Stictoleptura (Stictoleptura) scutellata (Fabricius, 1781)	Khankendi
Pachytodes erratica erratica var. erythrura (Küster, 1848)	Khojali, Khojavend, Khankendi, Shusha, Lachın, Kalbajar
Pachytodes erraticus erraticus (Dalman, 1817)	Khojali, Khojavend, Khankendi, Shusha, Lachın, Kalbajar
Leptura quadrifasciata Linnaeus, 1758	Khojali, Khojavend, Khankendi, Shusha,
Stenurella (Stenurella) melanura melanura Linnaeus, 1758	Khojali, Khojavend, Khankendi, Shusha,
Stenurella (Priscostenurella) bifasciata bifasciata (O.F. Müller, 1776)	Khankendi
S.(Nigrostenurella) nigra nigra (Linnaeus, 1758)	Khojali, Khojavend, Khankendi, Shusha, Lachin,
Strangalia attenuata (Linnaeus, 1758)	Khankendi
Rutpela maculata (Poda von Neuhaus, 1 76 1)	Khankendi
NECYDALINI Latreille, 1825	
Necydalis (Necydalis) ulmi Chevrolat, 1838	Khojali, Khojavend, Khankendi, Shusha, Aghdere
ASEMINI Thomson, 1860	
Asemum striatum (Linnaeus, 1758)	Khojali, Khojavend, Khankendi, Shusha, Aghdere
SPONDYLIDINI Audinet-Serville, 1832	
Spondylis buprestoides (Linnaeus, 1758)	Khojali, Khojavend, Khankendi, Shusha, Aghdere
HESPEROPHANINI Mulsant, 1839	
Hesperophanes sericeus (Fabricius, 1787)	Jabrayil
Trichopherus holosericeus (Rossi, 1790)	Kalbajar-Lachin, Xankəndi
Stromatium auratum (Böber, 1793)	Terter
CERAMBYCINI Latreille, 1804	
Cerambyx Cerambyx) cerdo acuminatus Motschulsky, 1853	Aghdam, Lachin
C. (Cerambyx) dux (Faldermann, 1837)	Aghdam, Khankendi
C.*(C.) miles* (Bonelli, 1812)	Khojali, Khojavend, Khankendi, Shusha, Aghdere
COMPSOCERINI Thomson, 1864	
Rosalia alpina (Linnaeus, 1758)	Shusha
PURPURICENINI Thomson, 1864	
Purpuricenus budensis (Götz, 1783)	Askeran, Aghdere, Khankendi
P.budensis budensis var. punctiger Apfelbeck	Askeran

Table continued

1	2
GRACILIINI Mulsant, 1839	
Gracilia minuta (Fabricius, 1781)	Khojali, Khojavend, Khankendi, Shusha, Aghdere
MOLORCHINI Mulsant, 1863	
Molorchus (Molorchus) umbellatarum umbellatarum (Schreber, 1759)	Khojali, Khojavend, Khankendi, Shusha, Aghdere
CERTALLINI Faimaire, 1854	
Certallum ebulinum (Linnaeus, 1767)	Aghdam
C. ebulinum ruficolle (Fabricius, 1781)	Aghdam
CALLIDIINI Kirby, 1837	
Ropalopus (Ropalopus) clavipes (Fabricius, 1775)	Khankendi
Semanotus russicus russicus Fabricius,1776	Khojali, Khojavend, Khankendi, Shusha, Aghdere
Phymatodes testaceus (Linnaeus, 1758)	Ağdam
Phymatodes(Phymatodes) lividus Rossi, 1794	Khojali, Khojavend, Khankendi, Shusha, Aghdere
CLYTINI Mulsant, 1839	
Plagionotus arcuatus (Linnaeus, 1758)	Fizuli
P. arcuatus lugubris (Ménétriés, 1832)	Khankendi
Echinocerus floralis floralis (Pallas, 1773)	Fizuli
Isotomus speciosus ssp. comptus (Mannerheim, 1825)	Khankendi
Chlorophorus varius varius (O.F.Müller, 1766)	Shusha
Ch.sartor (O.F.Müller, 1766)	Shusha
Xylotrechus (Xylotrechus) arvicola (Olivier, 1795)	Shusha
DORCADIINI Latreille, 1825	
D.(C.) shirvanicum azerbajdzhanicum Plavilstshikov, 1937	Khojali, Khojavend, Khankendi, Shusha, Aghdere
D.(C.) scabricolle corpulentum Ménétriés, 1832	Shusha, Terter, Khankendi
Dorcadion (Cribridorcadion)seminudum Kraatz, 1873	Khojali, Khojavend, Khankendi, Shusha, Aghdere
D. scabricolle var. lutescens Kraatz, 1873	Terter
D.sulcipenne caucasicum Küster, 1847	Shusha
D.shushense Lazarev, 2010	Shusha
ACANTHODERINI Thomson, 1860	
Aegomorphus clavipes (Schrank, 1781)	Khojali, Khojavend, Khankendi, Shusha, Aghdere
ACANTHOCININI Blanchard, 1845	
Leiopus nebulosus caucasicus Ganglbauer, 1887	Khojali, Khojavend, Khankendi, Shusha, Aghdere
SAPERDINI Mulsant, 1839	
Saperda (Compsidia) populnea (Linnaeus, 1758)	Khojali, Khojavend, Khankendi, Shusha, Aghdere
Saperda (Anaerea) carcharias Linnaeus, 1758	Khojali, Khojavend, Khankendi, Shusha, Aghdere
Oberea (Oberea) linearis (Linnaeus, 1761)	Khojali, Khojavend, Khankendi, Shusha, Aghdere
Mallosia (Eumallosia) herminae Reitter, 1890	Khankendi
Phytoecia(Paracoptosia) compacta (Ménétriés, 1832)	Aghdam, Fizuli, Terter
Phytoecia (Musaria) puncticollis puncticollis Faldermann, 1837	Aghdam, Fizuli, Terter
AGAPANTHIINI Mulsant, 1839	
Calamobius filum Rossi, 1790	Khankendi, Shusha, Aghdere
Agapanthia (Epoptes) cynarae cynarae (Germar, 1817)	Khankendi, Shusha, Aghdere
A. (E.) villosoviridescens (De Geer, 1775)	Khankendi, Shusha, Aghdere

Images of most species of longhorn beetles are found on flowering plants, but they are divided into separate groups according to the feeding of larvae. Thus, species from 26 genera (*Purpuricenus, Cerambyx, Enoploderes, Molorchus, Necydalis, Prionus, Ropalopus, Rosalia, Saperda, Spondylis, Isotomus, Judolia, Leiopus, Pachytodes, Penichroa, Chlorophorus, Dinoptera, Stictoleptura, Aegomorphus, Gracilia, Asemum, Hesperophanes*, the larvae of species belonging to the genera *Phymatodes, Rutpela, Stenurella, Strangalia*) feed on the trunks of forest and fruit trees and shrubs. Representatives of 6 genera (*Agapanthia, Certallum, Dorcadion,* *Echinocerus*, *Mallosia*, *Phytoecia*) are herbivores both at the larval and adult stages. Some species of the genera Oberea and Plagionotus feed on the trunks of broad-leaved trees, while others feed on grasses. Representatives of the genera Stromatium and Trichopherus are considered technical pests and cause damage to wooden buildings and furniture. Among these species *Rosalia alpina* (Linnaeus, 1758), *Prionus asiaticus* Faldermann, 1837, *Necydalis* (*Necydalis*) *ulmi* Chevrolat, 1838, *Mallosia* (*Eumallosia*) *herminae* Reitter, 1890, *Cerambyx* (*Cerambyx*) *dux* (Faldermann, 1837), *C.* (*Cerambyx*) *cerdo acuminatus* Motschulsky, 1853 are rare. *R.alpina* is included in the World Red List, Appendix II of the Berne Convention of 1979 and I, II and III editions of the Red Book of Azerbaijan under the VU category (Fig. 1).

Fig. 1. *Rosalia alpina* (photo: N.Snegovaya)

The great capricorn beetle *C. (Cerambyx) cerdo acuminatus* is one of the greatest beetles in Azerbaijan (Fig. 2). Found on old oak trees.

The herbivorous longhorn beetle, which lives mainly in meadows and feeds on plant roots, was named the Shusha longhorn beetle (*Dorcadion shushense* Lazarev, 2010) since it was first recorded in Shusha in 1905 (Fig. 3).

Fig. 2. *Cerambyx cerdo acuminatus* (photo: I.Kerimova)

Fig. 3. *Dorcadion (Cribcidorcadion) shushense* (photo: M.Lazarev)

CONCLUSION

So, to date, 280 species of longhorn beetles have been registered in Azerbaijan (Samadov, 2010; Danilevsky, 2014), 59 of them were registered on the territory of Karabakh in the pre-occupation period. Of these, 3 species are found only in Terter, 23 species in Khojaly, Khojavend, Khankendi, Shusha and Aghdere, 4 species in Khankendi, Shusha, Aghdere, 2 species in Agdam, Fizuli, Terter, 8 species - only in Khankendi, 2 species in Kalbajar and Lachin, 1 species in Kalbajar, Lachin, Khankendi, 6 species only in Shusha, 2 species in Khankendi and Shusha, 1 species in Shusha, Tartar and Khankendi, 1 species only in Jabrayil, 2 species only in Fizuli, 3 species only in Agdam, 1 species in Agdam and Lachin, 1 species in Agdam and Khankendi, 1 species recorded only in Askeran, 1 species recorded in Askeran, Aghdere and Khankendi.

The liberation of Karabakh from occupation opens up new prospects for research in these areas for Azerbaijani scientists. The re-study of the entomofauna of Karabakh will also allow monitoring of rare and endangered species in this area. These studies will also create conditions for the discovery of new species.

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Qarabağın uzunbığ böcəkləri (*Coleoptera, Cerambycidae*)

Eyvazov Ələddin Qismət oğlu, Kərimova İlhamə Qüdrət qızı

Azərbaycan Respublikası Elm və Təhsil Nazirliyinin Zoologiya İnstitutu, Bakı, Azərbaycan

Azərbaycanın uzunbığ böcəklər (*Cerambycidae*) faunasına aid olan 280 növün 53-ü işğalaqədərki dövrdə Qarabağ ərazisində qeydə alınmışdır. Bu növlər içərisində *Rosalia alpina* (Linnaeus, 1758), *Prionus asiaticus* Faldermann, 1837, *Necydalis (Necydalis) ulmi* Chevrolat, 1838, *Mallosia (Eumallosia) herminae* Reitter, 1890, *Cerambyx (Cerambyx) dux* (Faldermann, 1837), *C. (Cerambyx) cerdo acuminatus* Motschulsky, 1853 azsaylı növlərdir. *Rosalia alpina* isə Ümumdünya Qırmızı Siyahısına və Azərbaycanın Qırmızı kitabına VU kateqoriyası ilə daxil edilmişdir. Uzunbığ böcək cinslərindən *Purpuricenus, Cerambyx, Enoploderes, Molorchus, Necydalis, Prionus, Ropalopus, Rosalia, Saperda, Spondylis, Isotomus, Judolia, Leiopus, Pachytodes, Penichroa, Chlorophorus, Dinoptera, Stictoleptura, Aegomorphus, Gracilia, Asemum, Hesperophanes, Phymatodes, Rutpela, Stenurella, Strangalia* növləri meşə və meyvə ağac və kollarının gövdələrində, *Agapanthia, Certallum, Dorcadion, Echinocerus, Mallosia, Phytoecia* ot bitkiləri üzərində qidalanır. *Oberea, Plagionotus* cinslərinin bəzi növləri enliyarpaqlı ağacların gövdələrində, bəzi növləri isə otlar üzərində qidalanır. *Stromatium və Trichopherus* cinslərinin nümayəndələri isə ağac tikililərə ziyan vurur. Qarabağ torpağının işğaldan azad edilməsi Azərbaycan alimləri qarşısında bu ərazilərdə tədqiqatın aparılması üçün yeni-yeni perspektivlər açır. Qarabağın entomofaunasının yenidən öyrənilməsi bu ərazidə nadir və nəsli kəsilməkdə olan növlərin də aşkar edilməsinə şərait yaradacaqdır.

Açar sözlər: *Fauna, uzunbığ böcəklər, növ tərkibi, Qırmızı Kitab, nadir növ, təhlükədə olan növ*

Жуки-усачи (*Coleoptera, Cerambycidae*) Карабаха

Айвазов Аладдин Гисмет оглу, Керимова Ильхама Гудрат гызы

Институт зоологии Министерства науки и образования Азербайджанской Республики, Баку, Азербайджан

Из 280 видов жуков-усачей (*Cerambycidae*) фауны Азербайджана 53 были отмечены на территории Карабаха в дооккупационный период. Из этих видов *Rosalia alpina* (Linnaeus, 1758), *Prionus asiaticus* Faldermann, 1837, *Necydalis (Necydalis) ulmi* Chevrolat, 1838, *Mallosia (Eumallosia)* *herminae* Reitter, 1890, *Cerambyx (Cerambyx) dux* (Faldermann, 1837), *C. (Cerambyx) cerdo acuminatus* Motschulsky, 1853 являются редкими. Альпийская розалия включена во Всемирный Красный список и Красную книгу Азербайджана по категории VU. Личинки *Purpuricenus, Cerambyx, Enoploderes, Molorchus, Necydalis, Prionus, Ropalopus, Rosalia, Saperda, Spondylis, Isotomus, Judolia, Leiopus, Pachytodes, Penichroa, Chlorophorus, Dinoptera, Stictoleptura, Aegomorphus, Gracilia, Asemum, Hesperophanes, Phymatodes, Rutpela, Stenurella* питаются древесиной лесных и плодовых деревьев и кустарников. А личинки *Agapanthia, Certallum, Dorcadion, Echinocerus, Mallosia, Phytoecia* обитают на травянистой растительности. Одни виды родов *Oberea* и *Plagionotus* питаются древесиной широколиственных деревьев, другие - травами. Представители родов *Stromatium* и *Trichopherus* повреждают деревянные конструкции. Освобождение карабахских земель от оккупации открывает перед азербайджанскими учеными новые перспективы для проведения исследований этих областей. Повторное изучение энтомофауны Карабаха создаст условия для обнаружения в этой местности редких и исчезающих видов.

Ключевые слова: *Фауна, жуки усачи, видовой состав, Красная книга, редкий вид, вид находящийся под угрозой исчезновения*

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Soils of the Karabakh Economic Region of Azerbaijan and their ecological assessment

[*1]Mammadov Garib Shamil, [2] Mammadov Zaman Rashid, [2] Osmanova Sona Abkhaz

[1]Presidium of Azerbaijan National Academy of Sciences, 30 Istiglaliyyat Str., Baku AZ 1001, Azerbaijan
[3]Institute of Soil Science & Agrochemistry, Ministry of Science and Education of the Republic of Azerbaijan, 4 M.Rahim Str., Baku 1073, Azerbaijan

***For correspondence:** garibmammadov1@gmail.com*

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The article presents extensive information about climatic and soil indicators, as well as the soil composition of the newly created Karabakh Economic Region. The given data cover the pre-occupation period, except for some districts, modern total data are described. Investigated soils of the Karabakh Economic Region, the state of their use in the rural economy, the composition of the soil cover. On the basis of indicators of the internal diagnostics of soils, distributed over the economic district, the assessment of administrative districts was carried out, and the DEM and soil map were prepared based on modern technologies on the GIS platform. Also, the results of the soil and climatic conditions of the new economic district were analyzed, an ecological assessment was carried out and a map was compiled. The results of the conducted scientific research proved the essence of relying on scientific principles in increasing the flexibility of the rational use of agricultural lands for carrying out restoration and construction works on territories freed from occupation.

Keywords: *Karabakh Economic Region, soil, fertility, assessment, ecological assessment, GIS, map*

INTRODUCTION

In order to ensure the sustainable development of cities and regions of our country, the President of the Republic of Azerbaijan signed a decree dated July 7, 2021. According to this decree, Azerbaijan is divided into 14 economic regions, one of which is the Karabakh Economic Region. This economic region includes the cities of Khankendi, Agjabadi, Agdam, Barda, Fuzuli, Khojali, Khojavend, Shushi and Tartar administrative regions. The mentioned regions and cities are the result of a very thoughtful policy for the restoration and rapid development of the ancient Karabakh region, which has its rich historical and cultural heritage and mysterious nature. The reintegration of the liberated regions into the economy of our country is a very important issue in terms of increasing the effectiveness of planned work on economic regions and ensuring flexibility in managing the economy.

It should be noted that since the middle of the 20th century, as in the whole world, in our republic, due to the rapid development of science and technology, the creation of various production areas, the rapid growth of the population, while at the same time, the aggressive policy of other countries and the violation of the legal regime surrounding lands had a negative impact on the ecological environment and natural resources of the country, especially on the use of soil resources (Mammadov, 2021).

In the modern period, the role and importance of the soil factor in human life have increased even more. The activity and development of the agricultural sector, functioning in a way to meet the natural needs of man and directly related to the soil, is associated primarily with the land factor, and then with the

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state of its use. Even industrial production, which at first glance is not directly related to the land factor, is to some extent connected with soil and other resources associated with it. It should be noted that land relations have always been one of the main factors that decided the fate of the country.

MATERIALS AND METHODS

The Karabakh Economic Region differs from other regions of the republic in the complexity of natural conditions. The vegetation of the region, characterized by various climatic features, attracts attention to its biodiversity. Wormwood semi-deserts, dry deserts and semi-deserts on the foothill plains, xerophilic thickets, broad-leaved forests (beech, oak, etc.) are common on mountain slopes.

As a result of the interaction of the natural complexes of the region, a unique composition of the soil cover was formed. The existing vegetation cover of the formed and developing area mainly consists of herbaceous mountain-meadow, steppe mountain-meadow, brown mountain-forest, mountain-black, gray-brown, mountain-chestnut, gray, meadow-forest are widely distributed alluvial subtypes and types of meadow soils. In the mountain-mid-mountain zone, it is characterized mainly by a mild warm climate with dry winters, and in the high mountain zone - a cold climate with dry winters. As can be seen from the climatic data, the air temperature fluctuates between 1.90-3.30 (Fizuli and Tartar) in the mountainous part, and in the middle mountain zone it reaches -0.50 (Shusha). The same regularities are observed in the change of air temperature by seasons of the year.

Methods of approaches to the ecological assessment of soils for agricultural, fodder and forest crops have undergone a significant transformation from the 80s-90s of the last century to the beginning of the present century. When establishing special rating scales for the degree of manifestation of individual characteristics, the materials of G.Sh.Mammadov's own research, as well as the scales of a number of researchers on salinity, the structural-aggregate composition of soils, as well as climatic indicators of soils in Azerbaijan, were used (Mammadov, 2007).

However, at the beginning of the 2000s, a more advanced assessment system was put forward, which retained the scientific, theoretical and methodological foundations of the general approach of professors S.Z.Mammadova and G.Sh.Mammadov. In assessing the degree of manifestation of environmental symptoms in previous studies, he expressed the degree of manifestation of environmental symptoms by a score, and not from concepts expressing quality, that is, "high", "low", "bad", "good", and so on (Mammadova, 2006).

Also, characterizing the bioclimatic potential of the territories, A.J.Eyyubov divided them into 7 groups according to gradations (<0.8; 0.8-1.2; 1.2-1.6; 1.6-2.2; 2.2-2.8; 2.8-3.4; >3.4) and assessed these groups in terms of severity using both concepts and evaluation points.

Even in recent years, guidelines "Compilation of interactive soil maps based on GIS" and "Guidelines for the preparation of interactive electron soil maps and maps of ecological assessment of soils at a scale of 1:100000" have been developed, which are more innovative methods in this direction (Mammadov et al., 2020; Mammadov, 2022).

RESULTS AND DISCUSSION

To revive the agrarian economy, first of all, it is necessary to organize the effective use of soils, specifically determine the types of land ownership, create a mechanism for monitoring the use of land resources, and resolve such issues as their protection and conservation. Therefore, it is necessary to comprehensively introduce theoretical and practical knowledge on the restoration, improvement and protection of soil fertility, especially issues related to soil ecology. Undoubtedly, the growing demand of the population for agricultural products depends primarily on solving the problem of restoring, increasing and protecting the fertility of soils used for this purpose. The soil cover as an important component of the biosphere and an independent natural object is formed as a result of the influence of abiotic (relief, climate, parent rocks), biotic (vegetation and animals) and anthropogenic

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factors that form the soil. It is from this point of view that the soils spread in the Karabakh Economic Region are distinguished by their diversity (Table 1).

Grassy mountain-meadow soils. These soils are typical soils, more common in the subalpine zone of the highlands of our republic. Grassy mountain-meadow soils are distributed at altitudes of 1800-2000 (2500) m, occupying a large area between mountain forests and alpine meadows. Grassy mountain-meadow soils form a single belt in the mountains of the Lesser Caucasus. Favorable relief conditions of the Karabakh volcanic highland, which has a relatively large area, created more favorable conditions for the development of these lands over a large area. Grassy mountain-meadow soils are rich in humus. Its amount in the upper layer is 16.6±2.9%. Grassy mountain-meadow soils are currently used mainly for summer pastures and mowing. However, intensive anthropogenic soil erosion is currently taking place in a number of areas, pasture paths, dirt roads, animal hooves destroy the grass layer of the soil, accelerate surface washout and create linear erosion (Mammadov, 2007).

Mountain meadow-steppe soils. Mountain-meadow-steppe soils stand out as an independent type of soil formation. These soils, characteristic of subalpine meadow steppes, are mainly distributed at altitudes of 1900-2100 m. However, in the southern regions of our republic, the upper boundary of the distribution areas of these soils rises to 2000-2200 m. Mountain-meadow-steppe soils are developed on the Karabakh plateau, Zangazur, Mikhtokan and Karabakh ranges in the Lesser Caucasus region.

Differences are observed in the sequence of genetic horizons and their thickness, depending on the relief conditions of the areas of soil development, the composition of parent rocks, and the age of soil formation. M.E.Salayev (1991) showed that the characteristic profile of mountain-meadow-steppe soils is characterized by the following morphological features: areas of distribution of mountain-meadow-steppe soils are used mainly as natural meadows. Only a small part of them is used for grain and potato crops.

Typical brown mountain-forest soils. In contrast to the subtype described above, typical brown mountain forest soils are distributed over relatively large forest areas in Azerbaijan. In the Lesser Caucasus, they are distributed above 1200 m. They can be found in all forests, especially on the eastern and western slopes, under oak and beech forests. The amount of humus in typical brown mountain forest soils is relatively high compared to other subtypes. In the upper layer, its amount ranges from 8.41-11.05%, and total nitrogen is within 0.54-0.9%. A sharp change in the amount of humus in the lower layers is characteristic. According to M.E.Salayev, the average amount of humus and nitrogen in the upper layer of these soils is 10.0±1.7% and 0.61±0.10%, respectively. Humus reserves of the upper meter layer of soil are 220-400 t/ha, nitrogen reserves are 20-40 t/ha (Mammadov, 2007).

Carbonate mountain black soils. Carbonate mountain black soils were formed as a result of the deep steppe formation of forests. Currently, these soils are being developed under forb steppes. In the described soils, the humus content belongs to the humus type, the amount of humic acids is higher than that of fulvic acids. If the Ch/Cf ratio is greater than one, a significant part of the humic acids combines with calcium, forming calcium humates. The fact that the C/N ratio in the upper horizons is low (3.7-7.7-9.6) indicates a deep decomposition of humus compounds in these soils. From the production point of view, carbonate mountain black soils are currently used mainly for grain, partly for tobacco and potatoes, without crop rotation.

Leached brown mountain-forest soils. Leached brown mountain-forest soils are not very large in the area; they occupy relatively small areas in the dry forest zone. These soils usually do not form an integral array, since they are formed mainly on the border with brown mountain forest soils on relatively well-moistened northern and northwestern forest slopes, in a relatively shaded forest zone. The amount of humus in the upper horizon of these soils ranges from 4.78-7.93%. Its average amount is 6.0±1.3%. The amount of humus gradually decreases in the lower horizons (Mammadov, 2007).

Typical brown mountain-forest soils. Typical brown mountain-forest soils are one of the soil subtypes widely distributed in the dry forests of the region. Typical brown mountain-forest soils occupy a large area in a relatively weakly fragmented mid-mountain zone. The described soils differ in that the amount of humus is somewhat higher than in leached brown mountain-forest soils. In the upper horizons, its amount ranges from 5.6 to 10.8%. In southwestern Azerbaijan, it reaches 5.72-6.98% (Hasanov, 1978). Its average amount is 6.4±1.2%. The humus layer is extended down, in some cases even at a depth of 60-70 cm the amount of humus is not lower than 0.7-0.8%.

Carbonate brown mountain-forest soils. The belt in which these soils are distributed borders on typical and leached brown mountain forest soils from above and gray-brown soils of dry subtropical steppes in the system of altitudinal zonality. In the dry forests of the region, typical carbonate brown mountain forest soils are formed under sparse, significantly grayed oak-beech forests, as well as xerophilic shrub formations with well-developed herbaceous vegetation. The total amount of phytomass in this zone often does not exceed 100 t/ha. The amount of humus in carbonate brown mountain forest soils is somewhat lower than in other subtypes. Its average amount often does not exceed 4.0-8.0%.

Dark gray-brown (chestnut) soils. Dark gray-brown (chestnut) soils are distributed over a relatively limited area compared to other subtypes. These soils are bordered by grayish-brown soils at an altitude of 500-550 m in the upper part, and the lower boundary passes at an altitude of about 200-300 m. These soils often develop on rubble-garnet soil-calcareous loams, carbonate loess-like loams and clays. The humus profile of dark gray-brown (chestnut) soils almost repeats the profile of brown soils. The amount of humus varies between 3-5%. The distribution of humus in the soil profile towards the lower layers is gradual. At a depth of 80-90 cm, its amount is 0.5-0.7% (Mammadov, 2007).

Ordinary gray-brown (chestnut) soils. Ordinary gray-brown (chestnut) soils are one of the widespread subtypes of gray-brown soils. The soils included in this subtype are distributed between heights of 200-400 m in the Karabakh plain in the surrounding parts of the Kur-Araz plain. The amount of humus in ordinary gray-brown (chestnut) soils is less than in dark gray-brown soils. Its amount fluctuates between 2.0-3.0% in the upper horizons. The amount of humus in ordinary gray-brown (chestnut) soils in the southwest of the country reaches 3.09% (Hasanov, 1978).

Light gray-brown (chestnut) soils. Light gray-brown (chestnut) soils are a drier variant of gray-brown soils and are common in the drier parts of dry steppes, often below dark and normal gray-brown soils. The described soils are mainly formed under sagebrush-aggot, ephemeral-sagebrush, and in some cases under sagebrush-grass-ephemeral plants. The amount of humus does not exceed 2.1-2.3%. In some areas, its number is lower. The change of humus in the lower layers of the soil profile occurs gradually (Mammadov, 2007).

"Sod" gray-brown (chestnut) soils. "Sod" gray-brown (chestnut) soils are distributed over a limited area compared to other subtypes of gray-brown soils. These soils were formed on the crust of sulfate and carbonate erosion and spread in the form of a whole strip from Shamkir to Ganja, as well as in the Gazakh region, throughout Araz (Jabrail, partially Fizuli and Zangilan regions), in the form of separate spots on the Karabakh plain. The amount of humus in "sod" gray-brown (chestnut) soils usually does not exceed 2.2-2.8%. There are hardened, carbonate, saline, irrigated and underdeveloped types of gray-brown (chestnut) soils.

Meadow gray-brown (chestnut) soils. Soils included in this subtype are formed on relatively high and poorly drained river terraces, in areas where groundwater is located closer to the surface of the earth (2-3 m). Groundwater, located close to the surface, has a large influence on the process of soil compaction. In addition, a certain role in the moistening of these soils is played by surface waters flowing from the surrounding slopes, since they spread over relatively low-relief elements.

Gray soils. Gray soils of the region are poorly supplied with humus. Its quantity in the upper soil layer is 1.4±0.1%. In some species, the amount of humus varies between 1.5-2.0%, and in some cases, its absolute amount exceeds 2%. The main part of humus accumulates in the upper horizons (A and AB) and decreases with depth, amounting to 0.3-0.6% at a depth of 1 m. However, at the same depth, in some cases, the amount of humus exceeds 1%. The absorption capacity of gray soils is characterized by average values. Absorbed sodium is 8-15% of the absorption capacity. Soils are usually alkaline.

Floodplain meadow-forest soils. The floodplain meadow-forest soils of our republic are mainly distributed in developed forests in the floodplains and low terraces of the main rivers of the Lesser Caucasus in the dry-steppe zone. In areas where floodplain meadow-forest soils are spread, groundwater is usually located close to the surface (1-3 m) and plays a major role in the soil treatment process. According to the profile, the amount of humus decreases sharply towards the lower layers. The amount of humus in the buried horizons of these soils is 2-3 times higher than in the horizons above and below it. Floodplain meadow-forest soils are sufficiently provided with organic matter. The average amount of humus in the upper horizon of the soil is 3.2±0.4%.

To prepare the soil map of the Karabakh economic region, a traditional map at a scale of 1:600000 was first scanned and reduced to coordinates in the ArcGIS program. Later, certain information was placed in the attribute database of contours after vectorization (Fig. 1).

To map a digital terrain model of this region, the boundary of the study area was first recognized in the Global mapper program and a DEM file was loaded (Fig. 2). The DEM file we received was loaded into the ArcGis program and set up for printing. Based on the DEM map, you can see the maximum and minimum heights of the terrain (Mammadov et al., 2020; Mammadov, 2022).

The Azerbaijani state, in accordance with the interests of the whole society, carries out state registration of rights to land plots, as well as control over the targeted use of landowners and tenants of these lands. Therefore, the study of land resources, not only from a legal but also from a natural and economic point of view, is considered one of the main tasks of the state land cadastre.

Table 1. The composition of the soil cover of the region

Types and subtypes	Area, ha
Primitive and peaty mountain-meadow	67
Grassy mountain-meadow	14931
Steppe mountain-meadow	23522
Typical brown mountain-forest	7174
Typical brown mountain-forest	101124
Grass carbonate mountain-forest	2124
Leached brown mountain-forest	42325
Carbonate and steppe brown mountain-forest	49443
Carbonate mountain black	7033
Dark and ordinary mountain gray-brown	67981
Dark and ordinary mountain-chestnut	116903
Partially humus sulfate (limestone) and not fully developed mountain chestnut	28578
Dark and ordinary chestnut	84372
Partly residually solonetzic light chestnut	45196
Humus sulfate (limestone) chestnut	23416
Meadow-chestnut and chestnut	56978
Dark gray	22100
Typical gray	24102
Light and primitive gray	16461
Grassy gray	45089
Gray-grass with high humus	59251
Gray-meadow with medium and low humus	8003
Floodplain and carbonate (tugai) meadow-forest	13386
Floodplain alluvial meadow	83876
Grass swamp and swamp	3111
Bare rocks and exposed various rocks	12871

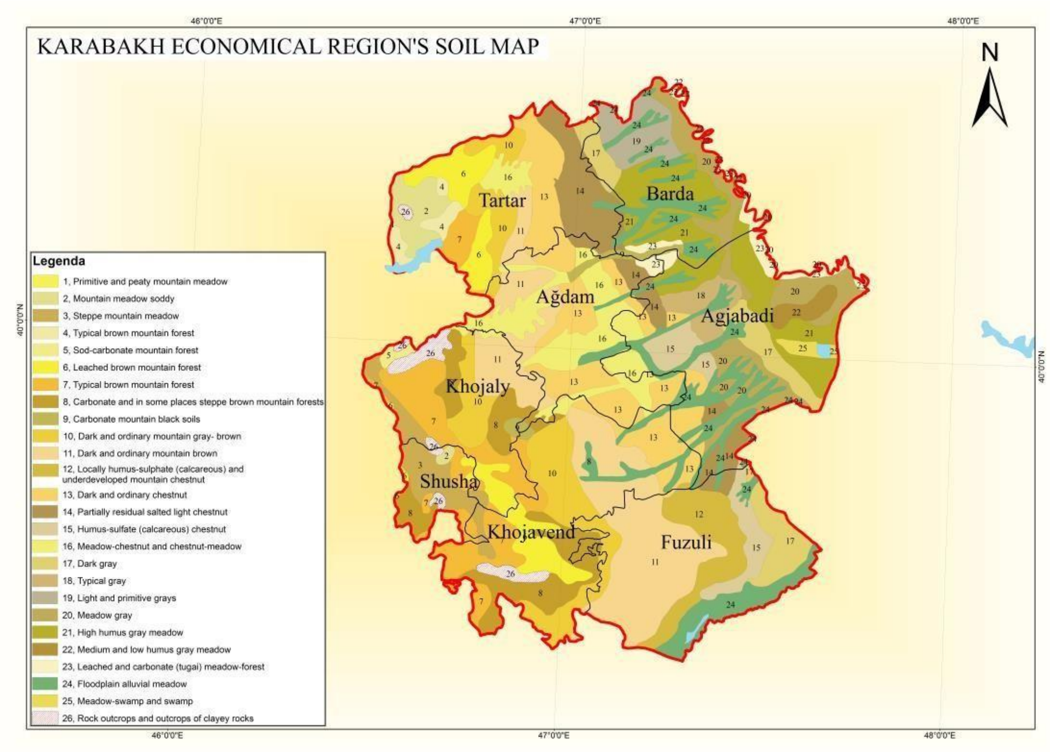

Fig. 1. Soil map of Karabakh Economic Region

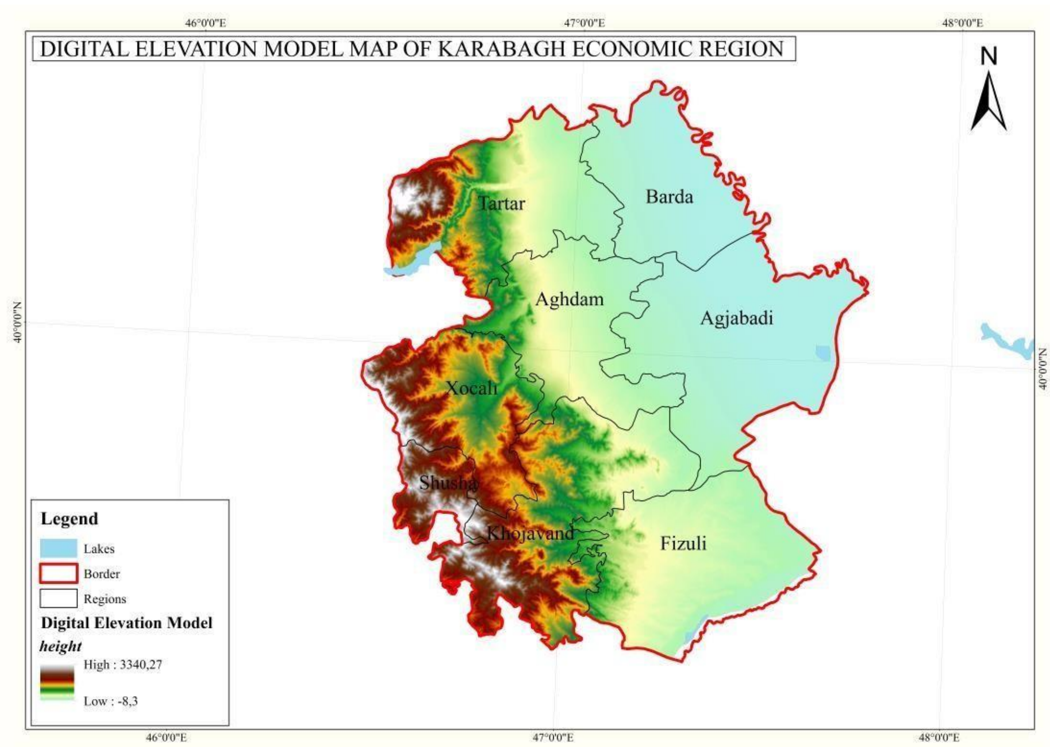

Fig. 2. DEM map of Karabakh Economic Region

Soil assessment has a dual meaning for the land registry. First, it is included in the land cadastre as an independent indicator; secondly, in the economic evaluation of soils, credit indicators ensure its objectivity, directly participating in the formation of the economic value of soils. Soils vary in fertility. Therefore, taking into account the diversity of soil fertility, their genetic and production classification and comparative assessment of their internal diagnostic indicators, i.e. their revision, are among the most important issues both in theoretical and practical terms. In table 2, the data of analyzes carried out for administrative regions in the bonitet scale of the lands of the Karabakh economic region are also reflected in the bonitet scores of the diversity of soils distributed in the region (Mammadov et al., 2022; Osmanova, 2022).

Table 2. Bonitet scale of soils of the Karabakh Economic Region (by administrative regions)

Soils	Area, ha	Bonitet scale
1	2	3
Aghdam		
Leached brown mountain-forest	42	84
Carbonate and steppe brown mountain-forest	867	93
Carbonate mountain black	2607	100
Dark and ordinary mountain gray-brown	1160	63
Dark and ordinary mountain-chestnut	17162	65
Dark and ordinary chestnut	37752	80
Partly residually solonetzic light chestnut	4982	77
Meadow-chestnut and chestnut-meadow	38919	56
High-humus gray-meadow	58	68
Floodplain and carbonate (tugai) meadow-forest	1703	88
Floodplain alluvial meadow	4459	63
Aghjabadi		
Meadow-marsh	3111	84
Meadow-gray	29041	80
Meadow-chestnut and chestnut-meadow	7818	67
Humus sulfate (limestone) chestnut	10734	100
Gray-meadow with medium and low humus content	6608	76
Partly humus sulfate (limestone) and unripe mountain chestnut	16	77
Partly residually solonetzic light chestnut	11298	95
Floodplain alluvial meadow	29544	75
Dark gray	12704	98
Dark and ordinary chestnut	9226	100
Floodplain and carbonate (tugai) meadow-forest	7121	99
High-humus gray-meadow	30598	93
Tartar		
Primitive and peaty mountain-meadow	67	20
Meadow mountain-meadow	13788	100
Typical brown mountain-forest	7114	98
Floodplain brown mountain-forest	21163	95
Typical brown mountain-forest	6947	96
Carbonate mountain black	409	100
Dark and ordinary mountain gray-brown	16560	77
Dark and ordinary mountain-chestnut	6124	73
Dark and ordinary chestnut	21102	89
Partly residually solonetzic light chestnut	25203	63
Meadow-chestnut and chestnut-meadow	7277	62
Dark gray	2436	92
Light and primitive gray	19	74
High-humus gray-meadow	285	76
Floodplain alluvial meadow	1009	71

Table 2 continued

1	2	3
Bare rocks and exposed various rocks	796	<10
Barda		
Light and primitive gray	16442	52
Meadow-gray	16048	100
Carbonate mountain-brown	1941	90
Partly residually solonetzic light chestnut	1395	95
Floodplain alluvial meadow	19851	75
Dark gray	5454	78
Floodplain and carbonate (tugai) meadow-forest	26088	89
High-humus gray-meadow	28309	86
Fizuli		
Carbonate and partly steppe brown mountain-forest	1877	100
Dark and ordinary mountain gray-brown	6420	75
Dark and ordinary mountain-chestnut	53322	77
Partly humus sulfate (limestone) and unripe mountain chestnut	28197	92
Dark and ordinary chestnut	279	95
Partly residually solonetzic light chestnut	1550	67
Humus sulfate (limestone) chestnut	12682	91
Dark gray	15491	97
Floodplain alluvial meadow	20214	75
Shusha		
Grassy mountain-meadow	1141	89
Steppe mountain-meadow	13321	96
Floodplain brown mountain-forest	1397	94
Typical brown mountain-forest	6408	96
Carbonate and partly steppe brown mountain-forest	6065	98
Bare rocks and exposed various rocks	1340	10
Khojaly		
Grassy mountain-meadow	3	89
Steppe mountain-meadow	7676	72
Grassy carbonate mountain-forest	2124	89
Floodplain brown mountain-forest	6244	84
Typical brown mountain-forest	26040	85
Carbonate and partly steppe brown mountain-forest	14604	69
Carbonate mountain black	1193	100
Dark and ordinary mountain gray-brown	12862	80
Dark and ordinary mountain-chestnut	15413	65
Dark and ordinary chestnut	57	80
Meadow-chestnut and chestnut-meadow	1307	56
Bare rocks and exposed various rocks	6877	<10
Khojavand		
Steppe mountain-meadow	2525	72
Floodplain brown mountain-forest	13478	99
Typical mountain-forest	22928	100
Carbonate and partly steppe brown mountain-forest	26029	100
Carbonate mountain black	679	99
Dark and ordinary mountain gray-brown	30980	81
Dark and ordinary chestnut	24882	76
Partly humus sulfate (limestone) and unripe mountain chestnut	366	76
Dark and ordinary chestnut	15956	76
Meadow-chestnut and chestnut-meadow	1658	65
Floodplain alluvial meadow	8799	74
Bare rocks and exposed various rocks	3858	<10

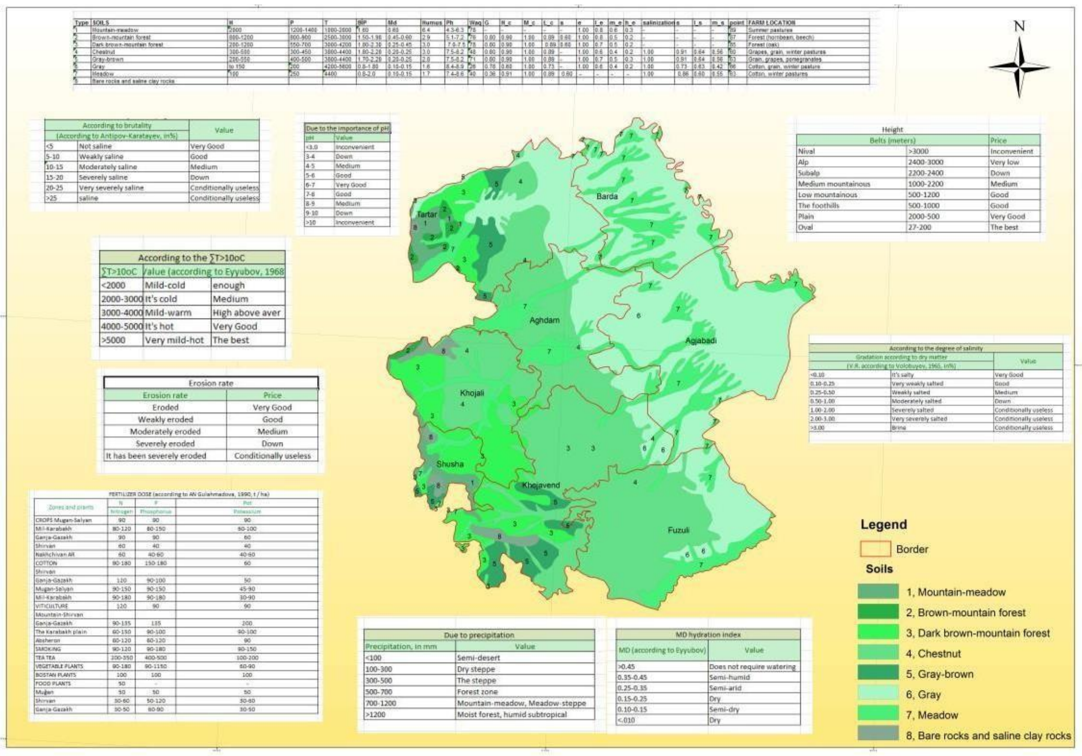

Fig. 3. Soil ecological assessment map of the Karabakh Economic Region

In the steppe zone, mountain-chestnut soils are common, occupying 29.6% of land resources. They are widely used in agriculture, horticulture, grain growing and animal husbandry. Brown mountain forest soils, which rank second in terms of the amount of soil resources in the region, occupy 25.1% of the total soil resources with partially steppe mountain forest soils. The main part of agricultural land, i.e. 48.9% are meadows and pastures. The areas of cultivated and rested lands, occupying the second place, are 38.3%. The area of land used for perennial crops reaches 9.1%. 34.% of the region's agricultural land is irrigated. The largest part of the irrigated areas suitable for agriculture, i.e. 67.8%, belongs to cultivated lands. 81.7% of perennial crops are cultivated on irrigated lands, which is 23.5% of irrigated areas in agriculture. The most irrigated areas in the region are registered in Aghdam and Fizuli regions (49.7-46.4 thousand ha). 25.4 thousand hectares of irrigated land in the Tartar region (Mammadov, 2007).

11.0% of the lands of agricultural turnover belong to the first quality group due to their high fertility. In terms of quality parameters, the main part of usable land is concentrated in 53.0% of the good quality group, which is somewhat less fertile, and the credit score ranges from 80-61. As a result of many years of careless use of land, fertility properties have deteriorated, so 31.4% of suitable land has been transferred to the group of the land of medium quality. Even 4.3% of the land used in the district was in poor quality land, as fertility indicators were seriously disturbed. The land that was once in circulation (0.3%) is not currently used, as it has been transferred to conditionally unsuitable land.

Drainage conditions of the area and salinization, waterlogging, erosion and other processes are among the factors that adversely affect the properties of natural soil fertility. At present, 39.7% of irrigated lands in the region are saline to some extent. 22.0% of saline soils are moderately saline and 11.6% are highly saline areas.

Table 3. Ecological assessment of soils of the Karabakh Economic Region (by administrative regions)

Soils	H	Y	T	BİP	Md	Humus	pH	Sag	Gr					E				S				point	Farm
									c	h.c	m.c	l.c	s	e	l.e	m.e	s.e	s	l.s.	m.s.	s.s.		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Aghdam																							
Brown mountain-forest	200-1200	550-700	3000-4200	1.80-2.30	0.25-0.45	3.0	7.0-7.5	78	0.80	0.90	1.00	0.89	0.60	1.00	0.7	0.5	0.2	-	-	-	-	85	Forest (oak)
Chestnut	300-500	300-450	3800-4400	1.80-2.20	0.20-0.25	3.0	7.5-8.2	48	0.80	0.90	1.00	0.89	-	1.00	0.6	0.4	0.2	1.00	0.91	0.64	0.56	60	Grapes, grain, winter pastures
Gray-brown	200-550	400-500	3800-4400	1.70-2.20	0.20-0.25	2.8	7.5-8.2	71	0.80	0.90	1.00	0.89	-	1.00	0.7	0.5	0.3	1.00	0.91	0.64	0.56	63	Grain, grapes, pomegranate, winter pastures
Gray	Up to 150	200	4200-5600	0.8-1.80	0.10-0.15	1.6	8.4-8.9	26	0.78	0.60	1.00	0.73	-	1.00	0.6	0.4	0.2	1.00	0.73	0.63	0.42	66	Cotton, grain, winter pastures
Meadow	100	250	4400	0.8-2.0	0.10-0.15	1.7	7.4-8.6	40	0.36	0.91	1.00	0.89	0.60	-	-	-	-	1.00	0.86	0.60	0.55	63	Cotton, winter pastures
Tartar																							
Mountain-meadow	2000	1200-1400	1000-2000	1.60	0.60	6.4	4.3-6.3	78	-	-	-	-	-	1.00	0.8	0.6	0.3	-	-	-	-	89	Summer pastures
Brown mountain-forest	800-900	2500-3000	1.50-1.90	0.45-0.60	2.9	5.1-7.2	76	0.80	0.90	1.00	0.89	0.60	1.00	0.8	0.5	0.2	-	-	-	-	-	87	Forest (beech)
Brown mountain-forest	200-1200	550-700	3000-4200	1.80-2.30	0.25-0.45	3.0	7.0-7.5	78	0.80	0.90	1.00	0.89	0.60	1.00	0.7	0.5	0.2	-	-	-	-	85	Forest (oak)
Chestnut	300-500	300-450	3800-4400	1.80-2.20	0.20-0.25	3.0	7.5-8.2	48	0.80	0.90	1.00	0.89	-	1.00	0.6	0.4	0.2	1.00	0.91	0.64	0.56	60	Grapes, grain, winter pastures
Gray-brown	200-550	400-500	3800-4400	1.70-2.20	0.20-0.25	2.8	7.5-8.2	71	0.80	0.90	1.00	0.89	-	1.00	0.7	0.5	0.3	1.00	0.91	0.64	0.56	63	Grain, grapes, pomegranate, winter pastures
Gray	Up to 150	200	4200-5600	0.8-1.80	0.10-0.15	1.6	8.4-8.9	26	0.78	0.60	1.00	0.73	-	1.00	0.6	0.4	0.2	1.00	0.73	0.63	0.42	66	Cotton, grain, winter pastures
Meadow	100	250	4400	0.8-2.0	0.10-0.15	1.7	7.4-8.6	40	0.36	0.91	1.00	0.89	0.60	-	-	-	-	1.00	0.86	0.60	0.55	63	Cotton, winter pastures
Fizuli																							
Chestnut	300-500	300-450	3800-4400	1.80-2.20	0.20-0.25	3.0	7.5-8.2	48	0.80	0.90	1.00	0.89	-	1.00	0.6	0.4	0.2	1.00	0.91	0.64	0.56	60	Grapes, grain, winter pastures
Gray-brown	200-550	400-500	3800-4400	1.70-2.20	0.20-0.25	2.8	7.5-8.2	71	0.80	0.90	1.00	0.89	-	1.00	0.7	0.5	0.3	1.00	0.91	0.64	0.56	63	Grain, grapes, pomegranate, winter pastures
Gray	Up to 150	200	4200-5600	0.8-1.80	0.10-0.15	1.6	8.4-8.9	26	0.78	0.60	1.00	0.73	-	1.00	0.6	0.4	0.2	1.00	0.73	0.63	0.42	66	Cotton, grain, winter pastures
Meadow	100	250	4400	0.8-2.0	0.10-0.15	1.7	7.4-8.6	40	0.36	0.91	1.00	0.89	0.60	-	-	-	-	1.00	0.86	0.60	0.55	63	Cotton, winter pastures

Table 3 continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Shusha																							
Mountain-meadow	2000	1200-1400	1000-2000	1.60	0.60	6.4	4.3-6.3	78	-	-	-	-	-	1.00	0.8	0.6	0.3	-	-	-	-	89	Summer pastures
Brown mountain-forest	200-1200	550-700	3000-4200	1.80-2.30	0.25-0.45	3.0	7.0-7.5	78	0.80	0.90	1.00	0.89	0.60	1.00	0.7	0.5	0.2	-	-	-	-	85	Forest (oak)
Chestnut	300-500	300-450	3800-4400	1.80-2.20	0.20-0.25	3.0	7.5-8.2	48	0.80	0.90	1.00	0.89	-	1.00	0.6	0.4	0.2	1.00	0.91	0.64	0.56	60	Grapes, grain, winter pastures
Gray-brown	200-550	400-500	3800-4400	1.70-2.20	0.20-0.25	2.8	7.5-8.2	71	0.80	0.90	1.00	0.89	-	1.00	0.7	0.5	0.3	1.00	0.91	0.64	0.56	63	Grain, grapes, pomegranate, winter pastures
Meadow	100	250	4400	0.8-2.0	0.10-0.15	1.7	7.4-8.6	40	0.36	0.91	1.00	0.89	0.60	-	-	-	-	1.00	0.86	0.60	0.55	63	Cotton, winter pastures
Khojaly																							
Mountain-meadow	2000	1200-1400	1000-2000	1.60	0.60	6.4	4.3-6.3	78	-	-	-	-	-	1.00	0.8	0.6	0.3	-	-	-	-	89	Summer pastures
Brown mountain-forest	800-1200	800-900	2500-3000	1.50-1.90	0.45-0.60	2.9	5.1-7.2	76	0.80	0.90	1.00	0.89	0.60	1.00	0.8	0.5	0.2	-	-	-	-	87	Forest (beech)
Brown mountain-forest	200-1200	550-700	3000-4200	1.80-2.30	0.25-0.45	3.0	7.0-7.5	78	0.80	0.90	1.00	0.89	0.60	1.00	0.7	0.5	0.2	-	-	-	-	85	Forest (oak)
Chestnut	300-500	300-450	3800-4400	1.80-2.20	0.20-0.25	3.0	7.5-8.2	48	0.80	0.90	1.00	0.89	-	1.00	0.6	0.4	0.2	1.00	0.91	0.64	0.56	60	Grapes, grain, winter pastures
Meadow	100	250	4400	0.8-2.0	0.10-0.15	1.7	7.4-8.6	40	0.36	0.91	1.00	0.89	0.60	-	-	-	-	1.00	0.86	0.60	0.55	63	Cotton, winter pastures
Khojavand																							
Mountain-meadow	2000	1200-1400	1000-2000	1.60	0.60	6.4	4.3-6.3	78	-	-	-	-	-	1.00	0.8	0.6	0.3	-	-	-	-	89	Summer pastures
Brown mountain-forest	200-1200	550-700	3000-4200	1.80-2.30	0.25-0.45	3.0	7.0-7.5	78	0.80	0.90	1.00	0.89	0.60	1.00	0.7	0.5	0.2	-	-	-	-	85	Forest (oak)
Chestnut	300-500	300-450	3800-4400	1.80-2.20	0.20-0.25	3.0	7.5-8.2	48	0.80	0.90	1.00	0.89	-	1.00	0.6	0.4	0.2	1.00	0.91	0.64	0.56	60	Grapes, grain, winter pastures
Gray-brown	200-550	400-500	3800-4400	1.70-2.20	0.20-0.25	2.8	7.5-8.2	71	0.80	0.90	1.00	0.89	-	1.00	0.7	0.5	0.3	1.00	0.91	0.64	0.56	63	Grain, grapes, pomegranate, winter pastures
Gray	Up to 150	200	4200-5600	0.8-1.80	0.10-0.15	1.6	8.4-8.9	26	0.78	0.60	1.00	0.73	-	1.00	0.6	0.4	0.2	1.00	0.73	0.63	0.42	66	Cotton, grain, winter pastures
Meadow	100	250	4400	0.8-2.0	0.10-0.15	1.7	7.4-8.6	40	0.36	0.91	1.00	0.89	0.60	-	-	-	-	1.00	0.86	0.60	0.55	63	Cotton, winter pastures

Slightly saline soils make up 66.4% of irrigated soils. The area of irrigated soils is 42.4 thousand hectares, which is equal to 26.6% of irrigated. 24.0% of them belong to medium and severely damaged areas. 45.9% of the region's soil resources are areas that are more or less subject to erosion. 23.4% of the eroded territories are classified as highly eroded, 28.5% moderately eroded and 48.1% slightly eroded soils. 43.3-49.1% of the territory of the Fizuli and Tartar regions is surrounded by erosion processes (Mammadov, 2007).

Fluctuations in a number of the listed soil factors testify to the importance of the ecological assessment of soils (Fig. 3, table 3). The ecological assessment of soils plays an important role in solving a number of problems in soil research. The ecological assessment of soils characterizes the conditions of their formation and the suitability of the soil cover for certain purposes. It is also possible to determine the correct place to classify soils using ecological assessment (Mammadov and Samadov, 2022).

Soil environmental assessment mapping should summarize the information obtained at all stages associated with soil assessment and should be reflected here. It should be noted that in the early 1990s, as a result of research by G.Sh.Mammadov. The author associated research in this direction primarily with the compilation of ecological evaluation maps of soils. Thus, an ecological map differs very significantly from a traditional soil map in that it includes the ecological characteristics of soils (Mammadov, 1998, 2004).

In general, since most of the region's land is located in mountainous and foothill areas, the erosion process is widespread here. Surface, linear, wind and irrigation erosion are widespread in these territories. In the foothill zone, there are many areas of development of gobu and ravine erosional types (Mammadov, 2014).

CONCLUSIONS

From the results of studies carried out according to the above methods, it can be seen that the soils common in the territory of the Karabakh economic region, according to their internal diagnostic indicators, are included in the group of soils of good quality. Thus, the assessment of soils in the general area corresponds to VIII and II quality groups.

The results obtained during the ecological assessment of the soil and climatic conditions of the region were of great interest. There are certain differences between the quality scores and ecological scores of soils. This is due to the diversity of soil and climatic conditions of the Karabakh region. In the ecological assessment, the highest score was 89 and the lowest score was 60.

In general, since most of the region's land is located in mountainous and foothill areas, the erosion process is widespread here. Surface, linear, wind and irrigation erosion are widespread in these territories. In the foothill zone, there are many areas of development of gobu and ravine erosional types.

Thus, in order to preserve the properties of natural fertility present in the soil cover and restore the lost fertility, complex anti-erosion measures are required.

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Azərbaycanın Qarabağ iqtisadi rayonunun torpaqları və onların ekoloji qiymətləndirilməsi

[1] Məmmədov Qərib Şamil oğlu, [2] Məmmədov Zaman Rəşid oğlu, [2] Osmanova Sona Abxaz qızı

[1]Azərbaycan Milli Elmlər Akademiyasının Rəyasət Heyəti, Bakı, Azərbaycan
[2]Azərbaycan Respublikası Elm və Təhsil Nazirliyinin Torpaqşünaslıq və Aqrokimya İnstitutu, Bakı, Azərbaycan

Məqalədə Qarabağ iqtisadi rayonunun iqlim və torpaq göstəriciləri, həmçinin torpaq tərkibi haqqında geniş məlumat verilmişdir. Bu məlumatlar işğalaqədərki dövrü (bəzi ərazilər istisna olmaqla) əhatə etmiş və hazırkı ümumi vəziyyətlə bağlı informasiya da təsvir edilmişdir. Qarabağ iqtisadi rayonunun torpaqları, onların kənd təsərrüfatında istifadəsinin vəziyyəti, torpaq örtüyünün tərkibi araşdırılmışdır. İqtisadi rayon üzrə yayılmış torpaqların daxili diaqnostik göstəriciləri əsasında inzibati rayonlar üzrə bonitirovkası aparılmış, müasir texnologiyalara əsaslanan DEM və torpaq xəritəsi CİS platforması üzərində hazırlanmışdır. Eləcə də yeni iqtisadi rayon üzrə torpaq-iqlim şəraitinin nəticələri təhlil edilərək ekoloji qiymətləndirmə aparılmış və xəritəsi tərtib edilmişdir. Hazırkı məqalədə verilmiş tədqiqat nəticələri işğaldan azad olunmuş ərazilərdə bərpa və quruculuq işlərinin aparılması zamanı kənd təsərrüfatı təyinatlı torpaqlardan səmərəli istifadənin çevikliyinin artırılmasında elmi əsaslara söykənmənin vacibliyini sübut etmişdir.

Açar sözlər: *Qarabağ iqtisadi rayonu, torpaq, münbitlik, bonitirovka, ekoloji qiymətləndirmə, CİS, xəritə*

Почвы Карабахского экономического района Азербайджана и их экологическая оценка

[1] Мамедов Гариб Шамиль оглу, [2] Мамедов Заман Рашид оглу, [3] Османова Сона Абхаз гызы

[1]Президиум Национальной Академии наук Азербайджана, Баку, Азербайджан
[2] Институт почвоведения и агрохимии Министерства науки и образования Азербайджанской Республики, Баку, Азербайджан

В статье представлена информация о климатических и почвенных показателях, а также о почвенном составе вновь созданного Карабахского экономического района. Приведенные данные охватывают дооккупационный период (кроме некоторых районов), описаны современные итоговые данные. Исследованы почвы Карабахского экономического района, состояние их использования в сельском хозяйстве, состав почвенного покрова. На основе показателей внутренней диагностики почв, расспространенных по экономическому району, проведена оценка административных районов, подготовлены DEM и карта почв на основе современных технологий на платформе ГИС. Также были проанализированы результаты почвенно-климатических условий нового экономического района, проведена экологическая оценка и составлена карта. Результаты проведенных научно-исследовательских работ подтвердили необходимость опоры на научные принципы в повышении гибкости рационального использования земель сельскохозяйственного назначения при проведении восстановительно-строительных работ на освобожденных от оккупации территориях.

Ключевые слова: *Карабахский экономический район, почва, плодородие, бонитировка, экологическая оценка, ГИС, карта*

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Biosecurity problems of liberated territories of Azerbaijan and their solutions

Muradov Panah Zulfugar

*Institute of Microbiology, Ministry of Science and Education of the Republic of Azerbaijan,
103 M.Mushfig Str., Baku AZ1004, Azerbaijan*

For correspondence: *mpanah@mail.ru*

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The presented work touches upon the importance of ensuring the biological safety of society and nature in modern times, as well as the points taken into account when ensuring it. It becomes clear that biosecurity is a process aimed at preventing the spread of bioterrorism and infectious diseases, which lead to dangerous consequences and is realized thanks to the participation of each individual. Biosecurity is an even more important issue for Azerbaijan in view of more than 70% of water resources forms at the expense of transboundary sources, and the presence of a state in the neighborhood that openly uses all types of terrorism (political, ecological, biological, etc.). This is clearly shown by the pollution of Okhchuchay, which enters Azerbaijan from the territory of the Republic of Armenia, according to its physicochemical and microbiological indicators. At the same time, the presented work shows the local, regional and global problems for biosecurity and touched upon points that are important to pay attention to their solution.

Keywords: *Biosecurity, bioterrorism, infectious diseases, transboundary waters*

INTRODUCTION

One of the characteristic features of our increasingly globalized world is the development of approaches to the security of the country. From this point of view, the comprehensive guarantee of biological security (BS) of the country is one of those types. Thus, BS is one of the main and most important components of the security system that ensures the stable development of the state. Biologically active materials(living or various metabolites derived from them), which shake the world and are even more terrible than weapons of mass destruction, can sometimes be used as a tool that can destabilize the local, regional and global space, create social tension and cause other negative situations to occur. Although the advancements in world politics and scientific research have had a positive effect on the biosecurity problem, they have not been directed towards solving this issue fundamentally. For this reason, BS today should be characterized as an issue that concerns everyone, from the ordinary citizen to the person at the highest level of power, and should be considered a realistic approach. If we add to what has been said, the achievements of biotechnology have a "double" character (Belyaletdinov, 2019; Romanovsky, 2021), then no further argument is needed to confirm how great the importance of this matter is.

First of all, it should be noted that in modern times, biosecurity (BS) is not only a concept that includes the fight against bioterrorism (Renault et al., 2021), it also includes the creation of conditions that allow the mass death of people and the emergence of serious problems of social and economic nature due to the purposeful and spontaneous spread of infectious diseases in the world. It is clear from this idea that it is necessary to create new technologies, develop and adopt strictly justified programs in the field of biosecurity within the country, and actively implement international relations to ensure BS.

Naturally, there must first be a legal basis for ensuring biosecurity, and this must be confirmed by the current Constitution of the Republic of

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Azerbaijan and the international conventions it has joined as a state, signed agreements, adopted laws and other documents. It is no coincidence that new laws (Romanovsky, 2021; https://adilet.zan.kz/rus/docs/Z2200000122; Xue and Shang, 2022) are currently being adopted in this direction in many countries of the world (Russia, China, USA, Kazakhstan, Belarus, etc.). It is only necessary to note that the recent decisions about BS make this issue more comprehensive and significantly differ from the Cartagena Convention, which entered into force on 11.09.2003, and reveals new perspectives on the essence of biohazard.

In general, the based on accepted and planned principles of biosecurity in the world (Shevired, 2020) firstly must be the people's health and protection, as well as the reconciliation of the interests and responsibilities of individuals, the public and the state in the field of biosecurity.

Of course, in order to solve this issue, it is necessary to carry out many tasks, but it would be logical to express in a general form: "Creating technologies that allow identifying, preventing and completely eliminating any biological threats and constantly developing them in accordance with changing requirements". The fulfillment of this task is possible in any country due to the management of society and the use of nature in accordance with the principles of sustainable development. To make this possible, it is necessary to carry out scientific research and modern research.

Although the problem of BS is one of the issues at the center of attention in the Republic of Azerbaijan, the situation cannot be considered satisfactory in the full sense. It would be appropriate to clarify this against the background of the tasks that are performed or are important to solve in terms of providing BS in several countries of the world.

The first is the tasks performed in connection with the timely identification of diseases caused by biological agents, the functionally active substances synthesized by them, and the preparation of events to prevent complications that may occur due to their influence. It should be noted that if we approach the solution of these tasks in Azerbaijan from a scientific point of view, it is clear that this field should be strongly developed. Thus should be prepared a large-scale research program for the timely identification of diseases and their causative agents, especially infectious diseases, preparation of scientific and practical bases of preventive measures aimed at the treatment of diseases, as well as preparation of methods and approaches that allow identification of metabolites produced by living organisms and causing various pathologies in humans. This program can be realized more successfully as a result of the joint activity of various fields (molecular biology, microbiology, biotechnology, genetic engineering, biochemistry, bioinformatics, toxicology, biophysics, etc.) of exact and natural sciences.

Secondly, tasks related to the use of resources, primarily bioresources, in accordance with the principles of safe and sustainable development. Extensive research is being conducted in this field around the world, and Azerbaijan is no exception in this respect. In the century we live in, the establishment of a scientific research institute under the Food Safety Agency, certain research in this field has been carried out in the institutes of ANAS (currently assigned to the Ministry of Science and Education of the Republic of Azerbaijan), the Ministry of Agriculture and Health of the Republic of Azerbaijan.

As it is known, up to 70% of Azerbaijan's water basin is formed due to transboundary waters (Yolchiyeva et al., 2020), and some of the states (Georgia and Armenia) located in the areas where these waters pass have not joined the relevant convention. On the other side, there are problems related to the security of water resources within the Republic of Azerbaijan itself. So, our territories that were occupied for nearly 30 years were returned to their original owners as a result of the 44-day Patriotic War. However, some issues that have not yet been resolved should be among the issues that should be given serious attention when ensuring the biological safety of waters from these areas to other regions of the country.

Therefore, the aim of the presented article is to clarify the points important for biosecurity and its provision in Azerbaijan.

MATERIALS AND METODOS

Initial biomonitoring was carried out in

Okchuchay under the leadership of the Ministry of Ecology and Natural Resources of the Republic of Azerbaijan with the participation of the institutes of Microbiology, Zoology, Botany, Physiology, Soil Science and Agrochemistry of ANAS(currently of the Ministry of Science and Education of the Republic of Azerbaijan), as well as other organizations. The samples were taken from the part of Okhchuchay that falls on the territories of Jahangirbeyli (N 39º24321'E 46º44928'), Tagli (N 39º643263' E 46º37446') and Burunlu (N 39º102218' E 46º304140') villages, and the samples from Basitchay, which was selected as the background, were taken from the part of Baharli (N 39º04178' E 46º41239') village. The water samples taken by the Institute of Microbiology were analyzed according to their physicochemical and microbiological indicators, for which standard methods (Aкsenov et al., 2014, Alimov et al., 2013; MУK 4.2.1884-04, Primary production of plankton, 1981) and devices such as Polintest-Photometer 7100, MW600 oxygen meter, HM digital pH-200 and others were used.

RESULTS AND DISCUSSION

The analysis of the samples taken from the monitoring points showed that there were no significant changes in the physical and chemical properties of the water. However, the amount of oxygen dissolved in the water is low (6.2 mg/l), which is not suitable for mountain rivers (8 mg/l), the amount of iron and molybdenum is 3-70 times higher than the permissible limit, the number of saprotrophic bacteria (3.5-6,0x10^3 CFU/ml) corresponds to the dirty water category (N≥10^3 CFU/ml), the amount of biodestruction of organic substances and the amount of primary organic substance formed is corresponding to it, and the amount of conditionally-pathogenic bacteria (mainly fecal coliform bacteria) is more than the permissible limit (PL). All these indicate water pollution and this happens mainly in the territory of Armenia, so when the river flows through the territory of Azerbaijan, pollution decreases (Tables 1 və 2).

Thus, Okhchuchay moves in the direction of Burunlu, Tagli and Chahangirbeyli in the Azerbaijan territory. The indicators in Basitchay, taken as a background for determining the situation in Azerbaijan, are much lower than those obtained in Okhchuchay. This fact alone allows us to say with certainty that it is one of the most important issues in terms of ensuring the biosecurity of water resources.

Table 1. General characteristics of some indicators of the samples taken from Oxchuchay and Basitchay

Hidrobiological indicators	Baharlı (Basitchay)	Jahangirbeyli (Okhchuchay)	Tagli (Okhchuchay)	Burunlu (Okhchuchay)	Permissible limit
Dissolved oxygen	7.4	7.3	-	-	6-8
Destruction	0.7	2.6	-	-	
Primary product	0.37	1.05	-	-	
Overall Density	215	320	390	390	50
Mg, mg/L	35	60	80	75	50
NO_2, mg/L	0.01	0.09	0.83	0.55	3.3
NO_3, mg/L	1.52	2.70	3.60	4.40	45
NH_4, mg/L	0.06	0.10	0.19	0.54	0.5
PO_4, mg/L	0.54	0.33	0.11	0.09	
P, mg/L	0.27	0.09	0.04	0.02	0.001
Fenol, mg/L	0.00	0.06	0.04	0.01	
Fe, mg/L	0.02	0.04	0.04	0.07	0.001
Cu, (Total) mg/L	0.00	0.08	0.42	0.40	1
Cu, mg/L	0.00	0.00	0.04	0.03	1
Zn, mg/L	0.00	0.05	0.08	0.12	1
Al, mg/L	0.01	0.08	0.09	0.12	0.5
MoO_4, mg/L	0.18	0.25	0.29	0.31	
Mo, mg/L	0.108	0.15	0.174	0.186	0.05

Table 2. Microbiological results of samples taken from Okhchuchay and Basitchay

Microbiological indicators	Baharli (Basitchay)	Jahangirbeyli (Okhchuchay)	Tagili (Okhchuchay)	Burunlu (Oxchuchay)
Saprotrof(SB)	2000	5800	6000	6500
Azotobacter	120	100	60	70
Cl. pasterianum	10^1	10^1	102	10^3
E.coli	9	17	19	29
SS (salmonella and shigella)	-	+	+	+
Bloody agar (Streptococcus,Staphylococcus	-	A lot of	A lot of	A lot of

Note: PL- Clean water – SB ≤100 CFU/ml; **Relatively clean water** - SB=100-1000 CFU/ml and **Dirty water** – SB>1000 CFU/ml

In order to achieve BS, based on the above, as well as the realities accepted in the world, the organization of biomonitoring of the environment, the prediction of threats aimed at the state of the biological environment and its safety, and the identification of cases of spontaneous and purposeful use of biological agents in a short period of time and individual and collective means of protection that allow eliminating their negative impact should be prepared as soon as possible. In addition, to ensure BS, it is important to train personnel (individual and institutional) who professionally organize the production of disinfectants, restrictive measures, organization of training, operative management of mobile resources and other issues. It is also necessary to prepare the necessary devices, equipment and reagents for ensuring BS, to prepare normative documents regulating their use, and to implement measures aimed at their improvement from time to time. These tasks can be realized as a result of the cooperation of individuals and institutions both locally, regionally and globally. Because threats to BS occur at these levels.

Local problems that pose a threat to biological security can be attributed to the level of development of each state, the state of well-being of its population, and other circumstances. Thus, the number of the world's population is gradually increasing within a stable area, and accordingly, serious problems are observed in terms of the increase in the demand of people for food, fodder, medical and technical products. It is worth noting only one fact, in 2050 the world population is predicted to be 9.8 billion. Accordingly, it is predicted [Islam and Karim, 2019] that the world's demand for food products, for example, wheat will be 10904 million tons in 2030 and 15970 million tons in 2050, which means that the production from 2030 to 2050 will increase 1.46 times. It does not seem very convincing that this can be solved in each country, as a result, it will be inevitable that there will be problems in providing biosecurity, at least locally in those countries.

The situation in the Caucasus region regarding threats that may occur on a regional scale can be cited as an example. So, each region has people with different traditions and cultures. It is possible that the states of which they are also citizens have a different attitude to the political struggle and the principles of peaceful coexistence. This has been confirmed many times in the example of the Republic of Armenia and the information given about water resources is a clear example of this. On the other side, there is no doubt that a state that considers it possible to use all types of terrorism (political, ecological, biological, etc.) to occupy foreign lands poses a threat to biological threats on a regional scale.

The following can be mentioned in relation to the dangerous situations on a global scale:

- Bio- and agro-terrorism and biological occupation;
- The spread of unknown infectious diseases in the world for a short period of time and the spread of known diseases in a new and aggravated form;
- Increase in the emergence of antibiotic-resistant forms (resistance) among disease-causing microorganisms, observation of characteristics of being able to overcome interspecies barriers in some microorganisms;
- Improper organization of control over the use of the results of biotechnology and

genetically modified organisms and products of this type;

- Development of synthetic biology, the purpose of which is to create artificial organisms that do not exist in nature, etc.

There is no doubt that there is a need to address these threats to BS. However, for this, during the provision of people's freedom, it is necessary to think of a model that does not define responsibilities at all three levels mentioned for its preparation. In short, biosecurity in the modern era is a process that will be realized due to the study and application of the traditions of the population of any country related to a healthy lifestyle for each individual, and its reconciliation with the processes taking place on a regional and global scale.

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Azərbaycanın işğaldan azad olunmuş ərazilərinin biotəhlükəsizlik problemləri və onların həlli yolları

Muradov Pənah Zülfuqar oğlu

Azərbaycan Respublikası Elm və Təhsil Nazirliyinin Mikrobiologiya İnstitutu, Bakı, Azərbaycan

Təqdim olunan işdə müasir dövrdə bioloji təhülkəsiliyin cəmiyyət və təbiətdə təmin edilməsinin əhəmiyyətinə və onun təminatı üçün diqqət yetirilən məqamalara toxunulur. Aydın olur ki, biotəhlükəsizlik hər bir fərdin də iştirakı sayəsində reallaşan, bioterrorizmin və yolxucu xəstəliklərin təhülkəli fəsadlara yol açan yayılmasının baş verməsinin qarşısının alınmasına istiqamətlənmiş bir prosesdir. Su ehtiyatlarının 70%-dən çoxunun transsərhəd mənbələr hesabına formalaşması, qonşuluqda terrorun bütün növlərindən (siyasi, ekoloji, bioloji və s.) açıq şəkildə istifadə edən dövlətin olması biotəhlkəsizliyi Azərbaycan üçün daha da əhəmiyyətli bir məsələyə çevirirmişdir. Bunu Ermənistan Respublikasının ərazisindən Azərbaycana daxil olan Oxçuçayın fiziki-kimyəvi və mikrobioloji göstəricilərinə görə çirklənməsi də aydın şəkildə göstərir. Eyni zamanda biotəhlükəsizlik üçün lokal, regional və qlobal səviyyədə olan problemlər göstərilir və onların həlli üçün diqqət yetirilməsi vacib olan məqamlara toxunulur.

Açar sözlər: *Biotəhlkəsizlik, bioterror, yolxucu xəstəliklər, transsərhəd sular*

Проблемы биобезопасности освобожденных территорий Азербайджана и их решение

Мурадов Панах Зулфугар оглу

Институт микробиологии Министерства науки и образования Азербайджанской Республики, Баку, Азербайджан

В представленной работе затронута важность обеспечения биологической безопасности общества и природы в современное время, а также моменты, учитываемые при её обеспечении. Выявлено, что биобезопасность – это процесс, направленный на предотвращение возникновения биотерроризма и распространения опасных последствий инфекционных заболеваний, реализуемый участием каждого индивидуума. Формирование более 70 % водных ресурсов за счет трансграничных источников, наличие по соседству государства, открыто использующего все виды терроризма (политического, экологического, биологического и т.п.), делает вопрос биобезопасности еще более важным для Азербайджана. Это наглядно проявляется в загрязнении Охчучая, поступающего в Азербайджан с территории Республики Армения, по его физико-химическим и микробиологическим показателям. При этом показаны локальные, региональные и глобальные проблемы биобезопасности и затронуты важные моменты, решение которых требует особого внимания.

Ключевые слова: *Биобезопасность, биотерроризм, инфекционные заболевания, трансграничные воды*

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On the vegetation of the northern part of East Zangezur

Ibadullayeva Sayyara Jamshid, *Yusifov Elman Farhad

Institute of Botany, Ministry of Science and Education of the Republic of Azerbaijan, 40 Badamdar Highway, Baku AZ1004, Azerbaijan

***For correspondence:** yusifov_e@yahoo.com*

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As a result of the conducted research, 124 species of plants belonging to 42 families were recorded in the subalpine and alpine landscapes of the area. The area has high endemism (39%). Thus, of the described species, 48 species belonging to 23 families are endemic species of different categories. Of them, 40 macroendemic species and 8 subendemic species belonging to 21 families were described. Five of the subendemic species are subendemic species for the Greater Caucasus, and three species are subendemic species for the Lesser Caucasus.

Keywords: *East Zangezur, landscapes, flora, alpine, subalpine, endemism*

INTRODUCTION

The northern part of East Zangezur mainly consists of subalpine and alpine belts. The study of high altitude is very important. Due to the extreme habitat of the area, the number of species distributed here is much smaller than in other zones. It is for this reason that the relationships between the widespread taxa and the limiting factors that surround them are relatively easy to identify and also have important scientific importance. On the other hand, the high altitude belt has high endemism. The study of the endemism of the area allows understanding of the mechanisms of florogenesis and speciation centers, to develop the theoretical basis of these processes.

On the other hand, the rational use of the natural resources of high-altitude landscapes for economic purposes remains an acute problem in the context of overgrazing. This problem is exacerbated by the fact that the territory remained neglected and out of control due to the long occupation. In this regard, the inventory of the vegetation of East Zangezur is also relevant in terms of the assessment of the category and status, as well as the resource potential of the species distributed here.

MATERIALS AND METHODS

As a result of the geobotanical research conducted during the period before the occupation of East Zangezur by the Armenian armed forces, data and herbarium specimens of 83 species belonging to 7 families were collected in the area. The main studies on taxa belong to families *Apiaceae* (21 species) and *Asteraceae* (50 species).

In the current year, monitoring and field-research works were carried out by us, information on 124 species belonging to 42 families found only in subalpine and alpine landscapes, including herbarium materials were collected.

The northern part of East Zangezur economic region mainly covers Kalbajar administrative district and partly mountainous parts of Lachin district. The average annual precipitation here is 600 mm, the average temperature of the coldest month is -10-1ºC, and the average temperature of the warmest month is 5-20ºC.

The relief of the area is mainly mountainous (Fig. 1). Its territory is surrounded by Eastern Goycha in the northwest, Murovdag in the north, Karabakh ridges in the east, Karabakh plateau in the west. The main mountainous areas of the

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territory are Gamishdag (3724 m), Delidag (3616 m), Sarjali (3433 m), Mikhtikan (3411 m), Ketidag (3399 m), Hinaldag (3367 m), Gelingaya (3335 m) peaks. The main water basins are Tartar (200 km), Levchay (140 km), Tutgunchay (136 km), Alagoller, Garagol, Zalkhagol lakes.

Fig. 1. East Zangezur location map

The area has a rich soil cover. Nine out of 14 soil types and subtypes spread in the area are found in subalpine-alpine landscapes: Mountain-forest brown leached; Floodplain meadow (alluvial meadow); Mountain meadow primitive; Mountain meadow soddy; Mountain forest meadow; Mountain forest brown typical; Mountain gray-brown dark; Mountain meadow dark and Mountain meadow black (National Atlas of Azerbaijan Republic, 2014).

The climate of the area is mild, with dry winters in the plains and lowlands, and cold in the high altitudes.

Mainly 2 landscapes are distributed in the area's high-altitude landscapes with vegetation. These are the following:

1. Nival, subnivale, partially-glacial landscapes of high altitude mountains (3200-3600 m) landscapes;
2. Alpine and subalpine meadows of high-altitude mountains (1800 – 3200 m) landscapes;

The subalpine landscapes of East Zangezur are mainly distributed on the western slopes of the Karabakh ridge, the Karabakh plateau, the foothills of the Murovdag ridge, the eastern foothills of the Boyuk Isigli mountain at altitudes of 1800-2900 m depending on the exposure of the slopes, the mountain slopes and high plateaus in the surrounding areas of Kalbajar and Lachin cities (Fig. 2). Alpine landscapes of the area are found around the peaks of the area, Boyuk and Kichik Alagols (Kalbajar), Karagol, Jilli lake (Lachin) between 2300 - 2500 m and 3200 m altitude (Fig. 3). Subnival landscapes are mainly found in the form of small spots at altitudes of 3200-3600 m near the peak of Gamishdag, Hinaldag, Isikhli and Kilinjdag mountains. Above it is already permanent snow, glaciers and bare rocks. There is no vegetation in these areas. Only lichens belonging to their families (*Megasporaceae*, *Rhizocarpaceae*, *Verrucariaceae*, *Teloschistaceae*, etc.) and some microorganisms (*Naviculaceae*, *Chlamydomonadaceae*) are found here.

As mentioned above, we have recorded 124 background species belonging to 42 families in the area (Table 1). As can be seen from the table, *Asteraceae* (14 species), *Lamiaceae* (10 species), *Fabaceae* (10 species), *Scrophulariaceae* (9 species), *Campanulaceae* (6 species) and *Campanulaceae* (6 species) families are the dominant families which are in development.

RESULTS AND DISCUSSION

During the one-week expedition, the eastern slopes of the Karabakh plateau, the southern slopes of the Murovdag ridge and the western slopes of the Karabakh ridge were inspected, and the background species of the area were investigated. New ranges of some plants were identified.

Asyneuma campanuloides (M.Bieb. ex Sims) Bornm. plant was previously described only in Nakhchivan and Talysh in the territory of Azerbaijan (Asgarov, 2016). The mentioned plant was recorded by us from the territory of Lachin district, Aghbulag village surroundings, from the alpine meadow.

Fig. 2. Subalpine landscapes of the area: a – Surroundings of Boyuk Alagol Lake (Kalbajar, 2780 m); b – Surroundings of Kichik Alagol Lake (Kalbajar, 2780 m); c – The foothills of Gatirdash mountain (Lachin, 2600 m); d – Surroundings of Keshdak village (Kalbajar, 1800 m)

Fig. 3. Alpine landscapes of the area: a – Omar pass (Kalbajar, 3200 m); b – Surroundings of Delidag (Kalbajar, 3000 m); c – The foothills of Gelingaya mountain (Lachin, 3100 m); d – Agbulag plateau (Lachin, 3000 m)

Table 1. Taxonomic structure of background species found in East Zangezur economic region

№	Family	Species
1.	*Asteraceae* Bercht. & J.Presl	*Achillea millefolium* L., *Anthemis iberica* M. Bieb. syn *A.cretica* subsp. *iberica* (M.Bieb.) Grierson , *Artemisia vulgaris* L., *Cirsium obvallatum* (M. Bieb.) Fisch., *C.kosmelii* (Adams) Fisch. ex Hohen. , *Erigeron caucasicus* Steven. , *E.venustus* Botsch. syn. *E.caucasicus* ssp. *venustus* (Botsch.) Grierson. , *Eupatorium cannabinum* L., *Inula helenium* L., *Psephellus transcaucasicus* Sosn. *syn. C.sevanensis* Sosn., *Senecio caucasigenus* Schischk., *Taraxacum stenolepium* Hand.-Mazz., *Tragopogon reticulatus* Boiss. & A.Huet
2.	*Fabaceae* Lindl.	*Astragalus aureus* Willd., *A.uraniolimneus* Boiss., *Colutea orientalis* Mill., *Lathyrus laxiflorus* (Desf.) Kuntze., *Lathyrus miniatus* M. Bieb. ex Steven, *Melilotus officinalis* (L.) Lam., *Onobrychis biebersteinii* Sirj., *O.cornuta* (L.) Desv., *O.radiata* (Desf.) M. Bieb., *Trifolium bordsilovskyi* Grossh.
3.	*Lamiaceae* Martinov.	*Betonica macrantha* K. Koch syn. *B.grandiflora), Lamium album* L., *Leonurus quinquelobatus* Gilib., *Mentha longifolia* (L.) Huds., *Nepeta pannonica* L., *Phlomoides tuberosa* (L.) Moench., *Salvia nemorosa* (Klokov) Soó, *Scutellaria orientalis L.*, *Scutellaria sedelmeyerae* Juz. , *Teucrium orientale* L.
4.	*Scrophulariaceae* Juss.	*Linaria grandiflora* Desf., *Linaria incomplete* Kuprian., *Melampyrum chlorostachyum* (Hohen.) Beauverd, *Rhynchocorys orientalis* (L.) Benth., *Scrophularia azerbaijanica* Grau, *Verbascum cheiranthifolium* Boiss, *V.marschallianum* Ivanina & Tzvelev, *V.oreophilum* K., *V.speciosum* Schrad
5.	*Campanulaceae* Juss.	*Asyneuma campanuloides* (M.Bieb. ex Sims) Bornm., *Campanula daralaghezica* (Grossh.) Kolak. & Serdyuk , *C.rapunculoides* L., *C.stevenii* M.Bieb, *C.trautvetteri* Grossh. ex Fed, *C.tridentata* Schreb.
6.	*Papaveraceae* Juss.	*Chelidonium majus* L., *Glaucium elegans* Fisch. & C.A.Mey., *Papaver dubium* L., *P.fugax* Poir., *P.orientale* L., *P.lacerum* Popov.
7.	*Caryophyllaceae* Juss.	*Dianthus integerrimus* Bunge., *D.orientalis* Adams., *Gypsophila sp., Silene caucasica* (Bunge) Boiss., *S.ruprechtii* Schischk. syn. *S.saxatilis* Sims.
8.	*Boraginaceae* Juss.	*Cynoglossum officinale* L., *Echium vulgare* L., *Huynhia pulchra* (Willd. ex Roemer & Schultes) Greuter & Burdet (M.echioides), *Myosotis alpestris* F.W.Schmidt., *Onosma caucasica* Levin.
9.	*Ranunculaceae* Juss.	*Delphinium albiflorum* DC., *Delphinium sp., Diedropetala freynii* (Conrath) Galushko, *Caltha palustris* L,, *Thalictrum minus* L.
10.	*Rosaceae* Juss.	*Agrimonia eupatoria* L., *Alchemilla erythropoda* Juz_B., *Cerasus incana syn. Prunus incana* (Pall.) Batsch , *Filipendula ulmaria* (L.) Maxim., *Fragaria viridis* Weston.
11.	*Caprifoliaceae* Juss.	*Cephalaria gigantea , Cephalaria media, Scabiosa sp., Valeriana tiliifolia* Troickij
12.	*Crassulaceae* J.St.-Hil.	*Hylotelephium caucasicum* (Grossh.) H.Ohba syn. *Sedum caucasicum* (Grossh.) Boriss., *Sedum pentapetalum* Boriss., *S.stoloniferum* S.G.Gmel.
13.	*Apiaceae* Lindl.	*Ferula orientalis* L., *Heracleum trachyloma* Fisch. & Mey.
14.	*Cannabaceae* Martinov.	*Cannabis ruderalis* Janisch. syn. *C.sativa, Humulus lupulus* L
15.	*Malvaceae* Juss.	*Alcea rugosa* Alef., *Lavatera thuringiaca* L. syn. *Malva thuringiaca* (L.) Vis
16.	*Orobanchaceae* Vent.	*Pedicularis sibthorpii* Boiss., *Rhinanthus subulatus* (Chabert) Soó
17.	*Polygonaceae* Juss.	*Bistorta carnea* (K. Koch) Kom., *Rumex alpinus* L.
18.	*Rhamnaceae* Juss.	*Rhamnus cathartica* L., *R.pallacii* L.
19.	*Valerianaceae* Juss.	*Valeriana sisymbrifolia* Vahl., *V.tiliifolia* Troickij
20.	*Solanaceae* Juss.	*Hyoscyamus niger* L, *Lycium barbarum* L.
21.	*Rubiaceae* Juss.	*Galium anfractum* Sommier & Levier, *G.consanguineum* Boiss.
22.	*Amarantaceae* Juss.	*Chenopodium foliosum* Asch**.** syn. *Blitum virgatum* L.
23.	*Amaryllaceae* J.St.-Hil.	*Allium cardiostemon* Fisch. & C.A.Mey.
24.	*Asparagaceae* Juss.	*Asparagus verticillatus* L.
25.	*Brassicaceae* Burnett.	*Cardamine uliginosa* M.Bieb.
26.	*Convolvulaceae* Juss.	*Cuscuta europaea* L.
27.	*Cucurbitaceae* Juss.	*Bryonia dioica* Bojer.
28.	*Elaeagnaceae* Juss.	*Hippophae rhamnoides* L.
29.	*Ephedraceae* Dumort.	*Ephedra procera* C.A. Mey.
30.	*Gentianaceae* Juss.	*Gentiana cruciata* L.
31.	*Grossulariaceae* DC.	*Ribes biebersteinii* Berland. ex DC.
32.	*Hypericaceae* Juss.	*Hypericum polygonifolium* Rupr. syn. *Hypericum linarioides* subsp. *linarioides*
33.	*Iridaceae* Juss.	*Iris imbricata* Lindl.

Table 1 continued

34.	*Linaceae* DC. ex Perleb.	*Linum hypericifolium* Salisb.
35.	*Lythraceae* J.St.-Hil.	*Lythrum salicaria* L.
36.	*Melanthiaceae* Batsch ex Borkh.	*Veratrum lobelianum* Bernh.
37.	*Onagraceae* Juss.	*Chamaenerion caucasicum* (Hausskn.) Sosn. ex Grossh.
38.	*Orchidaceae* Juss.	*Dactylorhiza urvilleana* (Steud.) H. Baumann & Kunkele
39.	*Resedaceae* Martinov.	*Reseda lutea* L
40.	*Saxifragaceae* Juss.	*Saxifraga cymbalaria* Steven.
41.	*Viburnaceae* Raf.	*Sambucus ebulus* L.
42.	*Violaceae* Batsch.	*Viola arvensis* Murray
Total		**124**

Table 2. Endemic species of different categories found in the East Zangezur economic region

№	Family	Species	
1.	*Asteraceae*	*Anthemis iberica , Cirsium obvallatum, C.kosmelii*, *Erigeron caucasicus, E.venustus, Psephellus transcaucasicus, Senecio caucasigenus , Taraxacum stenolepium, Tragopogon reticulatus*	
2.	*Fabaceae*	*Astragalus aureus, A.uraniolimneus, Colutea orientalis, Onobrychis biebersteinii, Trifolium bordsilovskyi*	
3.	*Campanulaceae*	*Asyneuma campanuloides, Campanula daralaghezica, C.trautvetteri, C.tridentata*	
4.	*Scrophulariaceae*	*Linaria grandiflora , Linaria incomplete, Rhynchocorys orientalis, Verbascum oreophilum*	
5.	*Caprifoliaceae*	*Cephalaria gigantea, Cephalaria media, Valeriana tiliifolia*	
6.	*Caryophyllaceae*	*Dianthus integerrimus, Silene caucasica, S.ruprechtii*	
7.	*Boraginaceae*	*Huynhia pulchra, Onosma caucasica*	
8.	*Rosaceae*	*Alchemilla erythropoda, Cerasus incana*	
9.	*Lamiaceae*	*Betonica macrantha, Scutellaria sedelmeyerae*	
10.	*Amaryllaceae*	*Allium cardiostemon*	
11.	*Apiaceae*	*Ferula orientalis*	
12.	*Grossulariaceae*	*Ribes biebersteinii*	
13.	*Hypericaceae*	*Hypericum polygonifolium*	
14.	*Iridaceae*	*Iris imbricata*	
15.	*Linaceae*	*Linum hypericifolium*	
16.	*Onagraceae*	*Chamaenerion caucasicum*	
17.	*Orchidaceae*	*Dactylorhiza urvilleana*	
18.	*Orobanchaceae*	*Pedicularis sibthorpii, Rhinanthus subulatus*	
19.	*Papaveraceae*	*Papaver orientale*	
20.	*Polygonaceae*	*Bistorta carnea*	
21.	*Brassicaceae*	*Cardamine uliginosa*	
22.	*Rubiaceae*	*Galium anfractum*	
23.	*Valerianaceae*	*Valeriana tiliifolia*	
Total number of background species			**124**
Number of endemic species of different categories			**48**
Percentage of endemism			**39%**

The species *Allium cardiostemon* Fisch. & C.A.Mey. was previously described only from Nakhchivan in the territory of Azerbaijan (Asgarov, 2016). The mentioned plant was recorded by us from the subalpine and meadows of Lachin and Kalbajar districts.

Scrophularia azerbaijanica Grau**.** as a subendemic species was previously described in Azerbaijan only from Nakhchivan and Talysh, and from abroad only from the territory of Iran (https://www.gbif.org/species/3738979).

Scutellaria sedelmeyerae Juz. was described from Azerbaijan (Gadabay, Soyudlu village surroundings) and Armenia (https://www.gbif.org/species/5608187).

This species was described by us from a new range - Kalbajar district, surroundings of Kesdak village, subalpine meadow at an altitude of 1800 m above sea level.

The results of the research show that the area has high plant endemism (Table 2). As can be seen from the endemism tables, *Asteraceae* (9 species), *Fabaceae* (5 species), *Scrophulariaceae* (4 species), *Campanulaceae* (4 species) families are the leaders of endemism in the region. While investigating the ranges of endemic species found in the area, we conditionally divided them into several groups. The vast majority of these species are in the regional range, the Caucasus Ecoregion (588,000 km^2) range (Table 3, Fig. 4).

Fig. 4. Subendemic species on the Caucasus ecoregion: **a** – *Astragalus uraniolimneus* Boiss.; **b -** *Senecio caucasigenus* Schischk.; **c -** *Hypericum polygonifolium* Rupr.; **d -** *Erigeron caucasicus* Steven.; **e -** *Linum hypericifolium* Salisb.; **f -** *Campanula daralaghezica* (Grossh.) Kolak. & Serdyuk

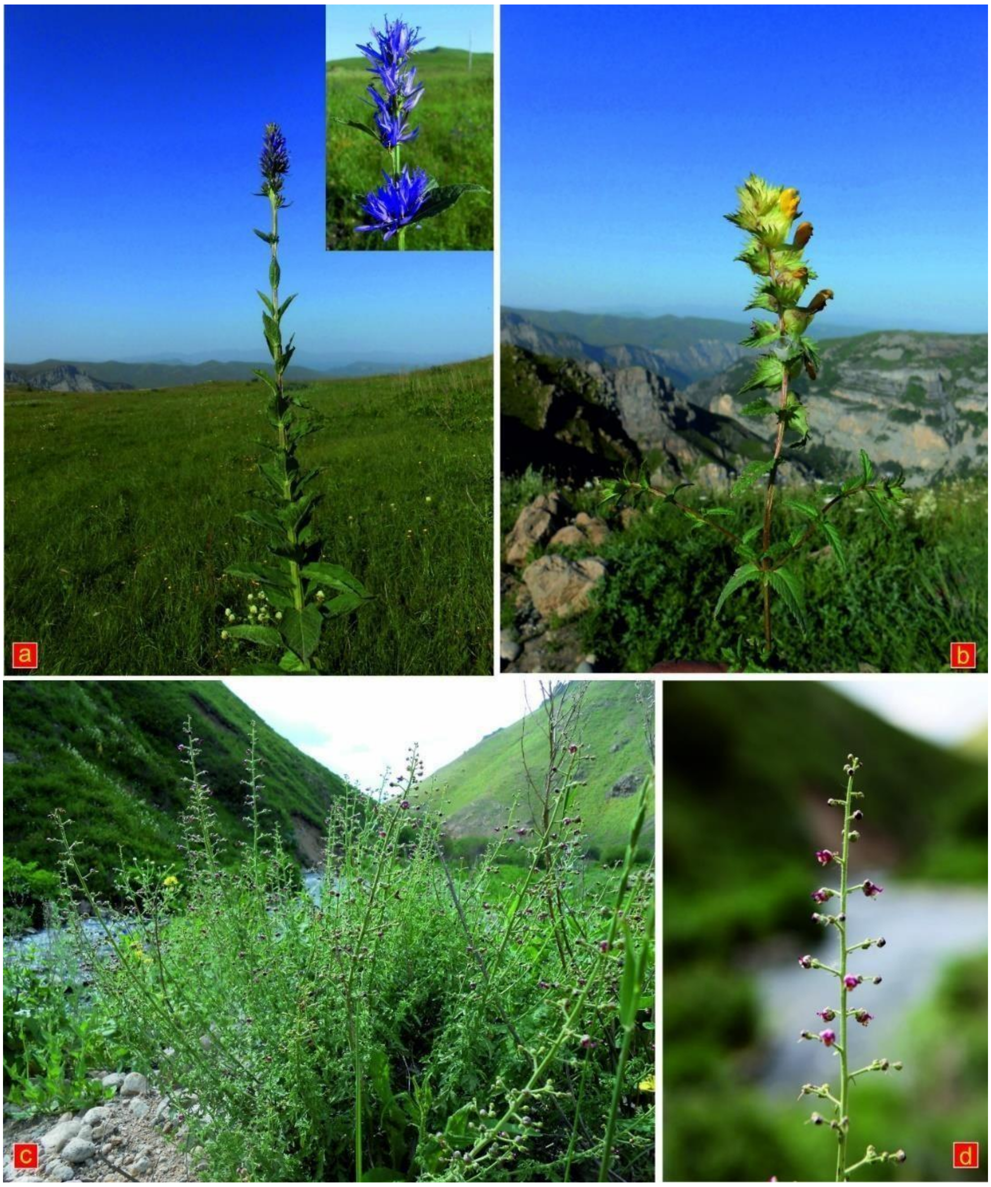

Fig. 5. Subendemic species of Azerbaijan on the Greater Caucasus (Caucasian endemics): a – *Asyneuma campanuloides* (M. Bieb. ex Sims) Bornm. (Lachin, 2930 m); b - *Rhinanthus subulatus* (Chabert) Soó (Lachin, Surroundings of Agbulag village, 2800 m); c and d - *Scrophularia azerbaijanica* Grau, (Kalbajar, Istisu, 2340 m)

Fig. 6. Subendemic species on the South Caucasus (Eastern slopes of Greater Caucasus and Lesser Caucasus): a – *Trifolium bordsilovskyi* Grossh (Kalbajar, the shore of Boyuk Alagol); b **-** *Scutellaria sedelmeyerae* Juz. (Kalbajar, Kesdak village surroundings, 1900 m); c **-** *Psephellus transcaucasicus* Sosn. *syn. C.sevanensis* Sosn. (Kalbajar, coast of Boyuk and Kichik Alagol, 2810 m)

These species are limited by the Main Caucasus mountain system (Greater Caucasus, Lesser Caucasus, Nakhchivan and Talysh mountains), Pontic Mountains (Turkey) and Alburs mountains (Iran) (Zazanashvili and Mallon, 2009). We note these species as macroendemic species.

We consider the plants found in this region as endemics with a broad category. In terms of the ecoregion, they are endemic to the Caucasus Ecoregion. Among the background species in this category, 40 species belonging to 21 families were mentioned. Here, the *Asteraceae* family dominates with 9 species.

Species included in the second category are partial or subendemic species for the Greater Caucasus. These species are common on both slopes of the main and lateral ranges of the Greater Caucasus (Table 4, Fig. 5). These species are found both in the Caucasus part of the Russian Federation and in the territories of Georgia (Georgian Biodiversity Database; Ivanov, 2019).

Table 4. Caucasian endemics found in the area (subendemic species of Azerbaijan on the Greater Caucasus

№	Family	Endemic species
1.	*Onobrychis biebersteinii*	*Fabaceae*
2.	*Asyneuma campanuloides*	*Campanulaceae*
3.	*Rhinanthus subulatus*	*Orobanchaceae*
4.	*Galium anfractum*	*Rubiaceae*
5.	*Scrophularia azerbaijanica*	*Scrophulariaceae*

Table 5. South Caucasus endemics found in the area (subendemic species of Azerbaijan on the Lesser Caucasus.

№	Family	Endemic species
1.	*Psephellus transcaucasicus*	*Asteraceae*
2.	*Trifolium bordsilovskyi*	*Fabaceae*
3.	*Scutellaria sedelmeyerae*	*Lamiaceae*

The species of the third category are subendemics of the Lesser Caucasus. *Psephellus transcaucasicus* Sosn. *syn. C.sevanensis* Sosn. species was described from Azerbaijan, Georgia and Armenia (https://www.gbif.org/species/3137957). *Trifolium bordsilovskyi* Grossh. syn. *Amoria bordsilovskyi* (Grossh.) Roskov was described from Azerbaijan (Nakhchivan, Zangezur) and Armenia (https://www.gbif.org/species/5358771).

Species belonging to the third category are subendemic species found only in the South Caucasus. We conventionally call these species the subendemics of Lesser Caucasus (Table 5, Fig. 6).

Thus, as a result of a partial inspection in East Zangezur, out of 124 background species belonging to 42 families found in the area, 40 macroendemic species and 8 subendemic species belonging to 21 families were described. Of these, 5 species are subendemic to the Greater Caucasus, and 3 species to the Lesser Caucasus.

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Şərqi Zəngəzurun şimal hissəsinin bitkiliyinə dair

İbadullayeva Səyyarə Cəmşid qızı, Yusifov Elman Fərhad oğlu

Azərbaycan Respublikası Elm və Təhsil Nazirliyinin Botanika İnstitutu, Bakı, Azərbaycan

Aparılan tədqiqatlar nəticəsində ərazinin subalp və alp landşaftlarında 42 fəsiləyə aid 124 növ bitki qeydə alınıb. Ərazi yüksək endemizmə malikdir (39%). Beləliklə, təsvir olunan növlərdən 23 fəsiləyə aid olan 48 növ müxtəlif kateqoriyalı endemik növlərdir. Onlardan 21 fəsiləyə aid 40 makroendemik və 8 subendemik növ təsvir edilmişdir. Subendemik növlərdən beşi Böyük Qafqaz, üçü isə Kiçik Qafqaz üçün subendemik növlərdir.

Açar sözlər: *Şərqi Zəngəzur, landşaftlar, flora, alp, subalp, endemizm*

О растительности северной части Восточного Зангезура

Ибадуллаева Сайяра Джамшид гызы, Юсифов Эльман Фархад оглу

Институт ботаники Министерства науки и образования Азербайджанской Республики, Баку, Азербайджан

В результате проведенных исследований в субальпийских и альпийских ландшафтах района зарегистрировано 124 вида растений, относящихся к 42 семействам. Район имеет высокий эндемизм (39%). Таким образом, из описанных видов, 48 видов, принадлежащих к 23 семействам, являются эндемичными видами разных категорий. Среди них описано 40 макроэндемичных и 8 субэндемичных видов, принадлежащих к 21 семейству. Пять из субэндемичных видов являются субэндемичными для Большого Кавказа, а три – субэндемичными для Малого Кавказа.

Ключевые слова: *Восточный Зангезур, ландшафты, флора, альпийский, субальпийский, эндемизм*

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Assessment of biological monitoring of Okhchuchay and Basitchay and saprobility of algoflora

Mukhtarova Shakar Jalal, Muradova Aytac Bahram, Mohbalizada Panah Shirin

Institute of Botany, Ministry of Science and Education of the Republic of Azerbaijan, 40 Badamdar Highway, Baku AZ1004, Azerbaijan

***For correspondence:** aytac_muradova_2016@mail.ru*

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In this paper the information about the biological monitoring carried out in Okhchuchay and Basitchay located in the Zangilan region, and algoflora saprophy of these rivers were reflected. As a result of the research, it was determined that species belonging to the oligosaprobic, mesosaprobic and polysaprobic zones are more often observed among the mass samples. The upper reaches of Okhchuchay and Basitchay are considered to be the most polluted zone, where the common species are called polysaprobic species. The aim of the work is a comprehensive study of the ecological condition of river basins subject to high anthropogenic influences, assessment of saprobity and protection of the water body as a unique biosystem.

Keywords: *Okhchuchay, Basitchay, saprob, phytoplankton, algoflora*

INTRODUCTION

Zangilan district - an administrative-territorial unit in the Republic of Azerbaijan, is located in the southeast of the Lesser Caucasus mountain range, on the left bank of the Araz river. Okhchuchay starts from the Kapichik ridge of the Zangezur range, cuts from the west to the east of the ancient Zangezur territory and flows into the Araz river at an absolute height of 300 m in the territory of Azerbaijan. The main part of the river basin is formed in the remaining part of Zangezur in the territory of Armenia (Budagov and Mikayilov, 1996).

Rivers located in the Zangilan region are severely polluted as a result of sewage discharged from factories located in the territory of Armenia. Okhchuchay and Basitchay belong to the affected rivers (Budagov and Mikayilov, 1996). Okhchuchay, which is excessively polluted by the wastes of Gafan and Gajaran mountain-mining industry, actually plays the role of a collector that removes industrial wastes from this region of Armenia. The length of the river is 85 km, 40 km of the river passes through the territory of Armenia, and the last 43 km through the territory of Azerbaijan. The area of the river basin is 1140 km². The water of the river is so poisoned that there is very little diversity of living things. Toxic waste and sewage generated in the copper-molybdenum and ore processing plants operated in that area are discharged directly into the Okhchuchay river without treatment. Life in the river is almost extinct now. There is exactly ecological disaster and terror in the river. As a result of the Okhchuchay flowing into the Araz river, the degree of pollution of the river is increasing day by day.

Basitchay is one of the polluted rivers flowing through the Zangilan region. Starting from the Bartaz plateau, it connects the Kikhovuz, Kukrataz, Sobusu rivers along its course. Being the left tributary of the Araz River, it takes its source from the territory of Armenia. The length of the river covers 44 km, of which 17 km passes through the territory of Azerbaijan. The area of the river basin is 354 km² (156 km² falls on the territory of Azerbaijan). The river is polluted by waste from pig farms in mountain villages of Armenia.

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Depending on the degree of river pollution, the study of the species that make up the saprob system of water bodies is of great importance. The saprobity system of water bodies was developed by German researchers Kolkwitz and Marsson in 1908-1909. According to Czechoslovak hydrobiologist Sladeček, saprobity is the biological condition of a water body determined by the density of organic matter and the intensity of its decomposition process. In the saprob system, the following zones, which differ according to the degree of water pollution, are defined: 1. Katarob (k); 2. Xenosaprobe (x); 3. Oligosaprobe (o); 4. α-Mesosaprobe; 5. β-mesosaprobe; 6. Polysaprobe (p); 7. Isosaprobe (i); 8. Metasaprobe (m); 9. Hypersaprobe (h); 10. Ultrasaprobe (u); 11. Antisaprobe (a); 12. Radiosaprobe (r); 13. α-Cryptosaprobe zone (c).

Catarobic and xenosaprobic zones are characterized by very clean water mass.

The oligosaprobic zone is considered a completely clean zone of water bodies. Water is usually saturated with oxygen. According to the chemical indicators of water, it differs little from catarobic and xenosaprobic basins, but traces of human activity are found. Thus, the amount of saprophytic organisms is high in this type of basins (zones). Phytoplankton is dominated by diatom algae. This zone is characterized by species diversity of algae. However, their number and biomass are small. From diatom algae - *Cyclotella comta* (Ehr.) Kuetz., *Diatoma vilgare* Bory., *Fragilaria bicapitata* A. Mayer., *Neidium productum* (W. Sm.) Cl., *Cymbella affinis* Kuetz., from green algae - *Ulotrix aequalis* Kuetz., *Closterium navicula* (Breb). Liitkom., *Hyalotheca dissilins* (Smith.) Breb. is characteristic of this zone (Alimjanova, 1991).

In the mesosaprobic zone, the degree of water pollution is relatively small, proteins are completely dissolved, hydrogen sulfide and carbon dioxide are in small amounts. The mesosaprobe zone, in turn, is divided into α and β -Mesosaprobe zones. β-Mesosaprobic zone has water contaminated with high amount of organic matter. Complete mineralization of organic matter occurs in this zone. The fauna of the mesosaprobic zone is characterized by high species diversity (Barinova et.al., 2006). The main groups of organisms in this zone are various algae. The α-Mesosaprobic zone is considered to be a zone where chemical processes are intense and highly polluted with organic substances. A number of blue-green algae are found here. α -Mesosaprobic zone is usually polluted with waste water. Organic compounds are dissolved under aerobic conditions, mainly by bacteria. Species attributed to α-Mesosapropic algae are: *Oscillatoria chalybea* (Mert.) Gom., *Phormidium uncinatum* (Ag.) Gom., blue-green algae, *Cyclotella meneghiniana* Kuetz., *Stephanodiscus hantzschii* Grun., *Synedra tabulata* (Ag.) Kuetz diatoms, *Enteromorpha intestinalis* (L.) Link is a species of green algae (Alimjanova, 2008). The β -Mesosaprobic zone contains many species of algae, but their number and biomass are much lower than in the α-Mesosaprobic zone. Blue-green algae are not found in this zone. From diatom algae – *Melosira varians* Ag., *Cyclotella kuetzingiana* Thw., *Fragilaria construens var.binodis* (Ehr.) Grun., *Navicula cincta* (Ehr.) Kuetz., *Gyrosigma acuminatum* (Kuetz). Raben., *Cymbella aspera* (Ehr.)., *C. cistula* (Hemp.) Grun., *C. prostrate* (Berk.)., *Gomphonema constrictum* Ehr., *Nitzschia communis* Rabenh., *Surirella angustata* Kuetz.; (Zabelina, Kisleyov, 1951) from eugenic algae *Trachelomonas oblanga* Lemm., *Phacus parvulus* Klebs.; from green algae - *Scendesmus bijugatus* (Turp.) Kuetz., *Ulotrix tenerrima* Kuetz., *Cladophora glomerata* (L.) Kuetz., *C. fracta* Kuetz., *Closterium parvulum* Naeg. species are found (Yuldasheva, 2018).

The polysaprobic zone has water contaminated with excessive organic and mineral matter. As a result of anaerobic decomposition of organic substances in this zone, a large amount of various substances and gases (ammonia gas, hydrogen sulfide, sometimes methane gas, etc.) accumulate in the water. Algal species found in this area are very few and their biomass is very high (Canter et al., 1951).

The isosaprobic zone is generally characterized by having highly organically contaminated water. An example of isosaprobity is fresh domestic water (waste).

The metasaprobic zone is characterized by stronger contamination with organic matter. In addition, toxic substances are also found in the waters of this zone. These substances enter through waste water.

The hypersaprobic zone is characterized by having water saturated with highly organic substances. In this zone, the decomposition of organic matter takes place under anaerobic conditions, and the water is mainly polluted by industrial waste.

The ultrasaprobic zone is known as the "dead" zone. There are no active living organisms here. However, algae spores are found in this zone.

The antisaprobic zone is found in industrial waste. This zone is considered a dead zone.

The radiosaprobe zone is contaminated with dangerous radioactive substances.

These substances accumulate in body of living beings and are transferred to other organisms through the food chain (Sladechek, 1973).

The cryptosaprobic zone is characterized by unfavorable physical conditions. In this zone - the environment (water) has excessively high or low-temperature conditions (Aghamaliyev, 2010).

MATERIALS AND METHODS

Material: Algological samples for the study were taken from the Zangilan district, located in the southeast of the Lesser Caucasus mountain range. These studies cover the months of May, July, and October 2022. In May, research was carried out only in Okhchuchay, and in July and October, both in Okhchuchay and Basitchay. Six sampling points were predetermined and samples were collected from those points. The samples were taken from Burunlu village on the upper stream of Okhchuchay, Tagly village on the middle stream, Jahangirbarli village on the downstream, Baharli village on the lower stream of Basitchay, Ordekli village on the middle stream of Basitchay, Rezere reserve on the upper stream of Basitchay. The biological analyzes were carried out on the samples taken from all 6places. In total, 13 samples were collected and 15 species were determined.

Methodology: A plankton glass and a plankton net were used to collect samples in the studied rivers, then phytoplanktons were collected by passing the water through a filter made of gas material No. 25 and No. 77, stored in hermetic glass containers, then the materials were labeled and the GPS coordinates of the collection sites were taken (Aghamaliyev, 2010; Schwoerbel, 2013). In addition to collecting the material, the water temperature is measured with a laboratory mercury thermometer, and the active reaction of the environment (pH) is measured with a universal indicator device. The process of collecting, recording and preparing the material that was taken for the study was carried out according to the generally accepted methodology (Gollerbach and Polyanskiy, 1951). For the further and detailed study of the materials, 40% formalin was added. For working in an electron microscope, the method described by G.Hasle and G.Fryxell (1970), which relatively preserves the thin structure of the upper crust, was used. The map-scheme of the research area was prepared with ArcGIS 10.7 version (Fig.1).

Electron microscopic examination (SEM) of diatoms was performed using a scanning electron microscope. A JSM-35 SEM produced by the Japanese company JEOL was used. The study of blue-green and green algae was carried out using a Nikon E 100 optical microscope. When specifying the names of algae species, the latest nomenclature was referred to using the "Algae Base" "California Academy" and "Alga Terra" websites [www.algaebase.org; www.algaterra.org; www.calacademy.org].

RESULTS AND DISCUSSION

Algal flora was studied in Okhchuchay and Basitchay rivers, which were affected by anthropogenic influence. Due to the loss of species inhabiting, the tendency of species diversity of leading flora groups to decrease, and the development of saprobic species in the waters subject to increasing pollution was simultaneously revealed. Plankton and macrophytobenthos were studied in these rivers. It has been shown that changes in the species diversity of algae occurred with the change in the mode of discharge of sewage into the rivers. The data obtained in Okhchuchay and Basitchay rivers are considered a good indicator for monitoring. The analysis of species composition of algae in the monitoring carried out in the rivers located in the Zangilan region showed that these algae have adapted to the high degree of pollution of water bodies.

14 species have been identified in these rivers. 8 species from the *Bacillariophyta* division- *Navicula cryptotenella* Lange-Bertw., *Frustulia vulgaris* (Thwaites) De Toni., *Synedra ulna* (Nitzsch) Ehrenberg., *Pinnularia viridis* (Nitz.) Ehrenb., *Cymbella amphicephala* Näegeli ex Kützing., *Nitzschia linearis* W.Smith., *Caloneis silicula* (Ehrenberg) Cleve., are species of *Navicula schoenfeldii* Hustedt (Jafarova, Mukhtarova 2018) 3 species from the *Charophyta* division - *Spirogyra crassa* (Kützing) Kützing., *Spirogyra porticalis* (O.F. Müller) Dumortier., *Spirogyra condensata* (Vaucher) Dumortier., 1 specie from the *Chlorophyta* division - *Cladophora glomerata* (Linnaeus) Kützing.. 2 species from the *Cyanoprokaryota* division - *Oscillatoria margaritifera* Kütz ex Gomont., *Oscillatoria limosa* Agardh ex Gomont - were identified. These species were photographed using SEM and light microscope (Figure 2).

Algae species are found in oligosaprobe, mesosaprobe, and polysaprobe zones. *Spirogyra condensata* (Vaucher) Dumortier. from the upper stream of Okhchuchay, *Synedra ulna* (Nitzsch) Ehrenberg. from the middle stream, *Navicula cryptotenella* Lange-Bertw., *Frustulia vulgaris* (Thwaites) De Toni., *Spirogyra crassa* (Kützing) Kützing., *Oscillatoria limosa* Agardh ex Gomont., from the lower stream *Caloneis silicula* (Ehrenberg) Cleve., Kützing species are identified. The upper stream of Okhchuchay is considered to be the most polluted place, this part starting from the territory of Armenia is a polysaprobic zone, its middle stream is a mesosaprobic upper stream, and it is considered an oligosaprobic zone.

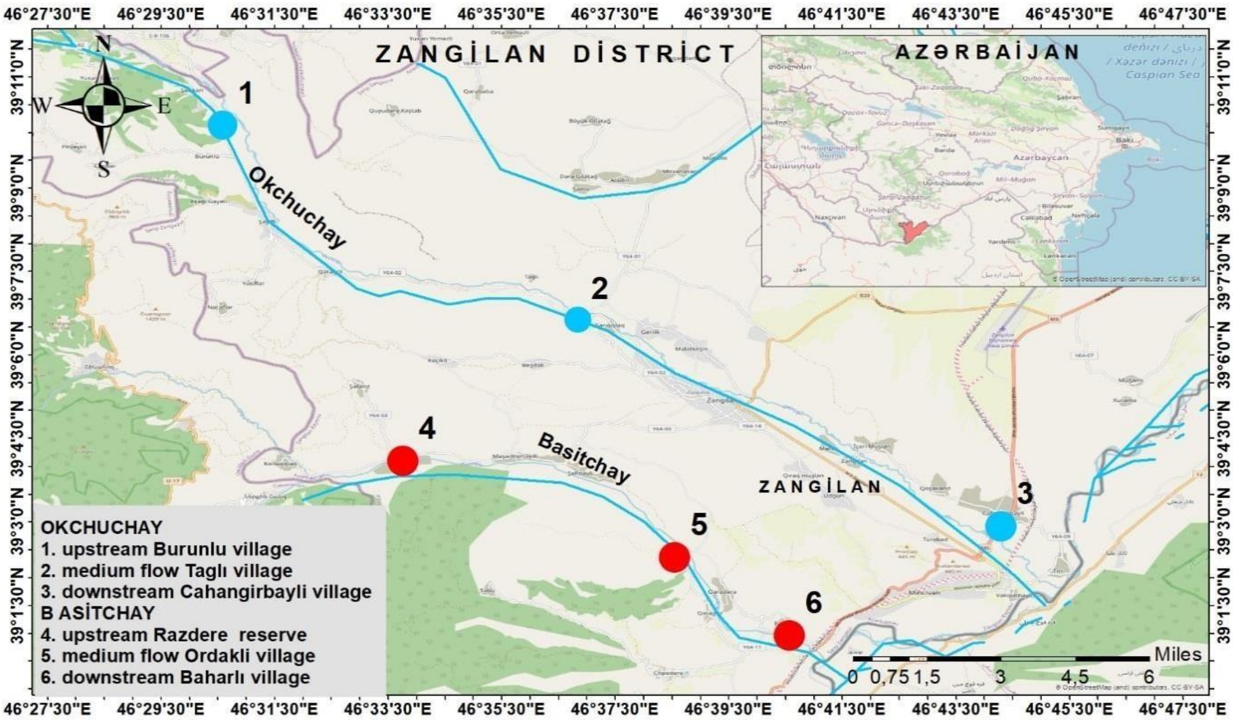

Fig. 1. Topographic map of the Zangilan district with the designation of rivers

Table. Environmental pH, temperature and dates of collection

Rivers	**16.05-20.05.2022**		**18.07-20.07. 2022**		**26.10-28.10.2022**	
	pH	temperature (ºC)	pH	temperature (ºC)	pH	temperature (ºC)
Okhchuchay						
upper stream Burunlu village	7.2	8.0	7.9	21	7.95	16.0
middle stream Tagli village	7.3	15.0	8	19	7.8	16.2

lower stream Cahangirbayli village	7.9	15.0	8.24	23	7.76	18.6
Basitchay						
upper stream Razdere reserve	-	-	-	-	8.32	15.0
middle stream Ordakli village	-			-	7.93	16.8
lower stream Baharli village	-	-	8.22	25	7.89	18.5

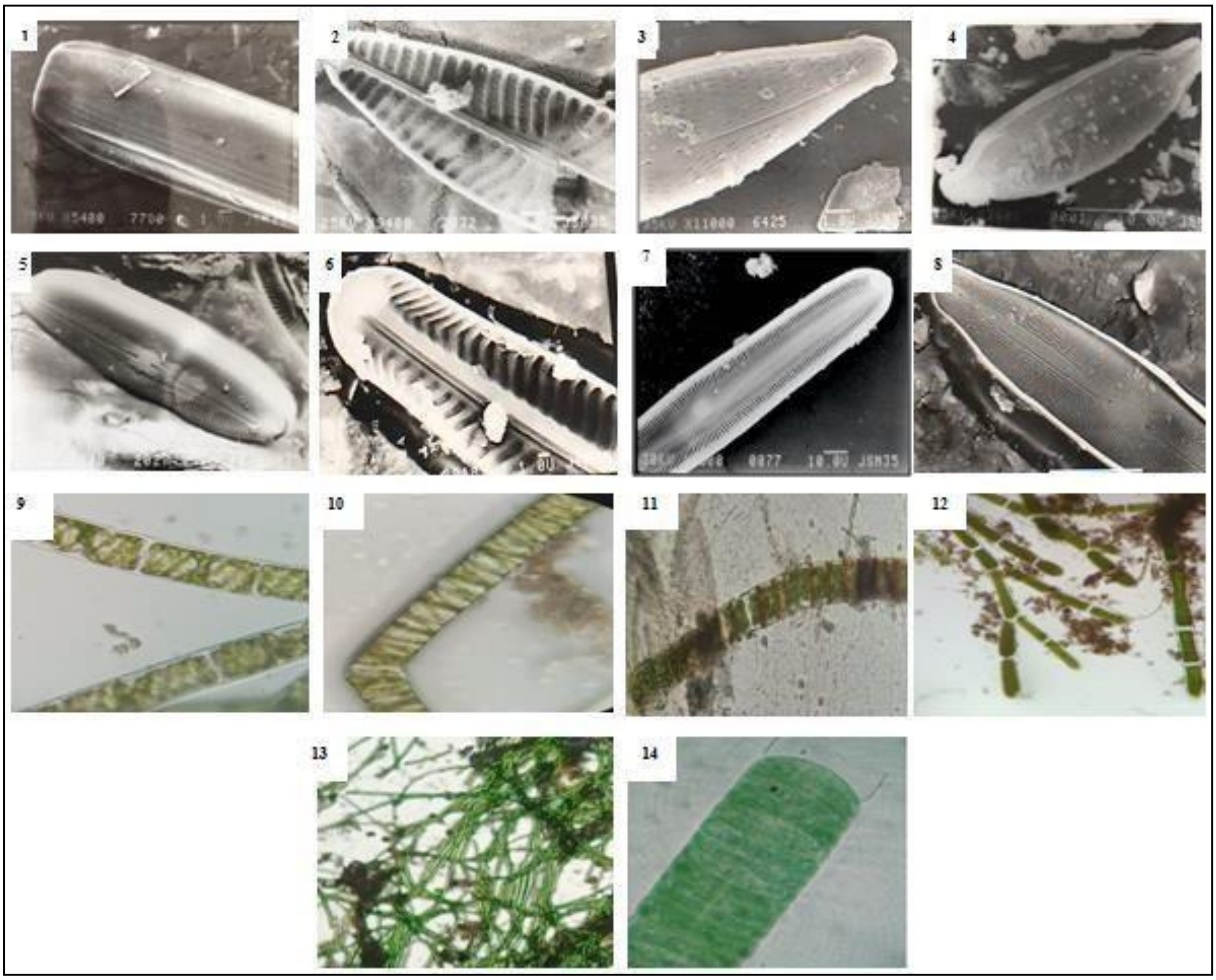

Fig. 2. View of species under the scan electron microscope (SEM) and light microscope:
1. *Nitzschia linearis* W.Smith., 2. *Navicula schoenfeldii* Hustedt., 3. *Navicula cryptotenella* Lange-Bertw., 4. *Cymbella amphicephala* Näegeli ex Kützing., 5. *Caloneis silicula* (Ehrenberg) Cleve., 6. *Frustulia vulgaris* (Thwaites) De Toni., 7. *Pinnularia viridis* (Nitz.) Ehrenb., 8. *Synedra ulna* (Nitzsch) Ehrenberg., 9. *Spirogyra porticalis* (O.F.Müller) Dumortier., 10. *Spirogyra condensata* (Vaucher) Dumortier., 11. *Spirogyra crassa* (Kützing) Kützing., 12. *Cladophora glomerata* (Linnaeus) Kützing., 13. *Oscillatoria limosa* Agardh ex Gomont., 14. *Oscillatoria margaritifera* Kütz ex Gomont

Spirogyra condensata (Vaucher) Dumortier. from the upper stream of Basitchay, *Navicula schoenfeldii* Hustedt. from the middle stream, *Cymbella amphicephala* Näegeli ex Kützing., *Oscillatoria margaritifera* Kütz ex Gomont., *Spirogyra porticalis* (O.F.Müller) Dumortier., *Cladophora glomerata* (Linnaeus) Kützing., and from the lower stream *Nitzschia linearis* W.Smith., *Pinnularia viridis* (Nitz.) Ehrenb. types were determined. The upper stream of Basitchay is considered to be the most polluted area, this is the polysaprobic zone, the middle stream is considered to be mesosaprobic, and the lower stream is considered to be oligosaprobic.

As a result, it was determined that in May, the species diversity and quantity of algae decreased compared to other months. Also, after the liberation of the Zangilan region, a noticeable increase in the diversity and number dynamics of algoflora is observed. During the study of the samples, the pH and temperature indicators of the environment and the dates of the collection were recorded (Table).

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Oxçuçay və Bəsitçayın bioloji monitorinqinin qiymətləndirilməsi və alqofloranın saprobluğu

Muxtarova Şəkər Cəlal qızı, Muradova Aytac Bəhram qızı, Möhbalızadə Pənah Şirin oğlu

Azərbaycan Respublikası Elm və Təhsil Nazirliyinin Botanika İnstitutu, Bakı, Azərbaycan

Məqalədə Zəngilan rayonunda yerləşən Oxçuçay və Bəsitçayla bağlı aparılan bioloji monitorinqlər və alqofloranın saprobluğu haqqında məlumatlar öz əksini tapmışdır. Tədqiqat nəticəsində müəyyən olunmuşdur ki, kütləvi nümunələr arasında oliqosaprob,mezosaprob və polisaprob zonaya aid növlər daha çox müşahidə edilir.Oxçuçay və Bəsitçayın yuxarı axını ən çox çirklənmiş zona hesab olunur, burada yayılmış növlər polisaprob növlər adlanır. İşin məqsədi yüksək antropogen təsirlərə məruz qalan çay hövzələrinin ekoloji vəziyyətinin hərtərəfli öyrənilməsi saprobluğun qiymətləndirilməsi və su obyektinin unikal biosistem kimi qorunmasıdır.

***Açar sözlər**: Oxçuçay, Bəsitçay, saprob, fitoplanktonun, alqoflora*

Оценка биологического мониторинга и сапробности альгофлоры Охчучая и Беситчая

Мухтарова Шакяр Джалал гызы, Мурадова Айтадж Бахрам гызы, Мохбалызаде Панах Ширин оглу

Институт ботаники Министерства науки и образования Азербайджанской Республики, Баку, Азербайджан

В статье даны сведения о проведении мониторингов рек Охчучая и Баситчая, расположенных в Зангиланском районе, а также о сапробности альгофлоры этих рек. В результате выявлено, что среди исселедованных образцов проб олигосапробные, мезосапробные и полисапробные виды встречаются довольно часто. Вследствие сильного загрязнения верхних течений Охчучая и Баситчая, распространенные здесь виды являются полисапробными. Цель работы - всестороннее экологическое изучение состояния бассейна рек, подвергшихся антропогенному воздействию, оценка сапробности и охрана водных объектов, как уникальных биосистем.

Ключевые слова: *Охчучай, Баситчай, сапробность, фитопланктон, альгофлора.*

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Integrated use of water reserve and green energy potential of rivers in Eastern Zangezur and Karabakh Economic Regions

***Mammadov Ahmad Shirin, Javadzade Elshad Baylar, Bayramov Arzuman Avaz**

"HIDROLOG" Limited Liability Company, 34 Tbilisi Ave., 53 Apart, Baku AZ1102, Azerbaijan

****For correspondence:** ahmad.m@hidroloq.az*

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The water resources formed in the territory of Eastern Zangezur and Karabakh region freed from the occupation are of special importance for the sustainable water supply of the republic. Efficient and comprehensive use of these water resources will contribute to the connection of fertile lands located in the freed Karabakh and East Zangezur economic regions to the agricultural cycle and the population can be settled quickly. Before settlement, irrigation and water supply systems should be established using the water and hydropower potential of the rivers located in this area. It is necessary to efficiently use the water resources of these rivers, during the autumn and spring high-water period. These rivers have a huge energy potential, and by building hydrotechnical facilities of various purposes on them, it is possible to fully satisfy the electricity demand of the population living in these economic regions, as well as to create a water management system that can be controlled in a self-flowing mode, which is more economically favorable. Engineering hydrological studies were carried out on the development of a more optimal water management system, taking into account the factors of natural conditions and relief indicators of the area, and the location of fertile land suitable for cultivation outside the river basins. In the article, the design solution for the creation of two derivative-type hydroelectric power plants outside the Okhchuchay riverbed in order to obtain green energy from the seriously polluted water resources of this river, which has a large hydropower potential, is presented. In the HPPs to be built on the Okhchuchay river, 80.0 million kWh of electricity can be obtained during the year, which will allow the permanent supply of electricity to more than 120,000 people. Besides, the article proposed project solutions related to the construction of water reservoirs on the rivers Hekari, Bargushad, Gargar (Zarisli tributary), and Guruchay, regulation of their flow regimes and use in the sustainable water supply of the region. The water management system to be created will allow providing a permanent drinking water supply to more than 4.0 million people and provide irrigation water to almost 80 thousand hectares of agricultural land.

***Keywords**: water supply, river, water resources, reservoir, riverbed*

INTRODUCTION

The water resources formed in the territory of Eastern Zangezur and Karabakh region freed from the occupation are of special importance for the stable water supply of the republic. Efficient and comprehensive use of these water resources will contribute to the connection of fertile lands located in the freed Karabakh and East Zangezur economic regions to the agricultural cycle and the population can be settled quickly. Before settlement, irrigation and water supply systems should be established using the water and hydropower potential of the rivers located in this area. It is necessary to efficiently use the water resources of these rivers, during the autumn and spring high-water period. These rivers have a huge energy potential, and by building hydrotechnical facilities of various purposes on them, it is possible to fully satisfy the electricity

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demand of the population living in these economic regions, as well as to create a water management system that can be controlled in a self-flowing mode, which is more economically favorable.

Engineering hydrological studies were carried out on the creation of a more optimal water management system, taking into account the factors of natural conditions and relief indicators of the area, the location of fertile land suitable for cultivation outside the river basins. The Okhchuchay river, which is 83 km long and has a water catchment area of 1175 km^2, begins from Gapijik Mountain (3285 m) of the Zangezur Range. The annual water reserve of the Okhchuchay river is 317.0 million cubic meters. The average water flow is 10.0 m^3/sec. The river enters the territory of our republic at an absolute level of 630.0 meters and after 30 km flows into the Araz River at an absolute level of 300.0 meters (Rustamov and Kashkay, 1989; Museyibov, 1998; Mammadov, 2022).

The cities of Gafan and Gajaran, the main industrial areas of Armenia, are located on the banks of the river. The city of Zangilan and the settlement of Minjivan of Azerbaijan are also located on the banks of this river. The annual hydropower potential of the river is 110 mln kw/h. The water of this river, which is a large water resource of the region, has been polluted for many years by industrial wastes from copper-molybdenum mines located in the territory of Armenia. The pollution of the river exceeded all norms and became extreme, and its fauna was completely destroyed. Currently, the Okhchuchay river is included in the list of the most polluted rivers in the world. Using river water for water supply and irrigation can cause serious consequences for people's health. In January-March 2021, water samples taken from Okhchuchay were found to be highly contaminated with heavy metals. According to the report of the Ministry of Ecology and Natural Resources of Azerbaijan, the amount of copper-molybdenum compounds in the water exceeds the norm twice, the amount of iron - four times, and the amount of nickel - seven times. Water samples taken from the Okhchuchay river show a serious threat to the environment. The water of the river is colored either white or yellowish periodically. Using only the hydropower potential of this river is considered more appropriate from economic and ecological points of view.

The water resources of the Hekari River, which is located in Eastern Zangezur and is mainly formed in the territory of the republic, in not currently used efficiently. The water of this river fully meets drinking water standards in terms of quality and is of great importance in ensuring the safety of the water supply for the population of the republic. Khochaz and Shalva tributaries of the river are formed entirely due to spring and snow waters located in the mountain range of the Lesser Caucasus and are not exposed to any pollution. The location of the main part of the water catchment basin of the river at a higher elevation gives a wide opportunity to use its hydropower potential to obtain electricity and to use the water in the self-flowing mode for water supply in the big cities of the republic.

The Bargushad river is one of the rivers of the Eastern Zangezur region, which has the most abundant water. Up to 85% of the water resources of this river are formed in the territory of Armenia, 4 reservoirs and hydroelectric power stations have been built on the river in the territory of Armenia, and its annual flow is fully regulated and enters the territory of the republic. Extensive studies have been conducted on the use of the water resources of this river for providing irrigation water to the surrounding areas. The conducted hydrological reports show that it is appropriate to build a reservoir at the absolute level of 540.0 m above Gubadli city. Up to 80,000 hectares of fertile land located in the Gubadli, Zangilan, Jabrayil, and Fuzuli regions will be supplied with water taken from the reservoir to be built at this level. It will be possible to provide irrigation water without using pumps.

The water resources of the Guru and Gargar rivers located in the Karabakh zone are not used efficiently. It is possible to use the autumn-winter-spring flow volumes of these rivers more efficiently by collecting them in reservoirs. The location plan of the main rivers in the territory of the Eastern Zangezur and Karabakh economic regions is given in Figure 1.

During the Soviet period, 35.0 thousand hectares of the 100 thousand hectares of arable land in the Zangilan, Gubadli, Jabrayil and Fuzuli regions were provided with irrigation water through 47 pumping stations built along the Hekari River, Hasanli, Maralarkh and Bash Mil canals. Irrigation water was raised to some parts of the areas by 2-stage pumps.

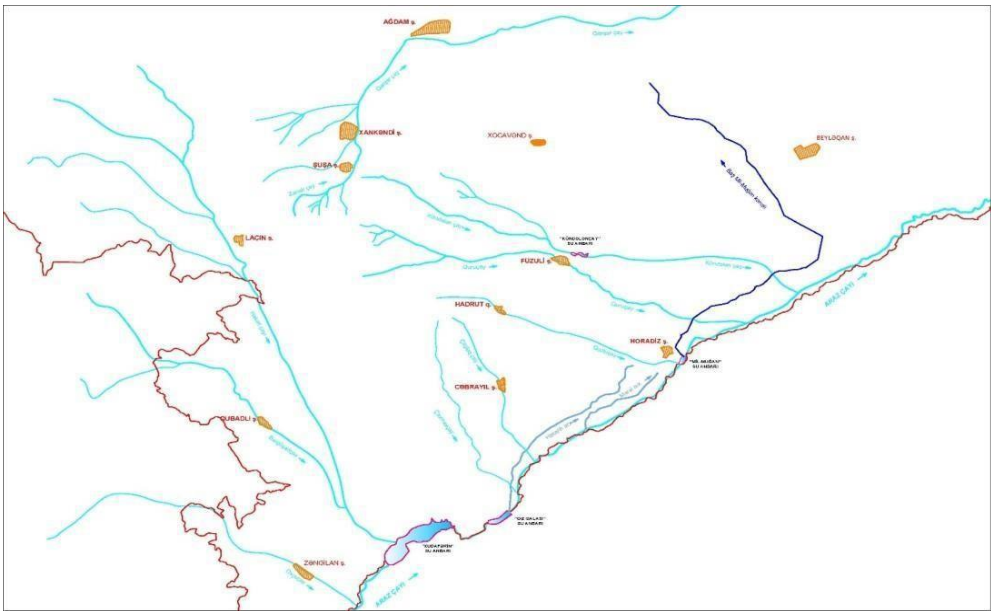

Fig. 1. The main rivers in the territory of Eastern Zangezur and Karabakh economic regions

From 3 high-pressure pumping stations (Balasultanli, Hamzali and Mammadbeyli pumping stations) built along the Hekari River, about 3.3 m^3 of irrigation water was raised to the Gayan Plain in one second. Using this water reserve, land plots belonging to the Gubadli (2500 ha), Jabrayil (3300 ha) and Zangilan (3400 ha) regions were irrigated in the Gayan plain. Through 17 pumping stations (total productivity 3.6 m^3 per second) on the Hasanlı and Maralarkh canals connected to the Araz River, irrigation water supplied up to 8,600 hectares of farmland located in the Jabrayil region. 27 pumping stations were built on the Bash Mil and Yukhari Mil canals to provide irrigation water to the agricultural fields located on the Harami plain in the Fuzuli region. Up to 20,000 hectares of farmland were irrigated in the Harami plain until the 1990s by using these pumping stations with a total productivity of 13.6 m^3 per second. Currently, many of these pumping stations are operating. Figure 2 describes the scheme of irrigation of cultivated fields till 1990.

It should be noted that since the 1980s, groundwater has been widely used for irrigation in order to develop viticulture in these areas. In total, more than 517 deep subartesian wells were dug in the Fuzuli and Jabrayil regions, from which 150 million cubic meters of precious, potable water was extracted and used for irrigation. According to the calculations, in total, 260 million kw/h of electricity was used to provide irrigation water to 45,000 hectares of agricultural land located in these regions. 200 million kw/h of this energy was used in pumping stations that raise water from canals.

Thus, efficient use of the water resources of the abundant rivers located in the region will create ample opportunities to provide the population with high-quality drinking water and the fertile soil of Karabakh with irrigation water without pumps.

Proposals regarding the use of hydropower potential of the Okhchuchay river. Protecting the ecosystem of the Okhchuchay river and using its hydropower potential can be solved within the framework of one project.

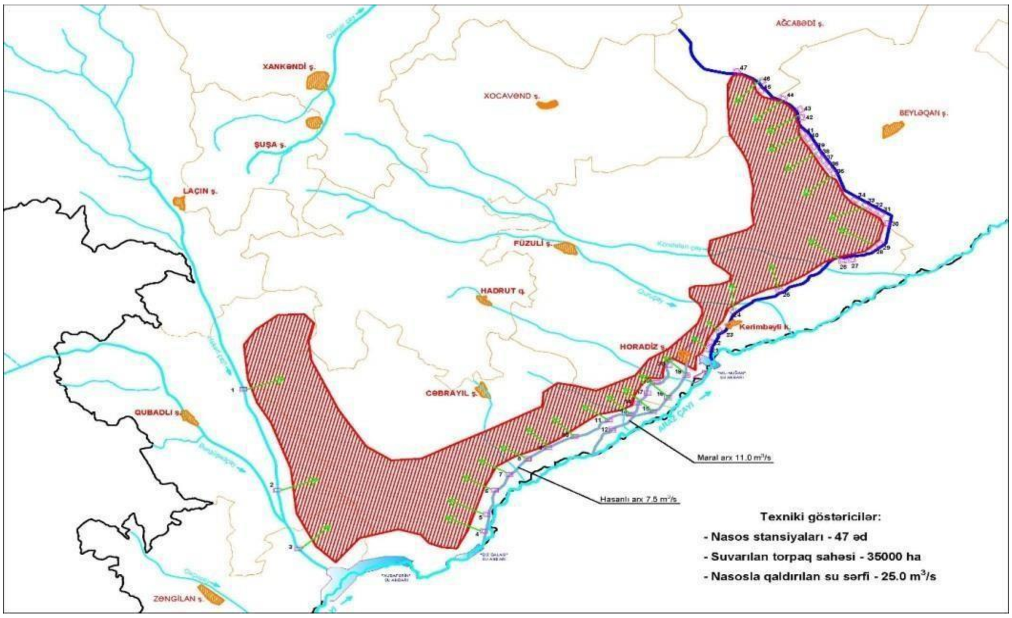

Fig. 2. Territories irrigated using pumps till the 1990s

For this, at the place where the river enters the territory of the republic, a regulatory reservoir with a volume of 5-6 million m^3 should be built at the level of 630 meters, and highly polluted river water entering the territory should be removed from the riverbed. The river water collected in this reservoir will be transferred to the "Zangilan-1" HPP, which will be built near the city of Zangilan at a level of 470 meters, with a total installed capacity of 9.0 MW, by diverting it from the channel through a derivation pipe with a diameter of DN 2200 mm and a length of L=13.0 km. It will be possible to produce 90 million kWh of electricity per year through this HPP. The river water from the first HPP will be diverted from the riverbed by means of a derivation pipe with a diameter of DN 2200 mm and a length of L= 17.0 km and transferred to the "Zangilan-2" HPP, which will be built on the bank of the Araz river at a level of 300 meters, with a total installed capacity of 6.5 MW. It will allow producing 65 million kWh of electricity per year using this HPP (Figure 3). It is possible to provide more than 120,000 people with continuous GREEN ENERGY through the electricity produced in both HPPs.

Transferring the river water out of the riverbed and transporting it in transit will create ample opportunities for the protection of the ecosystem. The riverbed will mainly contain clean water originating in the territory of the republic, which is of great importance for the protection of underground water. With the implementation of the envisaged project, it is possible to achieve substantial mitigation of the environmental disaster that has occurred around the Okhchuchay river and to obtain a sufficiently large amount of electricity.

Plan of integrated use of water resources of the Barghusad and Hekari rivers. Currently, the water resources of the Hekari and Barghusad rivers are used very little. According to the hydrological point where the rivers merge, the annual water reserve of the Bargushad River is estimated to be 500 mln m^3 (except for 250 mln m^3 used in the territory of Armenia), and the annual water reserve of the Hekari River is 500 mln m^3. Thus, a total of 1.0 billion m^3 of flow enters the Araz River every year through these rivers.

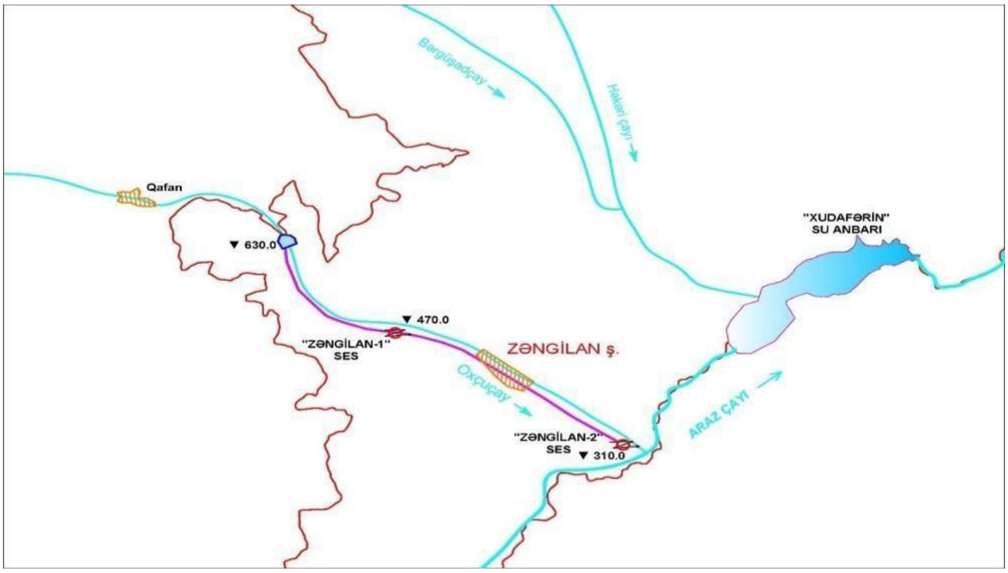

Fig. 3. The location plan of HPPs envisaged being built on the Okhchuchay river

According to the agreement signed with the Islamic Republic of Iran on the joint use of the water resources of the Araz River, 50% of the water resources of this river are to be used proportionally for each republic. According to this agreement, we can use only 500 million cubic meters of flow entering the Araz River through the Barghusad and Hekari Rivers.

The Bargushad River, which is 178 km long and has a basin area of 2711 km², begins from Zalkha Lake, located at an altitude of 3040 m, on the northern slope of the Zangezur range. The Bargushad river enters the territory of our republic near the Eyvazli village of the Gubadli region and merges with the Hekari river near the Garalar village of the district and flows into Araz. At the place where it flows into the Hekari river, the average annual water flow of the river is 24.0 m^3/sec. A part (2.0 m^3/sec) of this flow is formed in the territory of Armenia. The multi-year average water flow of the river in the Eyvazlar district is 22.0 m^3/sec (Rustamov and Kashkay, 1989; Mammadov, 2022).

The main part of the river flow is formed in the territory of Armenia. The annual flow volume has been fully regulated by building four reservoirs and several HPPs on the Bargushad river in the Armenian territory with a total volume of 300.0 mln m^3. The last of this cascade of created reservoirs is the Shamb reservoir and the derivative-type Tatev HPP. Tatev HPP, which is considered to have the largest pressure (static pressure 569 m) in the former USSR, currently occupies one of the main places in the energy network of Armenia and is mainly used during peak energy demand. According to the data of recent years, the average daily flow of water passing through this HPP is 18.5 m^3/sec and the maximum flow is 33.0 m^3/sec.

It should be noted that a part of the flow volume (about 167.0 mln. m3 per year) from the Spandaryan reservoir, which is the largest of the reservoirs built on the territory of Armenia on the Bargushad river, is planned to be discharged to the Ketchuk reservoir built on the Arpa River and from there to Goycha Lake. For this purpose, the 18.5 km long Vorotan - Arpa tunnel has been built and used since 2004. If this tunnel is used, the average flow rate entering the Azerbaijan side from the Bargushad River will be 14.0 m^3/sec. This tunnel, which has a maximum water release capacity of 30.0 m3/sec, is currently not in operation. If this tunnel is used in the future, taking into account other local needs, 250.0 mln m^3 of water is expected to be used in the territory of Armenia in a year. In this case, approximately 440.0 mln m^3 flow is expected to enter our republic. After the border, in the water accumulating part of the Bargushad river, taking into account the flow of about 60.0 mln m^3, the total annual flow volume of the river can be estimated as 500.0 mln m^3 (until it joins the Hekari river). As we mentioned above, the Barghushad river is mainly regulated in the territory of Armenia and enters the territory of the republic, and for this reason, the flow of the river has very little bottom and suspended sediments, and the flow enters the territory of the republic in a clear state. The high-water period is almost non-existent in spring and autumn. Using the water resources of the Bargushad river as follows can create an opportunity for the rapid development of the economy in the region:

- *Construction of the "Bakhtiyarli" water reservoir, which will have a volume of 50 million m^3, near the village of Bakhtiyarli in the riverbed;*
- *Construction of the "Bakhtiyarli-1" HPP with a capacity of 10.5 MW using the 120.0 m descent in the river between the village of Eyvazli and the "Bakhtiyarli" reservoir;*
- *Measures related to the use of 200.0 mln m^3 of the total water resources of the river in the local area and the lower part of the reservoir for ecosystem protection.*
- *Measures related to diverting 300.0 mln m^3 of water resources to irrigate agricultural fields of Zangilan, Jabrayil, and Fuzuli regions.*

There is a natural descent of 120 m in the 15 km long riverbed from the state border to the envisaged "Bakhtiyarli" reservoir, which constitutes a sufficient hydropower potential. In order to effectively use the hydropower potential of the Bargushad river, which enters the territory of the Republic under regulation, there is a wide opportunity to build a derivation-type HPP. It is possible to create a pressure of 120 meters by building a daily regulating reservoir-water intake device in the riverbed near the Eyvazli village of the Gubadli region, directing the river flow to the derivation pipe with a diameter of DN3000 mm and bringing it to the "Bakhtiyarli" reservoir. The capacity of the derivation-type "Bakhtiyarli-1" HPP will be 10.5 MW. Working continuously during the day, this HPP allows producing about 110.0 mln kWh of electricity, which will supply more than 80,000 people with continuous electricity. To use the water resources of the river more efficiently, it is planned to build the "Bakhtiyarli" reservoir above the city of Gubadli, at an absolute level of 540 m. According to the preliminary hydrological estimations, 200.0 mln m^3 of the total water resources of the Bargushad river is planned to be stored for ecosystem protection and local use in the lower part of the "Bakhtiyarli" water reservoir.

It should be noted that the Gubadli and Zangilan regions are located mainly in mountainous areas and there are few arable land areas. In these areas, there is no way to sufficiently use the abundant water resources of the Bargushad River for irrigation purposes. Using a part of the river's annual water reserve for irrigation in the Jabrayil and Fuzuli regions, which have larger agricultural fields and fertile lands, is considered more appropriate from an economic point of view.

The preliminary hydrological studies show that the annual flow of about 300 mln m^3 can be used to irrigate almost 80,000 hectares of farmland located in the Jabrayil and Fuzuli regions. Hydraulic estimations show that for this purpose, the construction of the self-flowing "Barghusad-Fuzuli" water pipeline with a length of approximately 97 km and a diameter of DN 2500 mm is considered an economically viable variant. The end of this water pipeline, which will provide irrigation water to the fertile lands located along the road, was chosen as the "Ashaghi Kondelanchay" reservoir located in the Fuzuli region. Preliminary hydrological estimation shows that the volume of the " Ashaghi Kondelanchay" reservoir - 9.6 mln m^3- can be increased to 25.0 million cubic meters by raising the earthen dam by an additional 10 meters. Within the framework of this project, it is planned to build "Bakhtiyarli-2" HPP with a capacity of 4.8 MW at the outlet of the irrigation system from the "Bakhtiyarli" reservoir.

The Hekari River, with a length of 113 km and a basin area of 2570 km^2 begins from the southern slope of the Mikhtoken range, at an altitude of 2580 m, joins with the Bargushad River and forms the Bazar River near the village of Garalar in the Gubadli region (340 m absolute level). The annual water reserve of the Hekari River at the confluence with the Bazar River is 500.0 mln m^3. The annual average water flow of the river (Abdallar district) until the confluence of the Zabukh River was estimated at 10.2 m^3/sec. The main water supply of the river (up to 300.0 mln m^3) begins from the confluence of the Shalva and Hojazsu rivers (950 m). The average annual water flow of the Zabukh River was estimated at 5.15 m^3/sec. In spring and summer, melting snow causes floods in the river. During the flood period (April-June), the annual flow of the river is more than 60-70%. The lowest water flow in the river is observed in the winter months. The average mineral level of the water is 200 mg/l. The spring high-water period is the main water regime phase of the Hekari river. The role of groundwater in the water balance of the river is very large. In the Abdallar district of the Hekari river, groundwater accounts for 48% of the annual flow, in the Khochazsu tributary, 63%, and in the Zabukh tributary, 88%. The river contains 10-15% rainwater. The high-water period begins in March and ends in June. In September - October, autumn floods are observed in the river. The degree of mineralization of the water in the upper flow of the river is low. Mineralization in the flood regime phase in the Lachin area is 170-270 mg/l. The water of the Hekari river fully meets the standards of "Drinking water" due to its mineral composition (5,6). In order to use the water resources of the river more efficiently, it is considered appropriate to use the annual flow volume (approximately 270.0 mln m^3) formed at the confluence of the Shalva and Khojazsu rivers (at an absolute height of 950 m) within the borders of the republic for the water supply of the population. It is planned to build the Hekari water reservoir in this part of the river with a volume of 70.0 mln m^3. By using 270.0 mln m^3 of water resources from the "Hekari" reservoir during the year, it is possible to substantially improve the supply of drinking water to the more than 4.0 million people living in the republic. By using the water resources collected in this reservoir, it will be possible to create the "Hekari-Aghdam" water pipeline and provide drinking water to the residential areas of the Aghdam region in a self-flowing mode. About 230 mln m^3 of the river's water resources are planned to be kept for ecosystem protection and local use in the lower part of the water reservoir. However, the Zabukh river, which has an annual water supply of almost 165 mln m^3, needs to be regulated after joining the Hekari river. Taking this into account, it is planned to build the Zabukh reservoir in the bed of the Hekari river, at an absolute level of 775 m. It will be possible to divert part of the water collected in the Zabux reservoir (approximately 90 mln m3 per year) to the "Barghusad-Fuzuli" water pipeline in a self-flowing mode. After the construction of both reservoirs along the Hekari riverbed, the annual flow regime of the river will be partially regulated and about 140 mln m^3 flow will remain.

Thus, after the partial regulation of the flow regime of both rivers, the total annual flow volume coming to the Araz river will be approximately 340 mln m^3. 130 mln m3 of this flow volume is intended to be used for technical and irrigation purposes in the villages located along the road (along both rivers) (about 20 thousand ha of cultivated land). Taking into account the release of 70 mln m^3 of sanitary flow to the Araz river during the year, for the protection of fisheries, about 140 mln m^3 of flow volume will be created at the confluence of the rivers for irrigation. This water reserve is also intended for irrigation. At the confluence of the Hekari and Barghushad rivers, at the absolute level of 340 m, it is planned to build the "Hekari-Barghushad" reservoir with a total volume of 80 mln m^3 to regulate the residual flows that occur throughout the year. There is a need to build a pumping station with a productivity of 18 m^3 per hour and an installed capacity of 5.8 MW in the lower part of the "Hekari-Barghusad" reservoir. The flow collected in this reservoir during the year is planned to be pumped and transferred to the pressure regulating chamber of the "Barghusad-Fuzuli" water pipeline, which will be located at the level of 500 m near the village of Veysalli. The General Plan for the integrated use of the water resources of the Barghusad and Hekari rivers is given in Figure 4.

Hekari-Aghdam water pipeline. Our research on the water balance of the Hekari River showed that the water reserve of the river of about 270.0 mln m^3 (refers to flows formed entirely within the borders of the republic) can be used mainly for the water supply of the population.

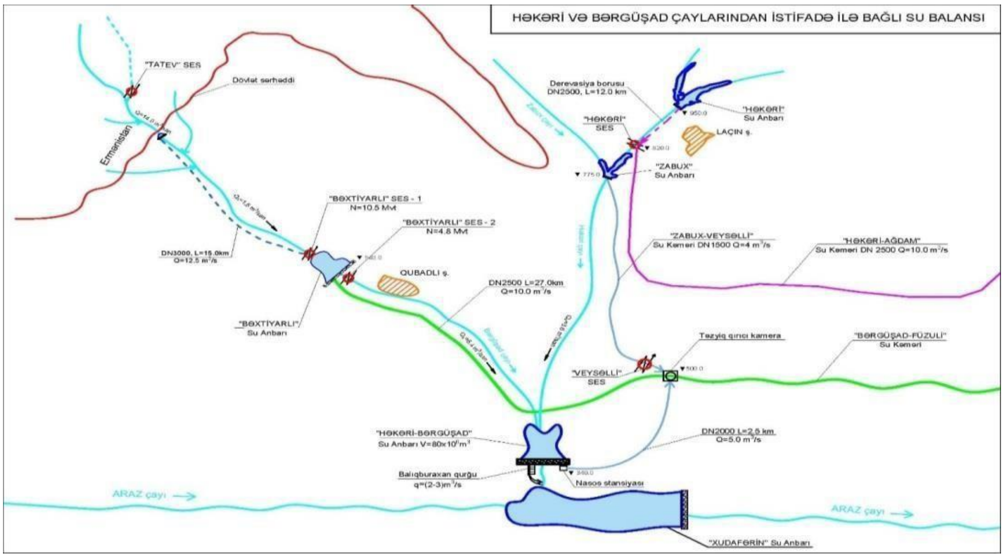

Fig. 4. General plan of integrated use of water resources of Barghusad and Hekari rivers

By using this amount of water resources, it is possible to provide a permanent water supply to more than 4.0 million people living in the territory of the republic. Preliminary studies show that water from the newly built "Hekari" HPP (820.0 m absolute level) will be self-flowing through a steel pipeline with a flow rate of 10 m^3/sec, a diameter of DN2500 mm, and a length of 34.0 km. It is possible to bring this water up to the absolute level of 775.0 m (to the upper level of the existing Chullu reservoir) in the Gayan plain of the Jabrayil region. The hydraulic calculations show that it will be possible to supply water from the water distribution chamber, which will be built at an absolute level of 775.0 m, to the water reservoir at an absolute level of 450 m, in the west of the Marzili village of the Aghdam region, with a total volume of 10.0 mln m^3 in a self-flowing regime without pumps. For this, it is necessary to build 44 km long, DN2000 mm "Gayan-Juvarli" and 60 km long, DN1200 mm "Juvarlı-Aghdam" water pipelines (*in general, the length of the Hekari-Aghdam water pipeline is planned to be 160 km, with a diameter of DN2500-1200 mm. The exact hydraulic parameters of the water pipeline and reservoirs will be specified during the development of the projects*).

To regulate the volume of flow in small reservoirs along the route of the water pipeline and to ensure that it is used locally for the water supply of the population, it is planned to build 6 water reservoirs with a total volume of approximately 152.0 million cubic meters along the water pipeline. In order to provide water supply to the cities of Gubadli and Zangilan and other settlements in a self-flowing mode, without pumps, it is planned to create the "Injachay" water reservoir with a volume of 7.0 million cubic meters in the riverbed of the Injachay at an absolute level of 610 m, where the newly built water pipeline reaches the Geyan plain (east of Chullu village of the Jabrayil district). By using the water reserve collected in this reservoir, it will be possible to provide an uninterrupted drinking water supply to the settlements located in the surrounding area independently of the hydraulic operation mode. The creation of such a small-scale local water source in the area is of strategic importance in terms of the sustainability of the population's water supply. Sustainable management of the system and minimization of operating costs will be possible only by cleaning and disinfecting the water supplied to the population only in one place. In all hydraulic modes of the water pipeline, it will be possible to supply water to the "Injachay" reservoir in a self-flowing manner. It is planned to build "Inja" HPP, which will have a capacity of 1.5 MW, using the large pressure that will be generated during the filling of the reservoir.

To provide a sustainable water supply to Jabrayil city and about 25 villages of the region by using the constructed water pipeline, it is planned to build the "Suleymanli" reservoir in the valley (640 m absolute level) where the Suleymanli village of the district is located. The water reservoir, which will be created by building an earthen dam, with a total volume of 8.0 mln m^3, will be able to provide a sustainable water supply to the local population. In case of an accident in the water pipeline, this reservoir will provide uninterrupted drinking water for more than 100,000 people living in the vicinity for almost 4 months. The NPL (Normal Pressure Level) in the reservoir is expected to be 680.0 m, which is below the piezometer level that will be created in the water pipeline. In all hydraulic modes of the water pipeline, it will be possible to supply water to the reservoirs in a self-flowing manner. The construction of "Suleymanli" HPP with a capacity of 2.0 MW at the outlet of the water intake facility is also considered. It is planned to build the "Hadrut" reservoir with a volume of 12.0 mln m^3 for the purpose of water supply and tourism at an absolute level of 550 m in the forested valley of Gozluchay in the east of the Hadrut settlement using the constructed water pipeline. It will be possible to provide a permanent water supply to the population living in about 15 villages of the Fuzuli region using the water resources collected in this reservoir. The NPL level in the reservoir is expected to be 620.0 m, which is below the piezometer level that will be created in the water pipeline. In all hydraulic modes of the water pipeline, it will be possible to supply water to the reservoirs in a self-flowing manner. This reservoir, which will be created by building an earthen dam, will be able to provide a sustainable water supply to the local population. In case of an accident in the water pipeline, this water reservoir will provide permanent drinking water to more than 150,000 people living in the surrounding area for almost 5 months. It is considered to build the "Hadrut" HPP with a capacity of 4.2 MW at the outlet of the water intake facility.

It should be noted that the "Hekari" reservoir, which is planned to be built on the Hekari river, is designed to collect mainly the river's spring flood by seasonal regulation. The reservoir is located in the region of the republic with a relatively harsh winter climate. In the winter months, in some years, the air temperature drops to minus 20ºC and the rivers completely freeze (Madatzade and Shikhlinski, 1968; Hasanov and Zamanov, 1973; Museyibov, 1998).

The population density in the area where the reservoir is being built and its immediate surroundings is very low, and there is no need to use large amounts of water. It is considered more strategic and operational to collect a part of the Hekari river's water resources in the reservoir in the densely populated area using the "Hekari-Aghdam" water pipeline. The preliminary hydrological studies show that in the area of the Fuzuli region, where the population will be more densely distributed, there are suitable valleys that can regulate the volume of flow up to 40.0-50.0 mln m^3. In terms of relief and level, the most suitable place was chosen in the valley where the Juvarli village of the Fuzuli region is located. The "Juvarli" water reservoir, which will have a volume of approximately 45.0 mln m^3, can be placed at an absolute level of 420 m in the west of the village of Juvarli. It will be possible to provide a permanent water supply to the population living in about 30 villages of the district, including the city of Fuzuli, by using the water resources collected in this reservoir. The NPL in the "Juvarli" reservoir is expected to be 500.0 m, which is below the piezometer level that will be created in the water pipeline. In all hydraulic modes of the water pipeline, it will be possible to supply water to the reservoir in a self-flowing manner. The construction of "Juvarli" HPP with a capacity of 5.4 MW is envisaged in the outlet of the water intake facility.

The "Juvarli" water reservoir is in a self-flowing mode in terms of height and will be able to provide water to Baku city, including settlements located in the Kura-Araz plain, without the use of self-flowing pumps. The level of the "Juvarli" water reservoir will allow water to be transferred to the "Alatava" water reservoir located in the highest area of Baku (location level 152.0 m) at a rate of 5.0 m^3/s in a self-flowing mode. It is possible to build the "Juvarli-Baku" water pipeline with a diameter of DN2000 mm and a length of 330 km for this purpose. It is possible to supply drinking water to the Hajigabul, Sabirabad, Saatli, Shirvan, Salyan, Neftchala, and Bilasuvar regions by building a new "Juvarli-Hajigabul" water pipeline from the

"Juvarli" reservoir to the city of Hajigabul and connecting the water supply to the existing Kura Water Pipeline. This reservoir will enable optimal management of the "Hekari-Aghdam", "Juvarli-Hajigabul", and "Juvarli-Baku" water pipelines. The "Juvarli" water reservoir is also able to supply water to 3.5 million people without interruption for a month during repairs and accidents that may occur in the "Hekari-Juvarli" (the part of the Hekari-Aghdam water pipeline up to the reservoir) water pipeline. Thus, the "center of gravity" of the water supply source will be the "Juvarli" reservoir, which will be built in the territory of the Fuzuli region, where the population will be more densely distributed, which will allow the transportation and distribution of water to the surrounding settlements in the self-flowing pressure mode, as well as ensure the stability and reliability of the system.

The establishment of a sustainable water supply system for the city of Aghdam and other villages of the region is considered one of the most strategic issues for our republic. As surface water resources are very small in this area, underground water is mainly used for water supply and crop irrigation. It is considered appropriate to create the "Aghdam" reservoir with a volume of 10.0 mln m^3 at an absolute level of 450 m in the west of the Marzili village of the Aghdam region, using the water reserves that will be collected in the "Juvarli" reservoir. The "Aghdam" water reservoir will allow the population living in 15 villages, including the city of Aghdam, to have a high-quality and sustainable water supply. The NPL level in the reservoir is expected to be 450.0 m, which is below the piezometer level that will be created in the water pipeline. The General plan of the "Hekari-Aghdam" water pipeline system that will be created is shown in Figure 5.

It should be noted that in all hydraulic regimes of the Hekari-Aghdam water pipeline, it will be possible to supply water to the reservoirs planned to be built along the road in a self-flowing manner. This water management system will provide ample opportunities for a sustainable water supply for the population of the republic by using the water resources of the Hekari River in the most comprehensive way.

Fig. 5. General Plan of the Hekari-Aghdam water pipeline system

Barghusad-Fuzuli water pipeline. As shown above, a flow of 14.0 m^3 per second will enter the "Bakhtiyarli" reservoir after the Azerbaijan state border. 10 m^3 / sec of this flow is planned to be released for irrigation and the remaining part (4.0 m^3/sec) into the riverbed for local use and sanitary flow. It should be noted that approximately 2.32 m^3 of water is formed per second in the part of the riverbed from the "Bakhtiyarli" reservoir to the point of confluence to the Hekari river (at the expense of the tributaries of the river). Thus, after the "Bakhtiyarli" reservoir, there will be approximately 6.32 m^3 of flow per second in the bed of the Bargushad river, which is enough for local use. The preliminary hydraulic calculations show that it is possible to transfer irrigation water up to 10.0 m^3 per second from the "Bakhtiyarli" Reservoir, from an absolute height of 540.0 m to the "Ashaghi Kondalanchay" reservoir located in the territory of the Fuzuli region in a self-flowing regime without using pumps. Preliminary studies show that the irrigation water from the Bakhtiyarli reservoir (540.0 m absolute level) at a flow of 10 m^3/sec through a steel pipeline with a diameter of DN2500 mm and a length of L= 27.0 km in a self-flowing mode in the west of Goyarchin Veyselli village of Jabrayil district, at an absolute level of 500.0 m will be taken to the pressure regulation device. The construction of this water pipeline from 2 steel pipes with a diameter of DN 2500 mm (L=70.0 km) after the pressure regulating device to the "Lower Kondalanchay" water reservoir is considered appropriate.

To regulate the discharge of the unused volumes of the flows intended for local use in the beds of the Hekari and Barghusad rivers into the Araz river, it is planned to create the "Barghusad-Hekari" reservoir at the confluence of these rivers. Up to 140 mln m^3 of the annual residual flow collected in this reservoir is planned to be directed to the "Barghusad - Fuzuli" self-flowing water pipeline through pumps. Taking into account the additional flow volumes from the "Hekari-Barghushad" reservoir and the "Zabukh" reservoir, the annual productivity of the "Barghushad-Fuzuli" water pipeline will be 500-530 mln m^3. It is also planned to build 3 HPPs with a total capacity of 19.8 MW on this system to be created. The General plan of the "Berghusad-Fuzuli" water pipeline system is given in Figure 6.

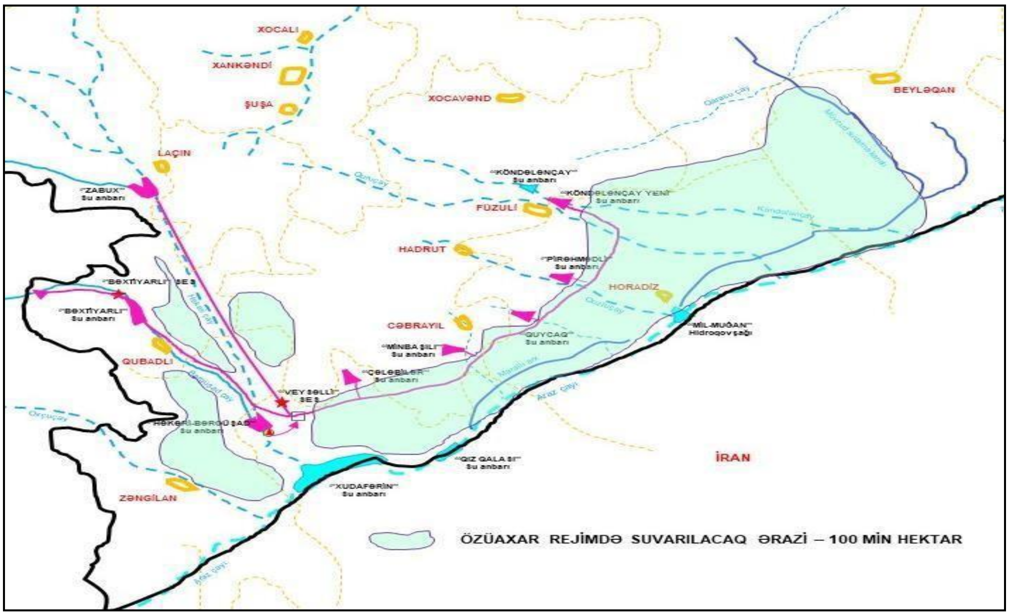

Fig. 6. General plan of "Berghusad-Fuzuli" water pipeline system

The preliminary hydraulic calculations show that the "Bargushad-Fuzuli" water pipeline will provide irrigation water to more than 80,000 hectares of agricultural land in the Gubadli, Zangilan, Jabrayil, and Fuzuli regions in a self-flowing regime without the use of pumps. The main goal of the proposed project is the use of the water resources of the Bargushad River to irrigate the fertile lands of the region without using electricity. While preparing the project, the creation of several regulatory reservoirs along the water pipeline is considered the main priority to reduce the volume of the "Bakhtiyarli" reservoir and create a self-flowing irrigation system using smaller diameter pipes.

To regulate the unregulated flows of the rivers Barghusad and Hekari, to ensure the reliability and stability of the irrigation system, to implement the emergency and planned stoppages in the pipelines, operation and service procedures, and to regulate the irregularities in the irrigation water demand of plants depending on the vegetation period, according to the location and relief of the areas to be irrigated, it is planned to build 5 reservoirs of appropriate volume along the route of the main water pipeline from the "Bakhtiyarli" reservoir to the existing "Ashaghi Kondalanchay" reservoir ("Chelebilar", "Minbashi", "Guyjag", "Pirahmadli" the existing "Lower Kondalanchay" is planned to be reconstructed).

It is considered appropriate to use a pressure system to supply water to the cultivated fields in a self-flowing mode. It is considered more purposeful from the point of view of hydraulics, technical economics and operation, to collect the volume of flow generated in the autumn-winter months in locally important water reservoirs near the agricultural fields and use them independently in the summer months. These water reservoirs, which will have a total volume of approximately 240.0 mln m^3, will collect the flow of the Bargushad River in the winter months and allow it to be used independently for irrigation in the summer months.

"Chelebilar" and "Minbashili" reservoirs that will be created along the water pipeline will ensure irrigation of about 13.5 thousand hectares of agricultural land (watered by pumps from the Hekari river and Hasanli canal during the Soviet period) in the Jabrayil region, mainly in the Geyan plain, with the application of new techniques and technology in a self-flowing pressure mode. The "Guyjag" water reservoir will provide irrigation of 8.5 thousand hectares of agricultural land (watered by pumps from the Hasanli and Maralarkh canals during the Soviet period) located in the south-eastern part of the Jabrayil district in a self-flowing pressure mode. The "Pirahmadli" water reservoir will provide irrigation of 7.2 thousand hectares of agricultural land located in the south-western part of the Fuzuli region (which was irrigated by pumps from the Bash Mil canal during the Soviet period) in a self-flowing pressure mode.

The end of the water pipeline is chosen as the existing Ashaghi Kondalanchay reservoir with a volume of 9.3 mln m^3, which is located at an absolute level of 360.0 m in the Fuzuli region. Hydrotechnical calculations show that by raising the earth dam of this reservoir by 10.0 m, it is possible to increase its volume to 25.0 mln m^3. With the reconstruction of the existing " Ashaghi Kondalanchay" reservoir, it will be possible to increase the volume of the reservoir, which will create the basis for more areas to be included in the irrigated crop cycle. By using the water reserves collected in this reservoir, there will be ample opportunities to irrigate up to 50,000 hectares of farmland located in the south-eastern part of the Fuzuli region and in the Harami plain (which were irrigated by pumps from the Bash Mil canal during the Soviet period) in a self-flowing pressure mode, with the application of new techniques and technology.

The proposed "Barghusad-Fuzuli" water pipeline system will allow the water source to be changed from the "Bakhtiyarli" reservoir located in the mountainous part of the Gubadli region, where arable land is scarce, to the existing "Ashaghi Kondalanchay" reservoir located in the Fuzuli district, where the region has more arable land. Thus, the "center of gravity" of the water source will be the "Ashaghi Kondalanchay" reservoir, which is surrounded by more agricultural fields, which will allow water to be transported and distributed in the fields mainly in a self-flowing pressure mode and will also ensure the stability and reliability of the system.

Creation of reliable water source for Shusha city and Dashalti settlement. The existing sources that supply the city of Shusha with drinking water have been studied and the problems that have arisen have been identified. Currently, the city of Shusha is supplied with surface water taken from Kichik Kirs and Zarisli water intake facilities. The source located in the village of Zarisli is located 10.7 km west of the city. In the bed of the Zarisli river, a water intake device with a concrete spillway was built at an absolute level of 1627 m. Depending on the flood level in the river, the flow of water taken by the device varies in the range of 5-25 l/sec. The second water source of the city is located in the Asgar valley in the northern part of the Kichik Kirs mountain, at an absolute level of 1652 m. In this source, a catchment device was built in the riverbed, and the water taken is transferred to the city in a self-flowing mode through a steel pipeline with a length of 11.2 km and a diameter of DN 300-500 mm. Depending on the water level in the river, the flood of water taken by the device varies in the range of 5-35 l/sec. Taking into account global climate changes and the prospective development of the city, we have conducted extensive research on creating a more sustainable source of water supply (Madatzade and Shikhlinski, 1968; Mahmudov, 2009).

According to the General plan of Shusha city, the population of the city will be about 25,000 in 2040. A water flood of 85-90 l/sec is needed for a sustainable water supply for this large population that will live in the city. Existing water sources do not allow for a sustainable water supply for such a large population. In the summer months, it is possible to supply water to the city from both sources at a rate of 10-15 l/sec. Creating a reliable and stable water source for the city of Shusha and the village of Dashalti is considered one of the most important issues of the day. Since the underground water in the area is very limited, the option of using the water supply of the Zarisli river, which is located around the city, was preferred for the population's water supply.

Using the hydrological data of the Aghakorpu station of the Gargar river for the years 1939-1988, the hydrological parameters of the stream in the Nabiler station of the Zarisli river were restored. Taking into account global climate changes and the prospective development of the city, creating a more sustainable source of water supply for the population is of strategic importance. The Zarisli tributary of the Gargar river is considered the most reliable water source for this area. The annual water supply of the Zarisli river passing through Dashalti village is estimated at 12-14 mln m^3. The preliminary studies show that it is possible to create a water reservoir with a volume of 7.5 mln m^3 on the Zarisli river, above the Nabilar village, at an absolute level of 1210.0 meters. In the "Galaba" water reservoir, it will be possible to collect two years' supplies of drinking water for Shusha city and provide the city with high-quality water continuously. Using the water resources of the Zarisli river, it is also considered appropriate to create the "Zafar" water reservoir with a total volume of 15 mln m^3 in a deep river valley with hard rocks, located in the lower part of the Jidir plain, below the village of Dashalti. It will be possible to supply water to other villages of the Shusha district in a self-flowing mode using the water reserves collected in the "Zafar" reservoir. "Victory" and "Zafar" water reservoirs, which will be created in a charming river valley surrounded by forests, will be a reliable source of water for Shusha and surrounding settlements and will create great opportunities for the development of winter and summer tourism in the area.

Integrated use of Guru Chay river water resources. One of the rivers formed in the territory of Karabakh is the Guru Chay river. Guru Chay river, with a catchment area of 201.0 km^2, is formed mainly in the Khojavand region. The main tributaries of the river, formed from the Big and Small Kirs mountains, merge near the village of Tugh and Boyuk Taghlar, and pass through the territory of the Fuzuli region and join the Araz river. The water resources of the river are partially used for irrigation. The average annual water supply of the river is estimated at 50 mln m^3. It is considered appropriate to use the water resources of the Guru river, which is formed due to spring and snow waters located in the mountain range of the Lesser Caucasus and is not subject to any pollution, to supply drinking water to the population living in the Fuzuli and Khojavand regions. The water of this river fully meets drinking water standards in terms of quality and is of great importance as a source of sustainable water supply for settlements located in this area.

Preliminary hydrological calculations show that it is possible to build the "Guruchay" reservoir with a total volume of 35.0 mln m^3 in order to use the water resources of the river more efficiently in the riverbed, near the village of Boyuk Taghlar.

It is planned to build the "Guruchay" reservoir in the lower part of the village of Boyuk Taghlar, in the valley of the river surrounded by forests, at an absolute level of 750 m. The main priority is to use the reservoir in a complex manner, taking into account the requirements of water supply, fishing and tourism requirements. For this purpose, the useful volume of the water reservoir should be 20.0 mln m^3, which will allow for the constant supply of drinking water for more than 120.0 thousand people living in the vicinity during the year. The area chosen for the construction of the water reservoir is surrounded by forests and monuments with ancient history (Azikh cave and numerous Albanian temples are located nearby), which is considered very suitable for the development of tourism. According to the developed General plan of the city of Fizuli, it is assumed that the population of the city will be almost 50,000 in the future. For irrigation of Fuzuli city, surrounding villages, industrial areas and greenery, approximately 350-600 l/sec of water is needed. Fuzuli city and large villages are mainly located in areas below 450.0 m level, which is about 300.0 meters below the location of the mentioned reservoir.

It will be possible to provide a permanent water supply to the city of Fuzuli and its surrounding settlements using the high-quality water reserves that will be collected in the "Guruchay" reservoir. It is also possible to create a 1.2 MW "Fuzuli" hydropower plant using the surplus water taken from the reservoir, which will be located 19 km from the city of Fuzuli. It should be noted that the "Guruchay" water reservoir is located 1.5 km away from the currently under construction Fuzuli-Shusha (Zafar road) highway. The road infrastructure will allow reaching the recreational facilities that will be built around the reservoir in a very short time.

The location plan of the reservoirs to be built on the Zarisli and Guru rivers is given in Figure 7.

The main benefits of the reservoir to be built in the channels of Zarisli and Guru rivers:

- New reservoirs will regulate the water supply of Zarisli and Guru rivers, minimize potential flood and environmental risks;
- It will create new opportunities for the development of tourism in the Karabakh region and the republic as a whole;
- It will create a foundation for the creation of recreation and leisure centers;
- With the construction of the "Galaba" water reservoir, a source of sustainable drinking water supply will be created for the city of Shusha and the village of Dashalti;

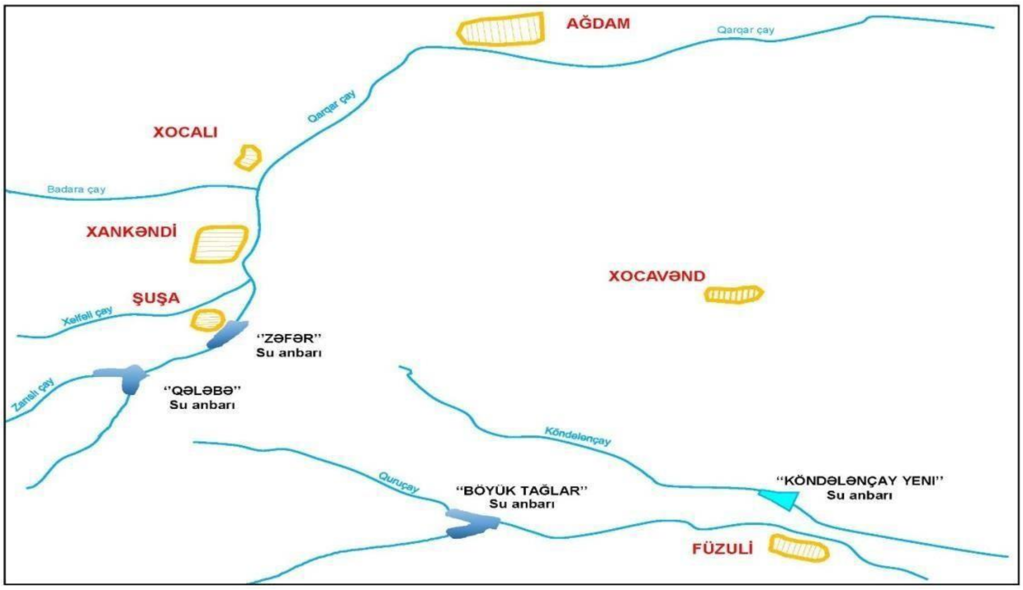

Fig. 7. Location plan of reservoirs to be built on Zarisli and Guru rivers

- The construction of the "Guruchay" water reservoir will create a wide opportunity to fundamentally improve the supply of drinking water to the villages of Khojavand and Fuzuli regions;
- "Guruchay" reservoir will create ample

opportunities for the development of intensive horticulture in the area;

- A favorable environment will be created for the development of fishing (mainly trout);
- The creation of reservoirs will greatly support population settlement in the area;
- Conditions will be created for the development of water sports;
- It will support the socioeconomic development of the region;
- It will allow mitigating the risks caused by global climate change;

CONCLUSIONS

1. Since the flow of the Bargushad river is fully regulated in the territory of Armenia and enters the territory of the republic, spring-autumn flow regimes are not observed in the river (the flow of the river mainly fluctuates in the range of 11-33 $m^{3/}$sec during the day).
2. In order to supply 80,000 hectares of fertile arable land located in the Gubadli, Zangilan, Jabrayil, and Fuzuli regions with irrigation water in a self-flowing mode without the use of pumps, it is considered appropriate to create the "Berghusad-Fuzuli" water pipeline system that will start from the "Bakhtiyarli" reservoir and end at the existing "Lower Kondalanchay" reservoir (about 300.0 mln m^3 of the river's flow will be used during the year).
3. In the summer months, it is considered appropriate to build 5 locally important, off-channel water reservoirs with a total volume of more than 220.0 mln m^3 to ensure independent irrigation of agricultural fields located along the aqueduct.
4. With the creation of the new "Bakhtiyarli" reservoir and the "Berghusad-Fuzuli" water pipeline system, it is possible to build 3 HPPs with a total capacity of 19.8 MW on this system, which will provide more than 120,000 people with GREEN ENERGY during the year.
5. The "Hekari" reservoir, which will be built in the bed of the Hekari river, at an absolute level of 940 m, will create ample opportunities to regulate its flow regime and provide more than 4.0 million people with high-quality drinking water.
6. The "Hekari-Aghdam" aqueduct, which will be created using the relief height of the area, will allow the population living in settlements located in Gubadli, Zangilan, Jabrayil, Fuzuli, Aghdam, Aghjabadi, and Beylagan districts and Kura-Araz plain to be provided with drinking water in a continuous, self-flowing mode. The envisaged water management system will create ample opportunities for a water supply in the Aghdam region in a reliable, self-flowing mode.
7. "Juvarli" water reservoir, which will be built in the area of the Fuzuli district, where the population will live more densely, at an absolute level of 500 m, will enable the reliable and sustainable operation of the envisaged water management system and will be able to provide water to Baku city in a self-flowing mode.
8. It will be possible to build 5 HPPs with a total capacity of 21.1 MW on the envisaged "Hekari" reservoir and the "Hekari-Aghdam" water pipeline, which will allow generating approximately 160.0 mln kw/h of electricity.
9. It is possible to provide a sustainable water supply to Shusha city and Dashalti village by using the water reserve of the Zarisli river (annual average flow volume is about 12-14 million cubic meters). By building the "Galaba" reservoir with a total volume of 7.5 mln m^3 in the riverbed above the village of Nabilar, it is possible to create a reliable and stable water source for a continuous water supply for the city of Shusha.
10. Using the water resources of the Zarisli river, it is considered appropriate to create a "Victory" reservoir with a volume of 15.0 million cubic meters, which can support the development of tourism in the lower part of the Dashalti village, under the Jidir plain, in the river valley surrounded by rocks on all sides. In addition to serving winter and summer tourism, this reservoir will be a sustainable source of water for the villages located along the Gargar river in the Shusha district.
11. In order to more efficiently use the water resources of the Guru Chay river, which has an annual water supply of 50.0 mln m^3, it is considered appropriate to build the "Guruchay" reservoir with a volume of about

35.0 mln m^3 in its bed, in the lower part of the village of Boyuk Taghlar. Using the water resources collected in this reservoir, it will be possible to supply water to the villages of Fuzuli city and Khojavand region in a self-flowing mode, and there will be ample opportunities for the development of tourism in the region.

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Şərqi Zəngəzur və Qarabağ iqtisadi rayonlarındakı çayların su ehtiyatı və yaşıl enerji potensialından inteqrasiyalı istifadə

Məmmədov Əhməd Şirin oğlu, Cavadzadə Elşad Bəylər oğlu, Bayramov Arzuman Əvəz oğlu

"HIDROLOQ" Məhdud Məsuliyyətli Cəmiyyəti, Bakı, Azərbaycan

İşğaldan azad edilən Şərqi Zəngəzur və Qarabağ iqtisadi rayonları ərazisində formalaşan su ehtiyatlarının respublikanın dayanıqlı su təminatında xüsusi əhəmiyyəti vardır. Burada yerləşən münbit torpaqların bu su ehtiyatlarından səmərəli və komples şəkildə istifadə etməklə əkin dövriyyəsinə qoşulması və əhalinin sürətli şəkildə məskunlaşması həyata keçirilə bilər. Məskunlaşmadan öncə bu ərazidə yerləşən çayların su və hidroenerji potensialından istifadə olunmaqla suvarma və su təchizatı sistemləri yaradılmalıdır. Payız və yaz gursululuğu böyük olan bu çayların su ehtiyatlarından səmərəli istifadə etmək zəruridir. Bu çayların çox böyük enerji potensialı vardır və onlar üzərində müxtəlif təyinatlı hidrotexniki qurğular tikməklə bu iqtisadi rayonlarda yaşayacaq əhalinin elektrik enerjisinə olan tələbatını tam ödəmək, həmçinin iqtisadi baxımdan daha əlverişli olan özüaxımlı rejimdə idarə oluna bilən su təsərrüfatı sistemi yaratmaq mümkündür. Təbii şərait və ərazinin relyef göstəriciləri, əkinə yararlı münbit torpaq sahələrinin çayların hövzələrindən kənarda yerləşməsi amilləri nəzərə alınmaqla daha optimal su təsərrüfatı sisteminin yaradılması ilə bağlı mühəndisi hidroloji araşdırmalar aparılmışdır. Məqalədə, böyük hidroenerji potensialı olan Oxçu çayın ciddi şəkildə çirklənmiş su ehtiyatından yaşıl enerji almaq üçün onun məcrasından kənarda, iki ədəd derevasiya tipli su elektrik stansiyasının yaradılmasının layihə həlli verilmişdir. Oxçuçay üzərində tikiləcək SES-lərdə il ərzində 80.0 mln kvt/saat elektrik enerjisi almaq olar ki, bu da 120 min nəfərdən çox əhalinin daimi olaraq elektrik enerjisi ilə təmin etməyə imkan verəcəkdir. Eyni zamanda məqalədə Həkəri, Bərgüşad, Qarqar (Zarıslı qolu) və Quruçay üzərində su anbarlarının tikilməsi ilə onların axım rejimlərinin tənzimlənməsi və regionun dayanıqlı su təminatında istifadə olunması ilə bağlı layihə həlləri təklif olunmuşdur. Yaradılacaq su təsərrüfatı sistemi 4.0 mln nəfərdən çox əhalinin daimi içməli su təminatını aparmağa və 80 min hektara qədər əkin sahəsini suvarma suyu ilə təmin etməyə imkan verəcəkdir.

Açar sözlər: *Su təminatı, çay, su ehtiyatları, su anbarı, məcra*

Комплексное использование водных ресурсов и зеленого энергетического потенциала рек Восточно-Зангезурского и Карабахского экономических областей

Мамедов Ахмед Ширин оглу, Джавадзаде Эльшад Байлар оглу, Байрамов Арзуман Аваз оглу

Общество с ограниченной ответственностью"ГИДРОЛОГ", Баку, Азербайджан

Водные ресурсы, формирующиеся на освобожденной от оккупации территории Восточного Зангезура и Карабахской области, имеют особое значение для устойчивого водоснабжения республики. Эффективное и комплексное использование этих водных ресурсов будет способствовать подключению плодородных земель, расположенных в свободных Карабахском и Восточно-Зангезурском экономических районах, к сельскохозяйственному циклу и быстрому расселению населения. Перед заселением должны быть созданы системы орошения и водоснабжения с использованием водного и гидроэнергетического потенциала рек, расположенных в данной местности. Необходимо рационально использовать водные ресурсы этих рек в период осенне-весеннего половодья. Эти реки обладают огромным энергетическим потенциалом, и, строя на них гидротехнические сооружения различного назначения, можно полностью удовлетворить потребность в электроэнергии населения, проживающего в этих экономических районах, а также создать систему управления водными ресурсами в самотечном режиме, что более выгодно с экономической точки зрения. Проведены инженерно-гидрологические исследования по разработке более оптимальной системы водопользования с учетом факторов природных условий и показателей рельефа местности, расположения плодородных земель, пригодных для возделывания вне бассейнов рек. В статье представлено проектное решение по созданию двух гидроэлектростанций производного типа вне русла реки Охчучай с целью получения зеленой энергии из сильно загрязненных водных ресурсов этой реки, обладающей большим гидроэнергетическим потенциалом. На строящихся на реке Охчучай ГЭС в течение года можно получить 80,0 млн кВтч электроэнергии, что позволит обеспечить постоянное электроснабжение более 120 тысяч человек. Кроме того, в статье предложены проектные решения, связанные со строительством водохранилищ на реках Гекари, Баргушад, Гаргар (приток Зарисли), Гуручай, регулирование режимов их стока и использование в устойчивом водоснабжении региона. Создаваемая система водного хозяйства позволит обеспечить постоянным питьевым водоснабжением более 4,0 млн человек и обеспечить оросительной водой почти 80 тыс. га сельскохозяйственных угодий.

Ключевые слова: *Водоснабжение, река, водные ресурсы, водохранилище, русло*