

The current state of plant landscapes of the surrounding areas of the Yenikend reservoir

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Abstract: An analysis of the landscapes around the Yenikend reservoir was carried out and it was found that the plants existing in the area formed six vegetation types spread over five soil types on 15 landscapes. In the south-eastern part of the territory, there are mild humid mountain-forest landscapes, in which broad-leaved forests are dominated by *Fagus orientalis* Lipsky - *Carpinus orientalis* Mill. and *Quercus iberica* M. Bieb. - *Carpinus orientalis* formation. The southern part of the reservoir belongs to the arid and semiarid landscape type of the low mountains. In addition to xerophytic and steppe landscapes, small hills and semi-desert landscapes of plain areas are widespread here. Among the soil types, the flood-plain alluvial-meadow type is found in the form of narrow strips around the reservoir and on the banks of the rivers, the washed and carbonated (tugai) meadow-forest type is found in the form of small patches in the southern and northern parts of the reservoir, and the partially saline light chestnut type is found in the northern and southern parts of the reservoir. Due to the intensive anthropogenic pressure, large areas have been deforested and turned into farmland. Around the reservoir prevail the dense tamarisk and reedbeds where *Phragmites communis*, *Tamarix meyeri*, and *T. ramossissima* species grow, ephemeral plants are dominated by the species *Atraphaxis spinosa* L.

Keywords: climate, diversity, parameters, soil, tamarisk, water reservoir

INTRODUCTION

The Yenikend reservoir is one of the most important artificial water reservoirs in the country, built on the Kura river which was put into operation in 2000. The height of the reservoir is 104 m a.s.l., the volume is 158 mln. m³, the area is 22.6 km² [Geography..., 2015]. In

addition to its energy importance, this water reservoir is also important for agriculture and fishery. This reservoir is relatively new with wide-purpose but small compared to others in the country. The relief of the area consists of medium and low highlands of arid-denudation character, medium-deep depressions, steep and gentle slopes, and watershed slopes. The geological structure and rocks of the area reveal that the sediments belong to Jurassic-Anthropogen system, as well as sediments of Pleistocene, Eopleistocene and Neogene the IV Period [National Atlas, 2014; WFO, 2023] spread. The main rivers of the area are Kura and its tributaries (Zayamchay, Jahrichay, Shamkirchay, Ganjachay, etc.). Flood-plain alluvial-meadow, washed and carbonated (tugai) meadow-forest, partially saline light chestnut, gray and gray-brown soils are widespread around the Yenikend reservoir. The area belongs to the Ganja-Dashkasan economic-geographical region of the Lesser Caucasus natural region.

From the point of view of protection of living nature and natural habitats, the study of water basins, the regulation of biodiversity, the study of current flora and vegetation of specific areas, determination of changes occurring there, as well as conducting research on ecological, anthropogenic and zoogenic effects are of great importance, both theoretically and experimentally [Darvoziev, 1977; Dolukhanov, 1969; Hajiyevev, 1965]. A biogeographical region is a continuously developing part of the earth's surface, it is important to study the vegetation around the reservoirs in order to notice timely changes [Corlett, 2015; Sun et al., 2021; Gillespie, 2023].

The multi-directional study and protection of various species living in the special ecosystem of the Yenikend reservoir, proper use of the area's vegetation, the study of xerophytic plants that adapt to water environments, as well as scientific-theoretical geobotanical-ecological studies for the restoration of the fertility and primary phytocoenosis of polluted areas and implementation of methodical basis is of great importance. Vegetation of the area have not been studied yet. The aim of the current study was to reveal the landscapes with emphasize to soil types, and vegetation cover, its formation and associations in Yenikend reservoir.

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MATERIAL AND METHODS

Research object. The research was carried out during 2015-2018 years by semi-stationary and stationary methods. More than 50 geobotanical notes on the structure of phytocenoses were taken together with the photos of rare species and formations. The herbarium of all collected species was prepared. Species were identified according to literature [Flora Azerb..., 1950-1961, Askerov 2016]. Name of taxa were checked against the WFO [2023].

During the expeditions, the ecobiological traits of the species were clarified based on the methodology of generally accepted geobotanical methods under field conditions [Shennikov, 1964]. During the study of the area from the ecological and geographical aspect, latest available literature sources followed were: National Atlas [2014], The geography of the Republic of Azerbaijan [2015], and the landscape map of the Republic of Azerbaijan [2017].

Hydrometeorological data was obtained from Ganja city Bureau of hydrometeorological forecasts [2022]. Based on the data, the average meteorological data of the area in recent years are given in Table 1. The table shows that the climatic factors, mainly weather, precipitation, and average annual indicators of solar radiation determine the steppe and semi-desert landscapes in the area. A sharp difference between the average annual precipitation (291.1 mm) and possible evaporation (1000 mm) in the area is also characteristic of semi-desert and steppe landscapes. The climatic continentality of the area is characterized by weak (less than 130), moderate (with a coefficient of up to 165) and moderate features (with a coefficient of up to 205) continentality [Mammadov et al., 2012].

Different approaches, methods and techniques related to the methodology of landscape science were used to understand the space-time organization of landscapes and their relationships with other objects [Golovanov, 2005].

RESULTS AND DISCUSSION

Main soil types around the Yenikand reservoir has been studied. It was found that in the area around the reservoir and riverbanks floodplain alluvial-meadow forms narrow strips, in the southern and northern parts washed and carbonated (tugai) meadow-forest form small spots, and partly saline open chestnut soil types are spread in the northern and southern parts. Gray and gray-brown soils are more common in the northern area of the reservoir (Table 2).

Despite of flowing of the Kura river and its tributaries (Zayamchay, Jahrichay, Shamkirchay, Ganjachay, etc.) in the vicinity of the area, the northern part does not possess any river system and the groundwater level is much lower. Therefore the northern areas consist of semi-desert and steppe landscapes and their characteristic poor vegetation, ephemerals and sparse drought-resistant plants.

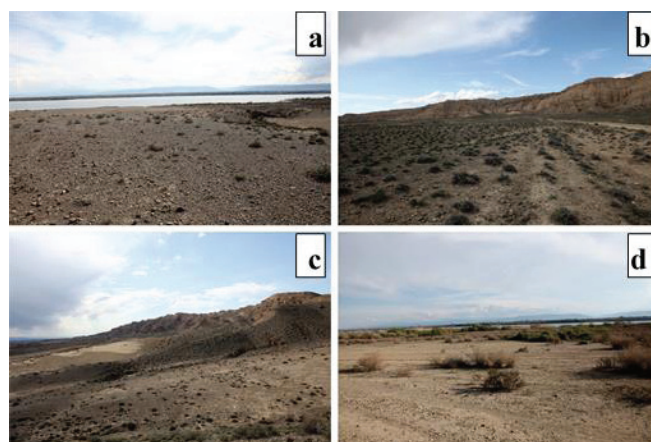


Figure 1. Landscape types from the surroundings of Yenikend reservoir: a) coastal accumulative plain; b) gray-brown soils wormwood; c) various bushes spread along the ditches, valleys and course of watersheds d) coastal areas consisting of dense tamarisk and reedy area

Table 1. Average annual values of the main climatic indicators of the area.

On years	Meteorological elements			
	Average air temperature, °C	Average amount of precipitation, mm	Average wind speed, m/sec	Duration of sunshine, hours
2015	15.1	295.9	2	2249.9
2016	14.7	331.1	2	2229.8
2017	15.1	246.4	2	2435.7

Table 2. Soil types around the Yenikend reservoir.

Soils	Areas where they are spread
Flood-plain-alluvial-meadow	In the form of narrow strips in the area around the reservoir and river banks
Meadow forest lixiviated and carbonate	In the form of small spots in the southern and northern part of the reservoir
Light chestnut, partly residually salinized	The northern and southern part of the reservoir
Gray soils	The northern part of the reservoir
Gray-brown soils	The northern part of the reservoir

According to data available a total of 15 landscape types are found in the area [Landscape map of RA, 2017]. Moderately humid mountain-forest landscapes are found in the southeastern part of the area (Fig. 2:1). These include mainly beech-hornbeam, and oak-beech forests of medium highlands and partly highlands. Broad-leaved forests with the dominance of *Fagus orientalis* - *Carpinus orientalis* and *Quercus iberica* - *Carpinus orientalis* formations are spread on these landscapes, mainly on the brown-forest soils of the moderately fragmented moderately inclined slopes of the lowland and mid-mountains of the area. From this area to the east, the elevation gradually decreases, and the previous landscapes are replaced by medium and low mountainous landscapes. The forest-steppe, steppe and mountain-meadow landscapes of the low and medium highlands prevail here (Fig. 2:2). The territory has been subjected to intensive anthropogenic effects, large areas have been deforested and turned into farmland. In the natural areas on the brown mountain soils composed of weakly broken slopes and plains we find bushes and wormwood belonging to the genus *Paliurus spina-christi* and *Rosa* sp.

In the south-eastern part of the territory, landscapes consist of wormwoods on chestnut, light chestnut and gray-brown soils on the inclined slopes of the low mountains formed by the Bozdag range (Fig. 2:7, 8).

In the north-eastern part of the territory, we find arid-denudation semi-deserts, badlands of weakly inclined ridgecrests on gray-brown and light chestnut soils, wormwood-goat's wheat areas, which mainly belong to the accumulative plain landscape types (Fig. 2:10, 11).

The southern part of the water reservoirs belongs to the arid and semiarid landscape type of the low mountains. Along with xerophytic and steppe landscapes, small hills and semi-desert landscapes (Fig. 2:12, 15) of the plain areas are also widespread here.

The deltas of these rivers are flowing into the Kura river and create intrazonal landscapes consisting of tugai forests, tamarisk, Christ's thorn and blackberry jungles on alluvial flood-plain meadow soils (Fig. 2:13).

On the banks of the rivers Zayamchay, Jahrichay, Shamkirchay, Ganjachay and Garasuchay; which flow into the Kura river; there are grass-steppe, grassswamp, and grass-shrub landscapes (Fig. 2:14). Such landscapes are also spread in the eastern part of the Yenikend reservoir, up to the Mingachevir reservoir.

The northern part of the territory has a rich landscape diversity. This is mainly related to the geological structure, rock structure and unique relief features of this area.

According to the shape and abundance of flora and vegetation, the territory is divided into five characteristic parts (Fig. 3).

Coastal landscapes cover the shores of the reservoir in the form of a narrow strip consisting of flood-plain alluvial-meadow soils found as a result of the silts and minerals brought by water flows. High humidity of soil is one of the main reasons in the area conditioning the growth of dense tamarisk and reedbeds where *Phragmites communis*, *Tamarix meyeri* and *T. ramossissima* species prevail. *Tamarix* formations occur as small patches in the intervening areas north of the coast. The main reason for this is the high level of groundwater in such areas and the separating layer of clay.

Landscapes formed by sparsely scattered perennial and ephemeral plants are dominated by the species *Atraphaxis spinosa* L. The area is dominated by stony and gravelly gray soils. Ephemeral, annual and perennial herbs and shrubs belonging to Poaceae, Polygonaceae, Aizoaceae, Amaryllidaceae, Apiaceae, Asteraceae, Brassicaceae, Fabaceae, Lamiaceae, Plumbaginaceae, Nitrariaceae, Orabanchaceae, Papaveraceae, Ranunculaceae, Rhamnaceae, Solanaceae, Tamaricaceae

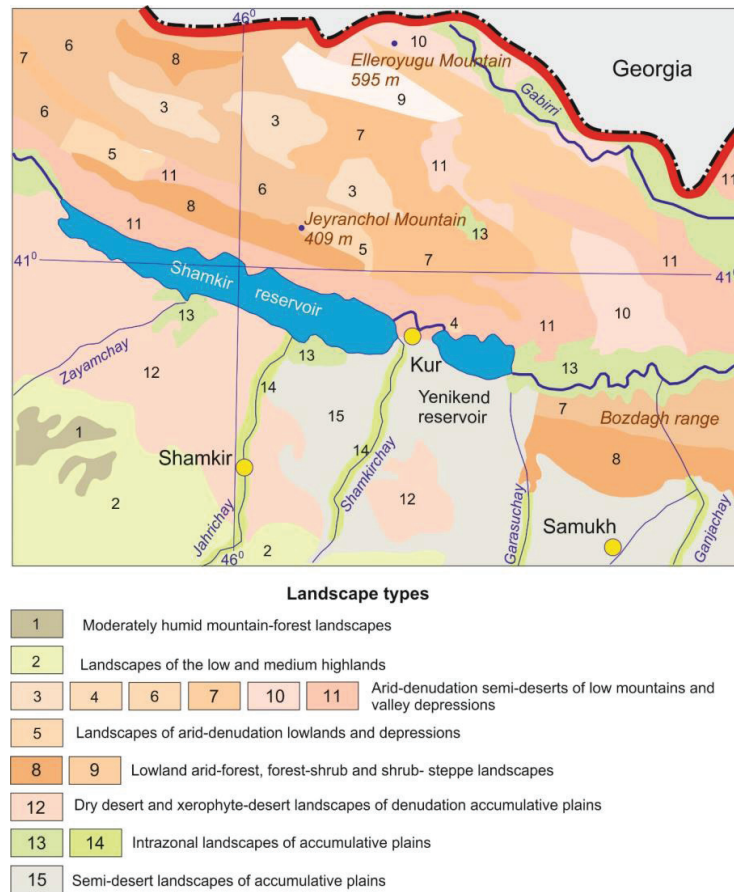


Figure 2. Main landscapes distributed in the area.

and Zygophyllaceae families are spread here. *Nitraria schoberi* L., *Lycium ruthenicum* Murray, *Zygophyllum fabago* L., *Limonium meyeri* (Boiss.) Kuntze, *Aizoon hispanicum* L. and *Alhagi pseudalhagi* (M. Bieb) Fisch. species are found on the saline soils closer to the coast.

In the northwestern part of the reservoir at 100-120 m a.s.l. and 100-300 m a.s.l. from the coast. Formations consisting of pistacia tree and other tree-shrub vegetation. There are single specimens and small populations of the species *Pistacia mutica* Fisch & C.A. Mey. The trees are surrounded by dense shoots of shrub, mainly by *Lycium ruthenicum* Murray. but *Berberis iberica* Steven, *Rhamnus pallasii* Fisch. & C.A. Mey and *Paliurus spina-christi* Mill also occur in the area. Most likely, these fragments are of the tugai forests which were spreading on the coast in the period before the establishing reservoir. Currently, *Populus*, *Crataegus* are found in the coastal areas downstream of the river on the farthest, relatively in high slopes, where the groundwater level is relatively low and *Pistacia mutica* Fisch & C.A. Mey, trees and shrubs are widely distributed.



Figure 3. Flora of the areas in the immediate vicinity of the Yenikend reservoir: 1. coastal areas consisting of dense tamarisk and reeds; 2. sparsely scattered perennial and ephemeral plants dominated by *Atraphaxis spinosa*; 3. formations consisting of *Pistacia mutica* etc. tree-shrub vegetation ; 4. various bushes spread along the course of ditches, valleys and watersheds; 5. remnants of tugai forests; 6. monoculture consisting of eggplant plantations cultivated in the area.

Table 3. Classification of species distributed in the area by families

№	Families	Species
1.	<i>Poaceae</i>	<i>Eremopyrum orientale</i> Jaub.Spach., <i>Phragmites communis</i> Trin.
2.	<i>Aizoaceae</i>	<i>Aizoon hispanicum</i> L.
3.	<i>Amaryllidaceae</i>	<i>Allium pseudoflavum</i> Vved.
4.	<i>Apiaceae</i>	<i>Torilis leptophylla</i> Rchb.f
5.	<i>Asteraceae</i>	<i>Anthemis fruticulosa</i> M.Bieb., <i>Senecio vernalis</i> Waldst & Kit
6.	<i>Brassicaceae</i>	<i>Sterigmostemum tomentosum</i> (Willd.) M. Bieb
7.	<i>Fabaceae</i>	<i>Astragalus bungeanus</i> Boiss, <i>Alhagi pseudalhagi</i> M. Bieb
8.	<i>Lamiaceae</i>	<i>Nepeta amoena</i> Stapf.
9.	<i>Nitrariaceae</i>	<i>Nitraria schoberi</i> L.
10.	<i>Orabanchaceae</i>	<i>Orobanche cernua</i> Loefl.
11.	<i>Papaveraceae</i>	<i>Papaver macrostomum</i> Boiss.
12.	<i>Ranunculaceae</i>	<i>Adonis bienertii</i> Butkov ex Riedl. syn <i>A. aestivalis</i> subsp. <i>aestivalis</i>
13.	<i>Rhamnaceae</i>	<i>Paliurus spina-christi</i> Mill, <i>Rhamnus pallasii</i> Fisch. & C.A.Mey
14.	<i>Plumbaginaceae</i>	<i>Limonium meyeri</i> (Boiss.) Kuntze
15.	<i>Solanaceae</i>	<i>Lycium ruthenicum</i> Murray
16.	<i>Tamaricaceae</i>	<i>Tamarix meyeri</i> Boiss., <i>T. ramossisima</i> Ledeb,
17.	<i>Zygophyllaceae</i>	<i>Zygophyllum fabago</i> L.
18.	<i>Polygonaceae</i>	<i>Atraphaxis spinosa</i> L.
19.	<i>Anacardiaceae</i>	<i>Pistacia mutica</i> Fisch & C.A. Mey.
20.	<i>Berberidaceae</i>	<i>Berberis iberica</i> Steven
21.	<i>Ulmaceae</i>	<i>Ulmus minor</i> Mill.
22.	<i>Rosaceae</i>	<i>Crataegus eriantha</i> Pojark
23.	<i>Punicaceae</i>	<i>Punica granatum</i> L.

The next area is represented by plants along the course of ditches, gullies, floodplains and watersheds, also are rich in minerals and decays than other areas, due to the floods. On the other hand, the humidity coefficient of the soil here is also high. For this reason, the plants spread in such narrow and short strips are richer than the surrounding areas in terms of both number and ecological forms. Single specimens of shrubs like *Paliurus spina-christi* Mill, *Rhamnus pallasii* Fisch. & C.A. Mey, *Berberis iberica* Steven in these areas are encountered. The *Nepeta amoena* (Lamiaceae) and *Astragalus bungeanus* Boiss (Fabaceae) are found here together with plants not encountered in other places.

The southern part of the reservoir is relatively low-sloping and plain, so it is intensively used as arable field and pasture, represented by remnants of Tugai forests, individual elements of tugai forests, which once existed, remain fragmented. Shrub species in these areas such as *Lycium ruthenicum* Murray, *Rhamnus pallasii* Fisch. & C.A. Mey, *Paliurus spina-christi* Mill, *Berberis iberica* Steven, *Punica granatum* L. are found rarely and singly. Among the tree species here, *Crataegus eriantha* Pojark

and *Ulmus minor* Mill. are found as single specimens. As a result of intensive grazing and other anthropogenic factors, the places of the destroyed trees have been replaced by dense blackberry forests.

In the northern part of the reservoir degraded and gray soils are characterised by poor flora diversity. Agrocenoses have been developed here mainly consist of eggplant plantations.

CONCLUSION

The species found in the area are spread over 15 landscapes, including six vegetation formations and five soil types.

Reservoirs created in the Kura, Araz and Tarter rivers located in the territory of Azerbaijan, as well as HPPs in Shamkir, Mingachevir, Yenikend, Varvara, Araz and Sarsang represent complexes of water supply facilities and these are used also for energy, irrigation, etc. The full volume of the republic's is reservoirs 21.4 km³, the volume of the worker is 12.4 km³, the area of the water reserve iss 694 km². In Azerbaijan, the flora and vegetation around the reservoirs has not been studied as

a separate research object. Only the vegetation around the river basin was appreciated by a group of researchers. Among them, E.M. Gurbanov [1984] studied the Nakhchivanchay basin, A.H. Ismayilov [2009] studied the Gilanchay basin, M.G. Musayev [2007] and F.Kh. Nabiyebe [2017] studied the flora of water bodies in the Kur-Araz plain. Studying the vegetation of Yenikend as a part of the vegetation of the country in general helps to get more detailed information about the plant diversity and the forms and associations found here. Research work is ongoing in this area and this allows us to help plant the area. Research work in these directions continues, and this allows us to characterize the area in terms of plant richness.

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Yenikənd su anbarının ətraf ərazilərinin bitki landşaftlarının hazırkı vəziyyəti

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Yenikənd su anbarının ətrafında landşaftların təhlili aparılmış, məlum olmuşdur ki, ərazidə mövcud olan bitkilər 15 landşaftda altı bitkilik və beş torpaq tipində formalaşmışdır. Ərazinin cənub-şərq hissəsində mülayim rütubətli dağ-meşə landşaftlarına rast gəlinir ki, bu tipdə əsasən *Fagus orientalis* - *Carpinus orientalis* və *Quercus iberica* - *Carpinus orientalis* növlərinin dominantlığı ilə enliyarpaqlı meşələr yayılmışdır. Su hövzəsinin cənub

hissəsi alçaq dağlığın arid və semiarid landşaft tipinə aiddir. Burada kserofit və bozqır landşaftlarla yanaşı xırda təpəciklər və düzənlik ərazilərin yarımsəhra landşaftları da geniş yayılmışdır. Torpaq tiplərindən subasar allüvial-çəmən tipinə anbarın ətrafı və çay kənarlarında dar zolaqlar şəklində, yuyulmuş və karbonatlı (tuqay) çəmən-meşə tipinə anbarın cənub və şimal hissəsində kiçik ləkələr şəklində, qismən şorlaşmış açıq şabalıdı tipinə anbarın şimal və cənub hissəsində rast gəlinir. İntensiv antropogen təzyiqli nəticəsində böyük ərazilər meşəsizləşərək əkin sahələrinə çevrilmişdir. Su anbarı ətrafında *Phragmites communis*, *Tamarix meyeri* və *T. ramossissima* növlərinin üstünlük təşkil etdiyi sıx yulğun və qamışıqlara rast gəlinir, efemer bitkilərdən isə *Atraphaxis spinosa* L. üstünlük təşkil edir.

Açar sözlər: iqlim, müxtəliflik, parametrlər, torpaq, yulğun, su anbarı

Современное состояние растительных ландшафтов окрестностей Еникендского водохранилища

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Проведен анализ ландшафтов вокруг Еникендского водохранилища и установлено, что существующие на территории растения сформировались в 6 типах растительности и 5 типах почв в 15 ландшафтах. В юго-восточной части территории расположены умеренно влажные горно-лесные ландшафты, в которых распространены широколиственные леса с доминированием видов *Fagus orientalis* — *Carpinus orientalis* и *Quercus iberica* — *Carpinus orientalis*. Южная часть водоема относится к ариднему и полуаридному типу ландшафтов низкогорья. Помимо ксерофитных и степных ландшафтов здесь распространены также небольшие холмы и полупустынные ландшафты равнинных территорий. Среди типов почв субсарский аллювиально-луговой тип встречается в виде узких полос вокруг водоема и по берегам реки, смытый и углекислый (тугайный) лугово-лесной тип встречается в виде небольших пятен на юге и северной части водохранилища, а в северной и южной частях водоема встречается частично засоленный открытый каштановый тип. Из-за интенсивного антропогенно-

го давления большие территории были вырублены и превращены в сельскохозяйственные угодья. Вокруг водоема преобладают густые тamarиски и заросли тростника, где произрастают виды *Phragmites*

communis, *Tamarix meyeri*, *T. ramossisima*, из эфемерных растений доминирует вид *Atraphaxis spinosa* L.

Ключевые слова: климат, разнообразие, параметры, почва, тamarиск, водоем