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STUDY OF THE MODERN BIO-ECOLOGICAL STATE ABSHERON COASTLINES

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Abstract. The aim of the article discusses the first experience of creating digital environmental maps and analyzing the spatial distribution of macrophytobenthos in the Yashma coast (Absheron). The role of environmental mapping in studying the state and causes of pollution of seawaters is indicated. A description of the object of study and sources of technogenic impact on the environment in the study area is given. The present study based on identification of the current ecological state of macrophyte growth. Since pollution in coastal water bodies increases every day, studying environmental indicators is relevant for Azerbaijani scientists. Were used QGIS plugin version 2.18.12 "*Semi-automatic classification plugin*", originally designed for interpretation of space images obtained from *Landsat-3* and *Sentinel* satellites. Studying the flora of the coasts of the Absheron Peninsula is very important for determining environmental pollution.

Keywords: *Bottom vegetation, algal flora, mycoflora, macrophyte, hydrobotanical survey, water pollution.*

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1. Introduction

Microalgae and micromycetes are often used as indicator organisms to assess the state of the environment, as they actively participate in the processes of purification of polluted waters. An increase in the concentration of nutrients in water, as a rule, accelerates the growth of microorganisms (including microalgae), which is manifested in an increase in the number of their cells and biomass (Neish & Bourgougnon, 2014; Bunyatova *et al*., 2025). Excessive development of some types of cyanobacteria, dinoflagellates, golden, diatoms and other microalgae leads to undesirable consequences

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and can harm marine biota (Sullivan & Short, 2023). Oil and oil products make up a significant share of pollution of sea and fresh waters (Dynowski, 2019). Since they are quite stable, can settle on the bottom and from there be carried by the water current back into the photosynthetic layer, it is necessary to establish the impact of this pollution on the development of phytoplankton, which determines 90% of the primary production of living matter in the sea (Evgrafov & Evgrafova, 2015; Huiskes *et al*., 2019). Sea grass thrown ashore during storms consists of lumps and strands formed by tangled leaves; it is heavily contaminated with sand, silt and shellfish. All these impurities contribute to the deterioration of the quality of dried grass, as a result of which the leaves turn brown, lose strength and elasticity. The Caspian Sea coastline, especially its northern coast, is characterized by a diversity of soils and their changes caused by both natural processes and anthropogenic activities (Hasanova *et al*., 2021; Hasanova & Abasova, 2024). The main types of soils found in this region include meadow-marsh, marsh and solonchak soils. The Caspian Sea level fluctuates significantly, which affects the state of coastal ecosystems (Hasanova & Asgarova, 2024). Rising sea levels lead to an increase in the area of coastal salt marshes and changes in the composition of vegetation. This also contributes to the migration of toxic salts into the soil, which negatively affects vegetation and can lead to desertification of lands. Human activity has a significant impact on the region's ecosystem. Pollution from oil products and other chemicals degrades water and soil quality, changing the characteristics of the Caspian flora and fauna (Mammadov *et al*., 2017). Anthropogenic factors contribute to increased salinization of the surface soil layer and can cause ecosystem degradation (Mammadova *et al*., 2024; Mirzezadeh *et al*., 2025). At present, the volumes of zostera reserves in the Caspian Sea have not been sufficiently studied; the places of mass growth of zostera, as well as the places of mass accumulation of storm emissions of zostera, formed after seasonal storm winds, remain unknown. Sea grasses of the *Zosteraseae* family, which are of practical importance for various areas of production, are represented in the waters of Azerbaijan by several species of macrophytes. *Zostera asiatica*, *Zostera japonica*, *Zostera marina* L., *Zostera nana*, *Nanozostera noltei* and others.

Mineralization of organic matter and death of microflora in sea water, depending on the degree of pollution, requires from 3 to 17 days. Adequately assessing the true situation with the current level of pollution in various parts of the sea, we emphasize the need to move to a balanced systematic approach to research of this problem based on the precautionary principle (Rowell, 1999; Solomon, 2014).

a. 

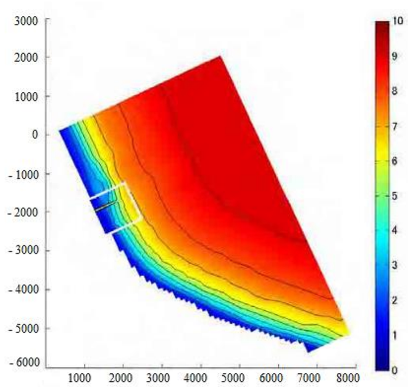
b. 

Figure 1. a - Research area and b - the calculation results of dispersion of thermal effluent

In the case of the southeast current at 0.3 m/s, the surface water temperature increases to 5^0C, compared with 14^0C at the intake (18^0C), in the areas within about 180 m from the water outlet in the direction of offshore and about 100 m in the direction of the coast (Talibi & Hasanova, 2022).

2. Materials and methods

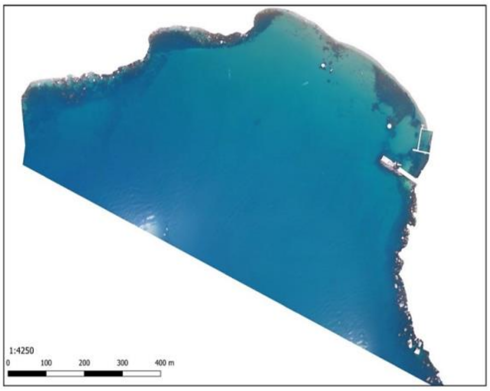
Yashma located in Absheron discrit (Azerbaijan) (40°42'11" N, 49°28'37" E). For mapping the macrophytobenthos of Yashma coast, materials from aerial photography (summer 2023) and hydrobotanical surveys (2020-2024) were used.

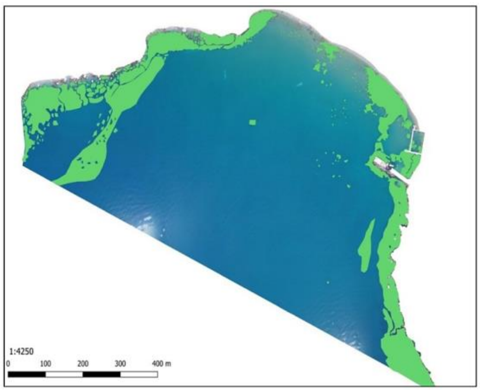
The organisms were examined in suspension of scrapings and identified in permanent preparations and from photographic materials. Photographing was performed using a MIKMED-1 light microscope with a Canon A550 digital camera. Subsequent image processing was performed in Adobe Photoshop CS3 Extended (Kropyanko, 2012; Nasirova *et al*., 2021).

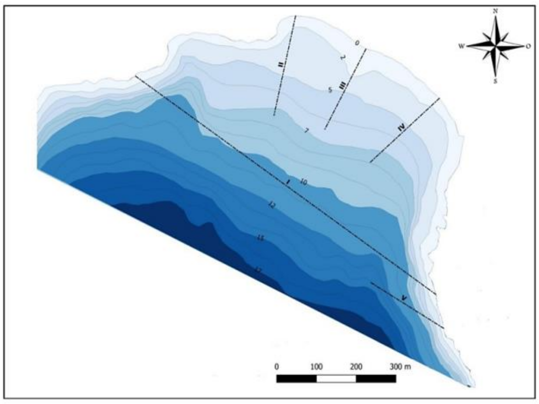
Organization and carrying out of aerial survey of the water area. Aerial photography of the water area was carried out using a *DJI Phantom 4 Advanced*. The images were taken during the entire flight of the vehicle and as a result of this work 198 images with a resolution of 2 cm pixel-1 were obtained (Khudaverdi, 2024). The range of the quadcopter flight was 1500-1600 meters. This is due to limitations on the part of the manufacturer to radio channel at 5 GHz and interference caused by third-party equipment. This distance was sufficient to cover the entire water area Yashma in one flight, during which the device was in the air for 15 minutes.

3. Results and discussion

Interpretation of aerial images. Image processing were processed in *Agisoft Metashape* program. After the images were glued together, the orthophoto plan was exported to *QGIS* program, where it was georeferenced by reference points on the shore with known coordinates in the system SC-61 zone X4, obtained with the *Geomax 25* GNSS receiver with an accuracy of 0.2 cm-m^{-2}. The georeferenced orthophoto in the coordinate system "SC61 zone X4" was obtained (Figure 2a).

a.


b.




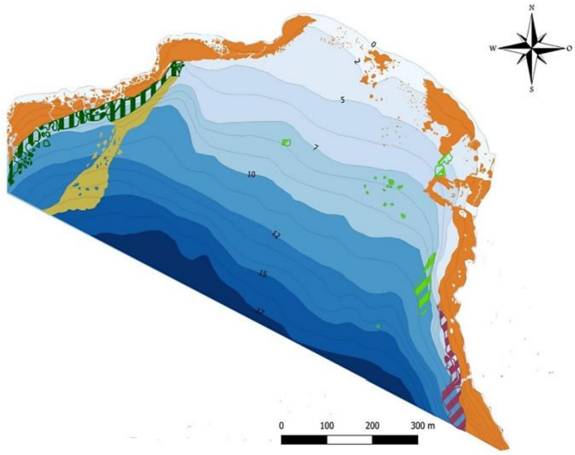
c.

Figure 2. a - Orthophotomap made from aerial images obtained with *DJI Phantom 4 Advanced quadcopter*; b - Boundaries of bottom vegetation contours in Yashma coast, obtained in the process of aerial photo interpretation (orthophoto); c - Map of the Yashma bay research area
Note: I–V are the numbers of hydrobotanical transects
Note: Compiled by the authors in 2023

At this stage, to minimize the errors created by the water column, the green one replaced the blue range and a color pair consisting of an image in the red, green and again in the green color range was obtained (Figure 2b).

Hydrobotanical studies of benthic vegetation. In order to study the composition and structure of macrophyto-benthos, a hydrobotanical survey was carried out using light diving equipment. Five transects were laid in the bay (Figure 2c). A survey diver equipped with a dive computer *(AERIS F10)* walked along the transect line, noting the depth of vegetation change, the lower limit of macrophytobenthos habitat and visually describing bottom sediments, while taking photos and videos. (Kropyanko, 2022). Transects were georeferenced using a GPS navigator *(Oregon 650)*. Based on the compiled profiles, a classification of the distribution of mass species of macrophytes and developed a legend to the map of bottom vegetation in Yashma coast (Figure 3).

Epibiont organisms of bottlenose dolphins have been identified: algae of the genera *Amphora*, *Licmophora*, *Navicula* and *Nitzschia*, fungi of the genera *Aspergillus*, *Alternaria* and *Cladosporium*. The average number of microalgae in enclosures was 411820±121442 cells/cm^2. Only fungal mycelium cells were present, which made morphological identification of the species impossible. Generative structures were rare, so the analysis of the structure of mycocomplexes was carried out based on the average number of propagules (the general name for spores and mycelial cells). The percentage ratio of the number of spores and mycelial cells in the sample characterizes the degree of functional activity of fungi in the ecosystem: the higher the proportion of hyphae, the higher the functional activity of the mycobiota. The average number of fungal propagules in the enclosure fouling was 22021±6205 propagules/cm^2, the proportion of mycelium was 70.3%. The average number of algae exceeded the number of fungi by 20 times (Figures 4 and 5).



	Cystoseira phytocenoses on boulder-block substrate and bedrock outcrops
	Phytocenoses of *Zostera marina* and *Zostera noltei* on sandy-silty soil
	Cystoseira-phyllophora phytocenoses, *Cystoseira* species on boulder-block substrate and *Phyllophora crispa* on gravel-sand deposits with broken shells
	Cystoseira eelgrass phytocenoses, *Cystoseira* species on a boulder-block substrate and eelgrass on a silty-psammitic substrate
	Phytocenoses of sea eelgrass on sandy-silty soil

Figure 3. Map of the distribution of macrophytobenthos phytocenoses in Yashma

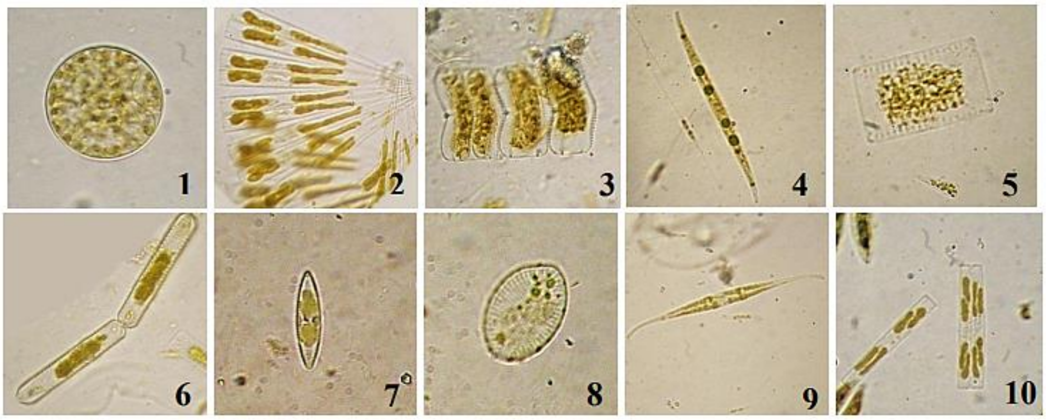


Figure 4. Some of micro algal flora of Absheron coastlines
Note: 1 - *Coscinodiscus*; 2 - *Licmophora*; 3 - *Achnantes*; 4 - *Pleurosigma*; 5 - *Striatella*; 6 - *Pinnularia*; 7 - *Navicula*; 8 - *Cocconeis*; 9 - *Nitzschia*; 10 - *Thalassionema*

The phytocenoses including *Cystoseira* species (*Cystoseira barbata* and *Cystoseira crinita*) is characteristic of pebbles-boulder sidewalks and underwater shore slopes composed of psephitic sediments with bedrock outcrops (Figure 3). It occupies the largest area, which reaches 5.4 hectares that which is more than 63% of the area occupied by macrophytes in the water area. The biomass of phytocenoses varies in a wide range, the highest quantitative values are observed in the upper sublittoral zone (0.5-1 m depth) and the lowest - in the middle sublittoral zone (3-5 m depth). The proportion of *Cystoseira* species is high, decreasing with increasing depth by a factor of 1.3. In the eastern and southeastern part of the bay, starting from a depth of 2.8 m, *Phyllohora crispa* is occasionally encountered, its share does not exceed 2% of the total biomass of macrophytes.

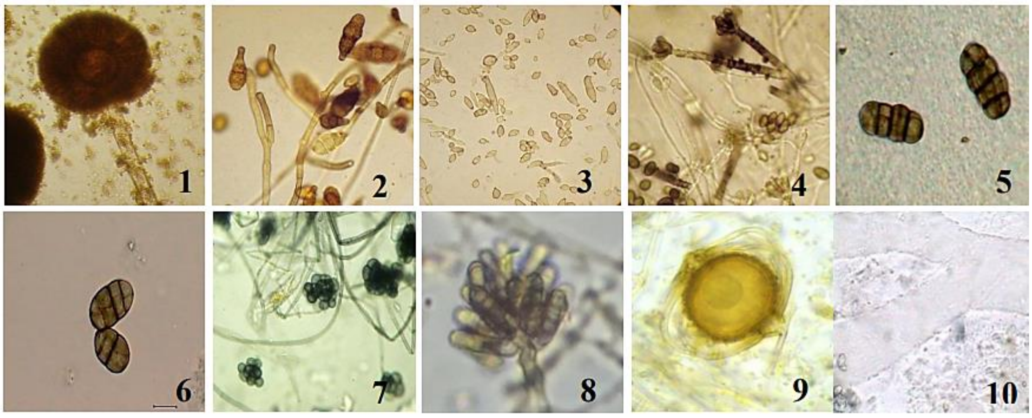


Figure 5. Representatives of mycobiota of Absheron coastlines
Note: 1 - *Aspergillus niger* 2023; 2 - *Alternaria alternata* 2023; 3 - *Cladosporium* sp. 2022; 4 - *Stachybotrus chartarum 2023*; 5 - *Stemphylium* sp.; 6 - *Stemphylium sarciniforme 2023*; 7 - *Zalerion varium* 2024; 8 - *Dendryphiella* sp. 2022; 9 - *Absidia* sp., zygoma 2023; 10 - *Allomyces* sp., hyphae

Cystoseira -phyllophora phytocenoses was recorded in the southeastern part of the bay on the underwater coastal slope composed of psephitic sediments with fragments of pebble-sandy sediments with broken shells, at a depth of 5 to 10 m. *Cystoseira barbata* and *Cystoseira crinita* occur on boulder substrate, the contribution of which is significantly higher than that of *Phyllophora crispa* inhabiting pebble-sand bottom sediments. The share of *Cystoseira* species decreases (1.2 times) and *Phyllophora* species increases (3.1 times) in the studied depth interval.

The phytocenoses of *Zostera marina* was recorded in the northwestern part of the bay at a depth of 10 to 15 meters. The relief is a leveled surface with silty-sandy bottom sediments. The area occupied by seagrass phytocenoses is 1.2 ha, which is almost 5 times lower than the area where *Cystoseira* phytocenoses is described. The biomass of the phytocenoses is low, with its edifier accounting for 77% of the total macrophyte biomass.

Phytocenoses is distributed in the north-western part at a depth of 5 to 10 m. The area of the phytocenoses does not exceed 0.8 ha of the water area and the underwater slope is shallow. The lower part of the slope is relatively leveled, composed of silt and sandy sediments with separately located clumps. *Cystoseira* species (*Cystoseira crinita* and *C. barbata*) predominate on the submerged coastal slope composed of psephitic sediments, while *Zostera marina* occurs on the silty psammite substrate. At this site, the total biomass of macrophytes decreases 4.5 times. On the clay substrate, the share of *Cystoseira* species decreases 1.7 times with increasing depth in the studied range. *Zostera marina* grows in fragments and inhabits the lower part of the underwater coastal slope. The contribution of eelgrasses reaches 25% of the total biomass of macrophytes.

The phytocenoses of seagrasses represented by *Zostera marina* and *Zostera noltei* species has a discrete distribution and is recorded in the central and eastern part at a depth of 5 to 15 meters. The biomass of the phytocenoses does not exceed 142.1 ± 55.7 $g \cdot m^{-2}$, where the first species accounts for 80% and the second for 11% of the total macrophyte biomass.

The area of the central part of the water area at a depth of 3-10 m, represented by a slightly sloping accumulative plain composed of psammite sediments, reef height up to 20 cm, is characterized by absence of bottom vegetation. The phytocenoses dominated by *Cystoseira* species is typical for Yashma coastline. The depth of distribution of this phytocenoses in the northwestern and eastern part of the bay to a depth of 5 m in 2020-2024, whereas in 1985 it reached a depth of 10-15 m. The most pronounced changes occurred at the top of the bay, where the phytocenoses is now confined only to freestanding cliffs, although in 1985 *Cystoseira* species grew in a continuous belt to a depth of 3 (5) m. Macrophyte biomass roughly doubled in 2020-2024 at the upper community boundary, while it tripled at the lower boundary, although the proportion of dominant *Cystoseira* species remained high, compared to the same values in 1985. More than 35 years ago, the biomass of phytocenoses fluctuated in the biomass of phytocenoses fluctuated in a wide range, with the highest quantitative values observed at a depth of 0.5-3 m and the lowest at a depth of 5-10 m. In the top of the bay, in its eastern and southeastern parts, starting from 3 m depth, *Phyllophora crispa* was encountered at the top of the bay, with the share of its participation not exceeding 10% of the total macrophyte biomass. The biomass of the phytocenoses reached over 2 $kg \cdot m^{-2}$. *Cystoseira* species dominated the macrophyte biomass composite, compared to this indicator of *phyllophora* in 2020-2024. Phytocenoses was recorded at shallower depths, total macrophyte biomass and contribution of dominant algal species. Macrophyte biomass increased 1.8 times with increasing depth (from 3127.9 ± 305.8 to 5741.2 ± 962.7 $g \cdot m^{-2}$) *phyllophora* contribution reached 73-96%, while the participation of *Cystoseira* species decreased sharply from 14 to 1% of total biomass. In 1985, *Phyllophora* phytocenoses was recorded along the entire bay at depths ranging from 5(10) to 20(25) m. In the north-western and central-eastern parts of the bay it was distributed at depths of more than 10 m and in the south-eastern part at depths of more than 5 m.

In 1985, the phytocenoses dominated by *Zostera marina* occupied the central part at a depth of 5 to 10 m, where the values of projective cover did not exceed 50%. Macrophyte biomass decreased 1.5 times with increasing depth decreased by 1.5 times. In 2020-2023, the phytocenoses of *Zostera marina* was described in the north-western part at a depth of 10 to 15 m and the biomass of macrophytes in the studied depth range decreased by 1.3-2 times (Figure 6).

a. 

b. 

Figure 6. a - Sea grass on the coastal line and b - survey location (macro benthos)

4. Conclusion

The number of algae genera varied seasonally from 11 to 24. The number of fungi species varied seasonally from 3 to 9, with the most common being conidia of *Alternaria* sp., spores of *Fungi* sp., columns of *Absidia* sp., gametangia and mycelium of *Allomyces* sp. Based on the materials obtained during aerial photography and hydro-botanical studies, five phytocenoses were identified and a map of macrophytobenthos distribution in the coast of Yashma (Absheron) was drawn up. Spatial patterns of distribution of dominant macrophyte species (*Cystoseira* species, *Phyllophora crispa*, Eelgrasses (*Zostera marina* and *Zostera noltei*)) were revealed and their quantitative characteristics were given. As the observation results showed, over a period of more than 35 years (1985-2024), changes were noted in the bay not only in the configuration of the boundaries and the depth of distribution of the macrophytobenthos contours, but also a significant structural reorganization of the plant component was revealed. The conducted studies of bottom vegetation could be used to develop scientific and practical foundations for optimizing nature management. The results show that the application of GIS techniques can be successfully used in assessing the ecological status of embankment soils. This new approach may lead to the development of functional phyto-indicators for better assessment of vegetation management methods.

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References

Bunyatova, L.N., Mammadova, G.I., Hasanova, T.A., Gahramanova, A.Y., Akhundova, S.M. & Alakbarli, G.Y. (2025). Main eco-properties of hazelnut (*Corylus avellana* L.) on the Sheki-Zagatala economic region. *International Journal of Applied Sciences, 14*(1), 209-216.

Dynowski, P., Senetra, A., Zrobek-Sokolnik, A. & Koziowski, J. (2019). The impact of recreational activities on aquatic vegetation in alpine lakes. *Water*, 11(1), 173.

Evgrafov, A.V., Evgrafova, I.M. (2015). Hydrological and hydrochemical observations as part of engineering and environmental surveys for seaport facilities. *Nature Management*, 3, 86-90.

FAO, UNEP (2020). *The State of the World's Forests 2020*. *Forests, Biodiversity and People*. FAO and UNEP publisher, 214. https://doi.org/10.4060/ca8642en https://www.fao.org/state-of-forests/en/

Hasanova T.A., Asgarova, G.F. (2024). Soil studies of mountain-forest soils of the Lesser Caucasus. *Scientific and Methodological Journal, Vestnik of the Belarusian State Agricultural Academy*, *1*(4), 32-37.

Hasanova, T., Abasova, N. (2024). Statistical analysis of the soil activity in Sheki-Zagatala economic region. *EUREKA: Life Sciences*, *3*(51), 3-11. https://doi.org/10.21303/2504-5695.2024.003564

Hasanova, T.A., Mammadova, G.I. & Asgarova, G.F. (2021). Phytomass of gray-brown soils forming in arid ecosystem of Azerbaijan. *Bulletin of Science and Practice, 7*(9), 110-115. https://doi.org/10.33619/2414-2948/70 (In Russian).

Hasanova, T.A., Mammadova, G.I., Bunyatova, L.N. & Gahramanova, A.Y. (2021). Importance of biodiagnostics and irrigation grey-brown soils. *Universal Journal of Agricultural Research*, *9*(3), 63-69. https://doi.org/10.13189/ujar.2021.090301

Huiskes, A.H.L., Blom, C.W.P.M. & Rozema, J. (1987). *Vegetation between Land and Sea*: *Structure and Processes*, 11. Springer Science & Business Media, 355.

Khudaverdi, S. (2024). Mapping of soil salinity in Absheron Soil based on SENTINEL-2 using LightGBM. *Proceedings of the Bulgarian Academy of Sciences, 77*(12), 1879-1887. https://doi.org/10.7546/CRABS.2024.12.17

Kropyanko, L.V. (2012). Application of GIS technologies for assessing the demographic load on the coastal zone of the Southern seas. *Fundamental and Applied Research: Problems and Results*, 1, 35-38.

Mammadov, G.Sh., Mammadova, S.Z. & Shabanov, J.A. (2017). *Ecological Monitoring of Lands*. Baku, 278. (In Azerbaijan).

Mammadova, G., Gahramanova, A., Bunyatova, L., Babayeva, T. & Huseynova, L. (2024). Determination of main properties and fertility capacity of soils under hazelnut cultivation in Azerbaijan. *Proceedings of the Bulgarian Academy of Sciences, 77*(4), 618-626. https://doi.org/10.7546/CRABS.2024.04.18

Mirzezadeh, R., Hasanova, T. & Asgarova, G. (2025). Comprehensive studies of Greater Caucasus river valleys soils. *EUREKA: Life Sciences*, 1, 11-18. https://doi.org/10.21303/2504-5695.2025.003654

Nasirova, A.I., Aliyeva, M.M., Mammadova, R.N. 7 Hasanova, T.A. (2022). Bioecological edificators of gray-brown soils in Ganja-Gazakh Massif (Azerbaijan). *Environment and Ecology Research*, *10*(3), 392-397. https://doi.org/10.13189/eer.2022.100307

Neish, I.C., Bourgougnon, N. (2014). *Advances in Botanical Research, Sea Plants*, 71. Academic Press, 507.

Rowell, D.L. (1999). *Soil Science: Methods & Applications,* first edition. London, 368. https://doi.org/10.4324/9781315844855

Solomon, J. (2014). *Red list of the Endemic Plants of the Caucasus: Armenia, Azerbaijan, Georgia, Iran, Russia and Turkey*. Missouri Botanical Garden Press, 451.

Sullivan, B.K., Short, F.T. (2023). Taxonomic revisions in zosteraceae (Zostera, nanozostera, Heterozostera and phyllospadix). *Aquatic Botany*, 187, 103636.

Talibi, S.M., Hasanova, T.A. (2022). Environmentally significant indicators of mountain meadow soils in Azerbaijan. *Bulletin of Nizhnevartovsk State University*, *57*(1), 102-107. https://doi.org/10.36906/2311-4444/22-1/11