Environmental Impact Assessment Of Mining Industry İn Dashkesan District

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Abstract

The article presents a comparative analysis of the impact of mining enterprises on vegetation, which is the main component of the environment, on the northeastern slope of the Lesser Caucasus.

The goal is to implement fundamental measures to prevent the impact of the mining industry on the environment and to minimize this impact, for which the main direction is the application of the most modern new technologies and equipment.

Dashkasan district was selected as the research area in order to assess the impact of the mining industry on soil and vegetation. The study was conducted on the basis of a comparative analysis of materials from 1990, 2000, 2010 and 2020. Initially, satellite images of the corresponding years were obtained.

The current study reflects the changes in ecosystems in the area in different periods. The decline in mountain species and forest-free areas indicates the effects of human activity, agriculture and climate change. At the same time, it shows the potential for the increase in shrubs and pastures, restoration and improvement of ecosystems.

This information is important in developing strategies for the protection and restoration of ecosystems. The following measures can be proposed to support the restoration process.

Keywords: Mining industry, environmental impact, vegetation, soil protection, ecosystem restoration, GIS technology.

Introduction

Open-pit mining of mineral resources in Azerbaijan is localized and concentrated mainly on the northeastern slopes of the Lesser Caucasus. However, the impact of these activities on vegetation and soil cover is more destructive and destructive [1, 3]. During the process of opening deposits, vegetation and soil cover of the Earth's surface are destroyed. This not only leads to the replacement of natural landscapes with technogenic landscapes but also causes serious changes in the relief of the territory and, as a result, changes in the hydrographic and hydrogeological background [5, 6]. These changes cause long-term ecological problems in the environment and disrupt the balance of natural systems [8, 9].

Starting from the middle of the 19th century, the development of the mining industry in the Dashkesan region has had a serious impact on soil-landscape complexes. As a result of this process, some areas have been destroyed and replaced by technogenic landscapes. Other areas have undergone transformation, and environmental problems such as steppe and desertification have arisen.

The main objective of this study is to assess the impact of the mining industry on the ecological balance and to propose measures to eliminate or reduce these impacts. For this, the Zaylik deposit and other local areas were selected as the main research object.

Object and methodology of the study. The main object of the study is the Zaylik deposit, and several local areas located in the Dashkesan region. The Zaylik deposit is rich in gold and other precious metals and has a significant impact on the regional economy. However, the environmental impacts of mining activities can be wide-ranging, and accurate assessment of these impacts is important for preserving ecological balance.

Various methodologies were applied in the study. GIS technology [2, 7], satellite images – NDVI [4] and the AWEI system [10,11] were used to assess changes in vegetation cover, soil and water bodies. This helps to visualize the impact of mining activities on the environment.

The exposure dose was determined using a radiometer-dosimeter device, the composition and specific activity of radionuclides were determined using the AAS (Atomic Absorption Spectroscopy) method to determine the chemical composition of soil samples, and the γ-Spectrometry method.

Finally, ecological monitoring systems were established and changes in various components of the environment were continuously monitored. Through these systems, the long-term effects of mining activities were monitored, and effective measures were developed for environmental protection. The information obtained through these methods aims to assess the environmental impact of mining activities in the Zaylik deposit and to develop appropriate measures to restore ecological balance in local areas.

The Zaylik alunite deposit is one of the largest alunite deposits in the world due to the scale of mineralization, formation conditions and layered deposit characteristics and stands out from other deposits with its uniqueness. The deposit is in the northeastern wing of the Dashkesan syncline, in an area formed by volcanogenic and volcanogenic-sedimentary rocks of the Middle and Upper Jurassic period, and its industrial reserves are approximately more than 170 million tons. Alunite, kaolinite (dickite), quartz, chalcedony, pyrophyllite, sericite, diaspore, zuniite, corundum, hematite and fluorite are the main minerals included in the mineral paragenesis of the deposit. Among the hypergenic minerals, galluazite, limonite, as well as in rare cases calcite, gypsum and other minerals are found, which increases the importance of the deposit and gives impetus to conducting an ecological assessment.

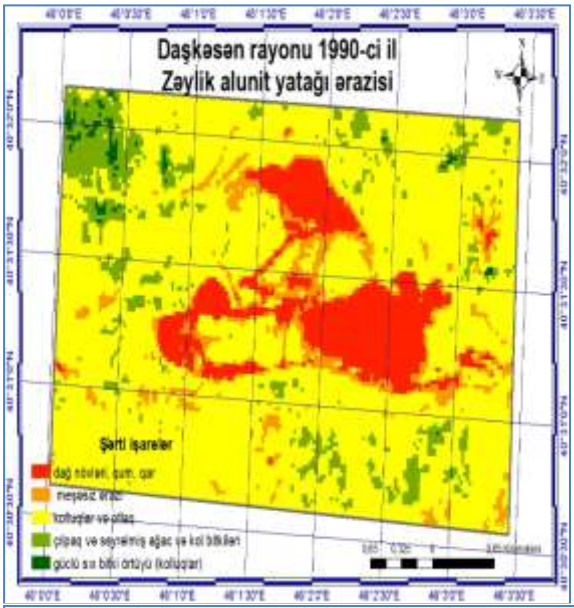
Analysis and discussion. To determine the location of the deposit, Add Basemap, OpenStreetMap and Google Earth Pro data were first used in the ArcGIS program, and the result is shown in Figure 1.

Figure 1. Zaylik alunite deposit

The state of the forest and vegetation cover of the area in 1990, 2000, 2010 and 2020 was analyzed in detail using the NDVI index. During these years, changes in the vegetation cover in the area were monitored, information was obtained about the ecological state of the landscape and the decrease or increase in green areas. The results of the analysis, vegetation cover and area indicators by year are reflected (Figure 2).

In 1990-2000, the area of forestless land increased from 108 ha to 584.6 ha, which is an increase of 476.6 ha. During this period, the increase in anthropogenic activity led to the expansion of the forestless area. By 2010, the forestless area decreased to 80.56 ha, which is a decrease of 504.04 ha. In 2020, the area increased to 101.7 ha, which is associated with the restoration of the environment and the creation of new ecosystems during this period. In 1990-2000, the area of shrubs and pastures decreased from 989.5 ha to 527.4 ha. This is a decrease of 462.1 ha. By 2010, the area increased to 662.65 ha, which indicates the restoration of the area. The fact that the area reached 819.6 ha in 2020 indicates the sustainable development of this ecosystem and the improvement of pasture areas.

In the period 1990-2000, the area of the ecosystem type such as bare and sparse trees and shrubs decreased from 121.7 ha to 21.1 ha, which indicates the negative impact of ecological changes and anthropogenic activities in the area. In 2010, the area increased to 433.79 ha, which indicates the possibility of ecosystem restoration. In 2020, the area decreased to 410.5 ha.

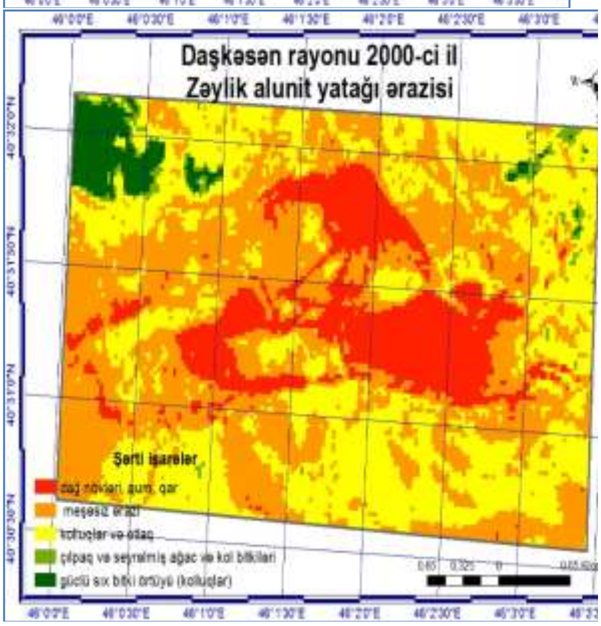


Table

zeylik_1990_etalon

FID	Shape	Class Name	sinif	sahə	fa
0	Polygon	-0.1 to 0.1	dağ növləri, qum, qar	160,2ha	11,5
1	Polygon	0.1 to 0.2	meşəsiz ərazi	108ha	7,8
2	Polygon	0.2 to 0.4	kolluqlar və otlaq	989,5ha	71,2
3	Polygon	0.4 to 0.5	çılpaq və seyrəlmiş ağac və kol bitkiləri	121,7ha	8,8
4	Polygon	0.5 to 0.67	güclü sıx bitki örtüyü (kolluqlar)	10,7ha	0,8

(0 out of 5 Selected)



Table

zeylik_2000_etalon

FID	Shape	Class Name	sinif	sahə	fai
0	Polygon	-0.1 to 0.1	dağ növləri, qum, qar	213,1ha	15,3
1	Polygon	0.1 to 0.2	meşəsiz ərazi	584,6ha	42,1
2	Polygon	0.2 to 0.4	kolluqlar və otlaq	527,4ha	37,9
3	Polygon	0.4 to 0.5	çılpaq və seyrəlmiş ağac və kol bitkiləri	21,1ha	1,5%
4	Polygon	0.5 to 0.67	güclü sıx bitki örtüyü (kolluqlar)	43,9ha	3,2%

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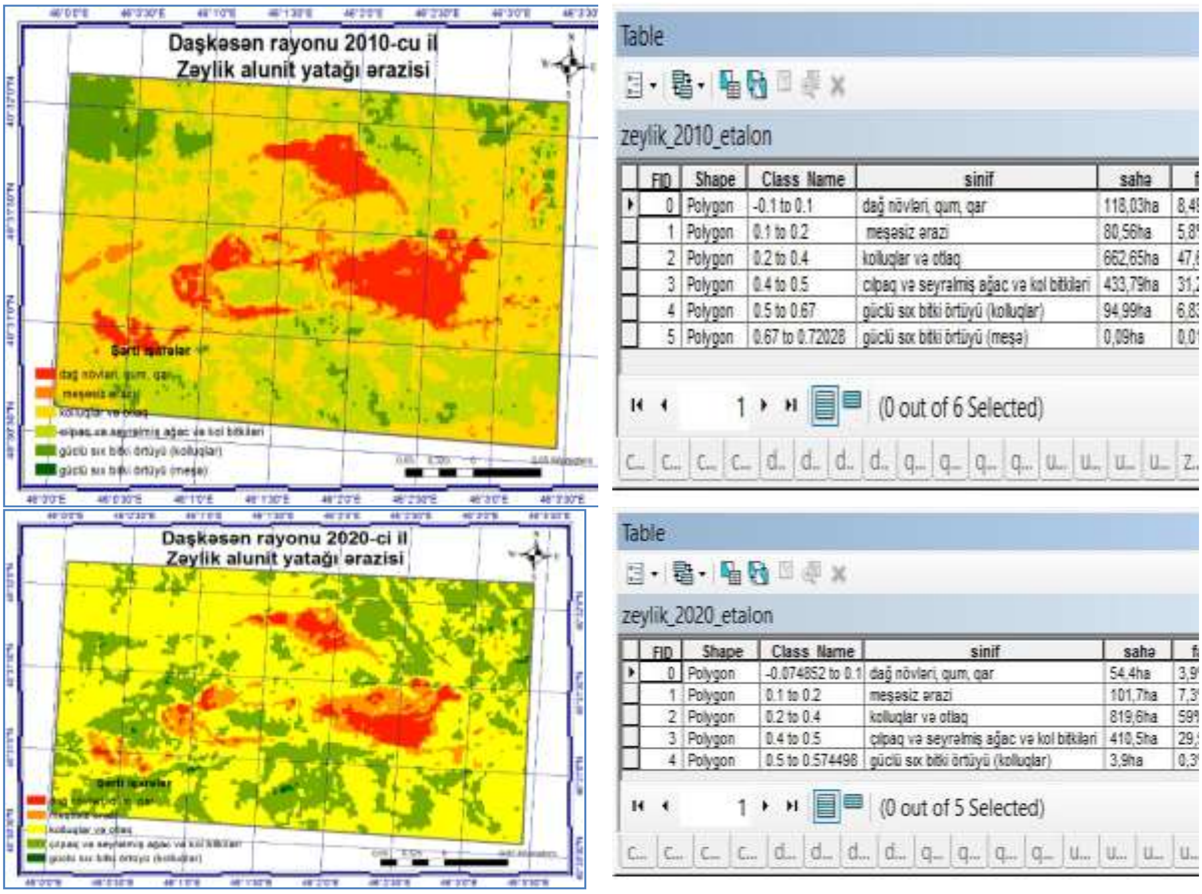

FID	Shape	Class Name	sinif	saha	f
0	Polygon	-0.1 to 0.1	dağ növləri, qum, qar	118,03ha	8,4
1	Polygon	0.1 to 0.2	meşəsiz ərazi	80,56ha	5,8
2	Polygon	0.2 to 0.4	kolluqlar və otlaq	662,65ha	47,
3	Polygon	0.4 to 0.5	cılpaq və seyrəlmiş ağac və kol bitkiləri	433,79ha	31,
4	Polygon	0.5 to 0.67	güclü sıx bitki örtüyü (kolluqlar)	94,99ha	6,8
5	Polygon	0.67 to 0.72028	güclü sıx bitki örtüyü (meşə)	0,09ha	0,0

FID	Shape	Class Name	sinif	saha	f
0	Polygon	-0.074852 to 0.1	dağ növləri, qum, qar	54,4ha	3,9
1	Polygon	0.1 to 0.2	meşəsiz ərazi	101,7ha	7,3
2	Polygon	0.2 to 0.4	kolluqlar və otlaq	819,6ha	59
3	Polygon	0.4 to 0.5	çılpaq və seyrəlmiş ağac və kol bitkiləri	410,5ha	29,
4	Polygon	0.5 to 0.574498	güclü sıx bitki örtüyü (kolluqlar)	3,9ha	0,3

Figure 2. Vegetation cover and area indicators of the Zaylik alunite deposit area in 1990, 2000, 2010 and 2020, respectively

Strong dense vegetation cover (shrubs) increased from 10.7 ha to 43.9 ha in 1990-2000, and in 2010 the area increased to 94.99 ha, but in 2020 the area decreased to only 3.9 ha, which indicates that the ecosystem has lost its sustainability under current conditions.

Strong dense vegetation cover (forest) has an area of 0.09 ha in 2010. This is an indicator that forests have sharply decreased or that local ecosystems are facing difficulties.

For a more comprehensive analysis of the results of soil surveys conducted in the local area in Dashkesan district, the following key aspects are noted in Figure 3.

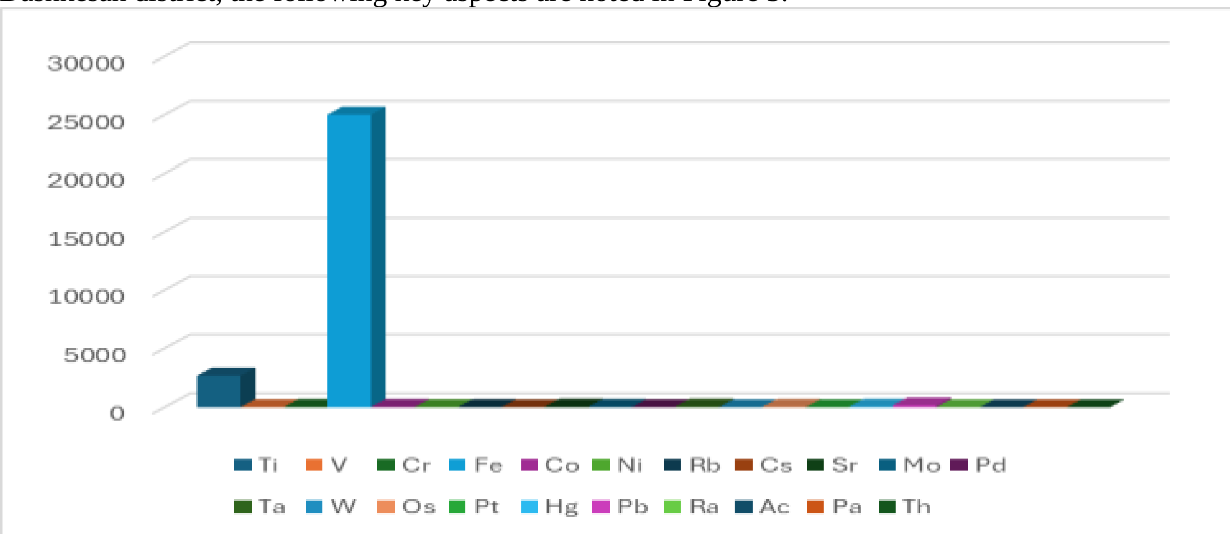

Figure 3. Elemental analysis of soil samples taken from a local area in Dashkasan district (mg/kg)

As can be seen in Figure 3, the amount of titanium (Ti) in the soil sample taken from a local area in Dashkasan district is 2654 and is present in high amounts in the soil sample. Titanium is mainly found naturally in mineral composition (as ilmenite and rutile). This may indicate the presence of titanium-rich minerals in the geochemical structure of Dashkasan district. The amount of vanadium (12.6) can be considered typical for the natural composition of the soil. Vanadium can enter from wastewater and industrial waste, as well as as a result of natural geological processes. The amount of chromium (55) is relatively normal and reflects the natural mineral composition of the soil. However, the risk of chromium contamination of anthropogenic origin (from industrial waste or fertilizers) should be considered. The very high level of iron (22325) confirms that Dashkasan district is rich in iron deposits. This can be considered as a main feature of the natural geochemical composition. The cobalt content (14.5) corresponds to the natural composition of the soil and may be of geological origin. Cobalt should be monitored as a heavy metal, and cases of increased concentration should be investigated. The nickel content (12.4) is considered normal and is thought to have entered the soil as a result of geological processes. The possibility of impact from anthropogenic sources should also be taken into account. Rubidium (145) is mainly of natural origin and may be associated with feldspar minerals. This value is an indicator of typical geological processes. The strontium level (61) corresponds to the normal natural range. Strontium can be found in carbonate minerals (strontianite) and other geological formations. The molybdenum level (36) is high. This may indicate that the Dashkesan region has natural molybdenum deposits or the impact of industrial activities. The palladium content (5) is very low and is present in the soil as a result of natural geochemical processes. This may also indicate anthropogenic impacts associated with metallurgical and industrial activities. The tantalum level (6) is low and is considered to be of geological origin. Although this element is used in high-tech products, it originates from natural minerals. The amount of osmium (2.6) is very low and is related to natural geological processes. The probability of anthropogenic impact is minimal. The level of mercury (11) is moderate and may indicate a possible anthropogenic impact (industrial waste, pesticides). Mercury is a toxic element that requires special attention. The level of lead (62) is higher than normal and the risk of anthropogenic impact (industrial waste, metallurgical activity) should be taken into account. This may cause environmental and health risks. Actinium (0.552) is present in very small quantities. This radionuclide is found in the soil as a natural uranium and thorium decay product. The amount of protactinium (0.4) is low and is considered to be of natural origin. It is formed as a result of uranium decay and affects the radiation background. The amount of thorium (0.9) is normal and comes from natural mineral composition. It is an element that increases the radiation level, but this level does not pose a serious threat.

The AAS method used to determine the chemical composition of soil samples failed to determine the elements cesium, tungsten platinum, radium.

As a result of the conducted research, it was determined that the exposure dose in local areas of the region varied between 3-5 mR/h. Later, the radionuclide content was determined in the soil sample taken
(Fugure4).

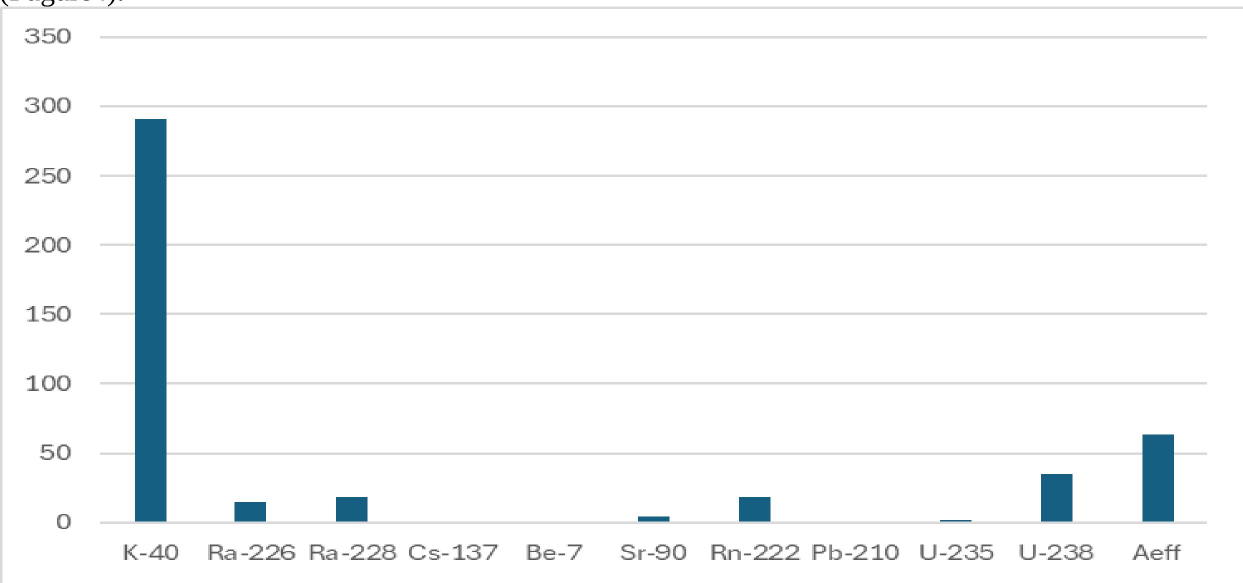

Figure 4. Radionuclide content in a sample taken from a local area (Bq/kg)

As a result of the assessment of radiation indicators in the Dashkesan region, it was determined that the activity in K-40 was determined as 291. This radionuclide is of natural origin and is found in the mineral composition of the soil. Its level is normal and does not pose a serious threat to the environment, but is the main component of the natural radiation background. The activity in Ra-226 is 14.8. Ra-226 is a natural radionuclide and belongs to the uranium series. This level is within the normal natural background, but requires attention as it plays a role in the formation of radon (Rn-222) gas. The activity for Ra-228 is 18. Ra-228, a radionuclide belonging to the thorium series, contributes to the radiation background of natural origin. This level can be considered normal. The activity in Cs-137 was recorded as 7 (MDA=3.2). Cs-137 is mainly of man-made origin and enters the soil as a result of nuclear tests or accidents. Its presence may indicate anthropogenic contamination, but this level does not pose a serious threat. The MDA for Be-7 is 6.3. The activity value has not been recorded, which indicates that its amount is very small or undetectable. Be-7 is mainly of cosmogenic origin and has a temporary effect on the radiation background. The activity for Sr-90 is 4.6. Sr-90 is a man-made radionuclide and is produced by nuclear activities. This level is relatively low, but monitoring is required for long-term effects. The activity for Rn-222 is determined to be 18.2. Radon gas is produced as a decay product of Ra-226. It can be released from the soil into the atmosphere and further research is recommended to ensure that radon levels do not pose a risk to human health. The MDA for Pb-210 is 8.6. The activity has not been recorded, which indicates that its level is very low. Pb-210 has a minimal impact on the radiation background. The activity for U-235 is 1.6. It is a naturally occurring uranium isotope and is at a normal level. It does not pose a serious threat to health and the environment. The activity for U-238 is 34.5. U-238 is one of the naturally occurring radionuclides and is present at a normal level in the soil. This value is considered to be consistent with the natural radiation background. Aeff is recorded as 63.1. This indicator reflects the total radiation background of the soil. The value can be considered normal, but it is advisable to compare it with international safety standards and assess potential risks.

To study in more depth the significant impact of mining enterprises located on the northeastern slope of the Lesser Caucasus (Dashkasan region) on the environment of the region, especially water bodies, AWEI satellite images were used, and a comparative analysis of these impacts over the years covers the following areas (Figure 5).

The following results were obtained from monitoring the changes observed in the water bodies of the Dashkesan region over a 30-year period:

Class 1 (Arid Regions - Arid Zone Areas): AWEI ≤ -500, this value indicates completely dry areas and indicates the absence of water bodies.

Class 2 (Semi-arid Zone Areas): -500 < AWEI ≤ 0. This range represents areas with poor moisture content or minimal water.

Class 3 (Low Moisture Regions): 0 < AWEI ≤ 500, this range indicates areas partially covered by water, i.e. seasonal and shallow water bodies

Class 4 (Wet Zones): 500 < AWEI ≤ 1000, this range is suitable for water-saturated soil and land.

Class 5 (Water Zones): AWEI > 1000, this range indicates deep water bodies and high water concentration.

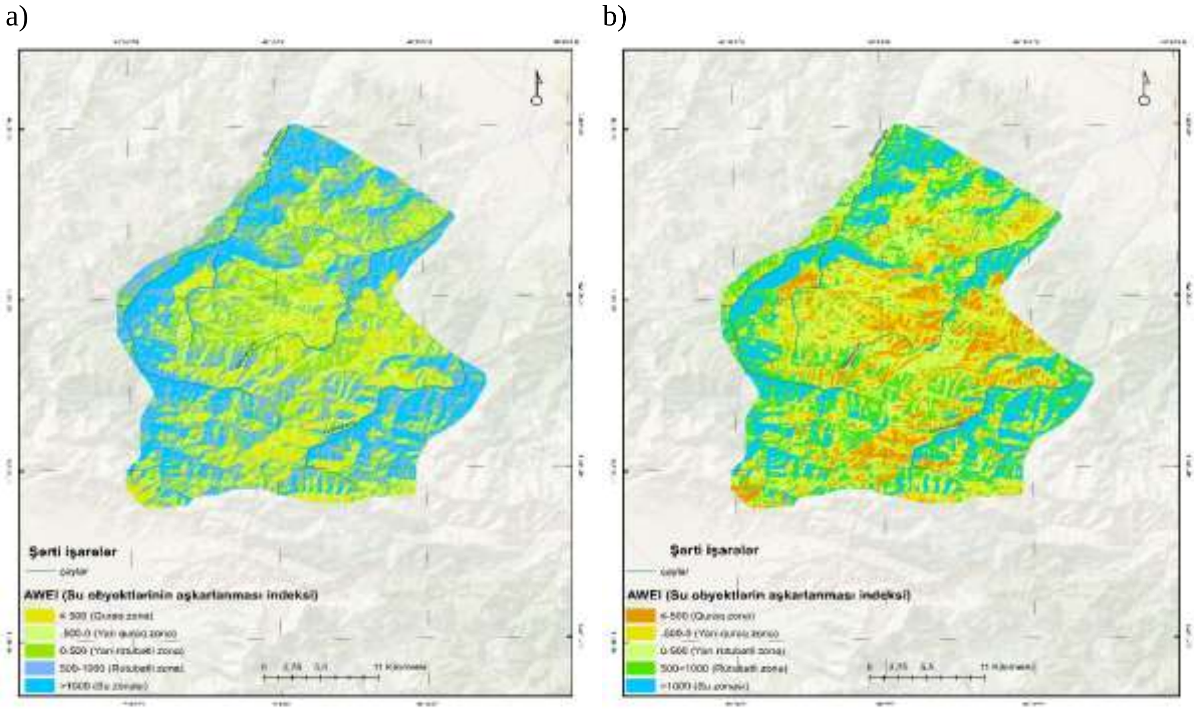

Figure 3. Changes observed in water bodies of Dashkesan district over 30 years: a) 1990; b) 2020

Conclusion

1. In 1990-2000, the area of mountain species increased (from 160.2 ha to 213.1 ha). During this period, favorable conditions were observed for the restoration of ecosystems. However, since 2010, a decrease in the area has been recorded due to the influence of anthropogenic activities, and in 2020 the area decreased to 54.4 ha.

2. Although the expansion of deforested areas (in 1990-2000) and subsequent decreases (in 2010) indicate the restoration of the ecological balance, an increase was recorded again in 2020, which indicates the need for continuous environmental protection measures.

3. The high content of the element titanium (Ti) (2654) indicates the mineral richness of the geochemical structure of the region. The very high concentration of iron (22325) confirms that the Dashkesan region is rich in iron deposits. The presence of Mercury (Hg) and Lead (Pb) indicates an ecological risk indicator related to anthropogenic impacts.

4. Among the radionuclides, K-40, Ra-226 and U-238 are radionuclides of natural origin and are at normal levels. Cs-137 and Sr-90 are radionuclides of technogenic origin, but their current levels do not pose a serious threat.

5. In the last 30 years, certain changes have occurred between arid and humid zones in the area of water bodies. The increase in arid zone areas indicates the expansion of drought conditions. The decrease in water-saturated land areas highlights the negative effects on the quality and quantity of water bodies.

6. Mining industry activities in the Dashkesan region have a serious impact on soil and water resources. In addition, radionuclide levels and concentrations of heavy metals require continuous monitoring for both ecosystems and human health.

7. Ecosystem restoration processes observed in previous periods show that it is possible to restore the natural balance with continuous protection and management measures. However, environmental monitoring and appropriate conservation strategies are essential to reduce the impacts of anthropogenic activities.

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