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Biogeochemical Signs of the Desertification Process in the Territory of Gabala Region of Azerbaijan

Abstract

The process of desertification in the Gabala region of Azerbaijan is seen as a very urgent ecological and socioeconomic concern for the hydrometeorological climate that is gradually drying up,

The process of desertification manifests itself in different intensity depending on the natural conditions of the area, especially anthropogenic, relief, climate, biological, etc.

The gradual increase of in drought in the region from year to year, indifferent changes in the temperature and humidity regime of the air, soil pollution with waste, overgrazing of pastures, etc. continue to have a negative impact on the ecological balance of the area.

Physical erosion of landscapes and the acceleration of the desertification process are caused by changes in the direction of air circulation, together with abrupt temperature variations (8-10^{0}C), dips in relative humidity below 30 %, and changes in atmospheric pressure.

The desertification process is displayed by an increase in xerophytic vegetation.

It is expedient to use natural biogeocenoses as a biogeochemical research method to assess the progress of the desertification process (Mamedov et al., 2016; Mustafabeyli, 2023, pp. 457-469). The aim is to demonstrate the strong buffering capacity of soils because of the high levels of organic carbon, potassium, phosphorus, and humus in the soils, as well as the stability of the climate type in biogeocenoses and high indicators of biodiversity.

Keywords: *Gabala region, biogeocenosis, landscape monitoring, silt samples, desertification process*

Introduction

In the territory of Gabala region, Bumchay, Tikanlichay, Hamzalichay, Damiraparanchay and Vandamchay rivers form a dense river network, and they unite in the southern part of the region to form Turyanchay river.

A variety of soil types can be found in the Gabala area, extending from the Great Caucasus watershed into the Alazan-Haftaran valley and the northern slope of the Sheki plateau (Rustamov &Rustamova, 2016; Mustafabeyli et al., 2020).

Mountain meadow-grass, mountain meadow-like black soil, mountain meadow-forest, mountain forest-brown, mountain forest, alluvial-meadow, meadow-swamp, mountain black and mountain chestnut soil types are widespread. Mountain meadow soils cover a relatively large area in the northeastern part of the region. Mountain-meadow lands cover a large area between 2000-3000 m above sea level in the alpine and subalpine zones near the watershed. The area of mountain meadow-forest soils is somewhat less, and was formed on the erosion products of clay cists at the upper border of the forest and inter-forest clearings, under sparse beech forests and subalpine meadows between 1800-2100 m above sea level (Regional geographical problems of the Republic of Azerbaijan, 2003; Mustafabeyli, 2012).

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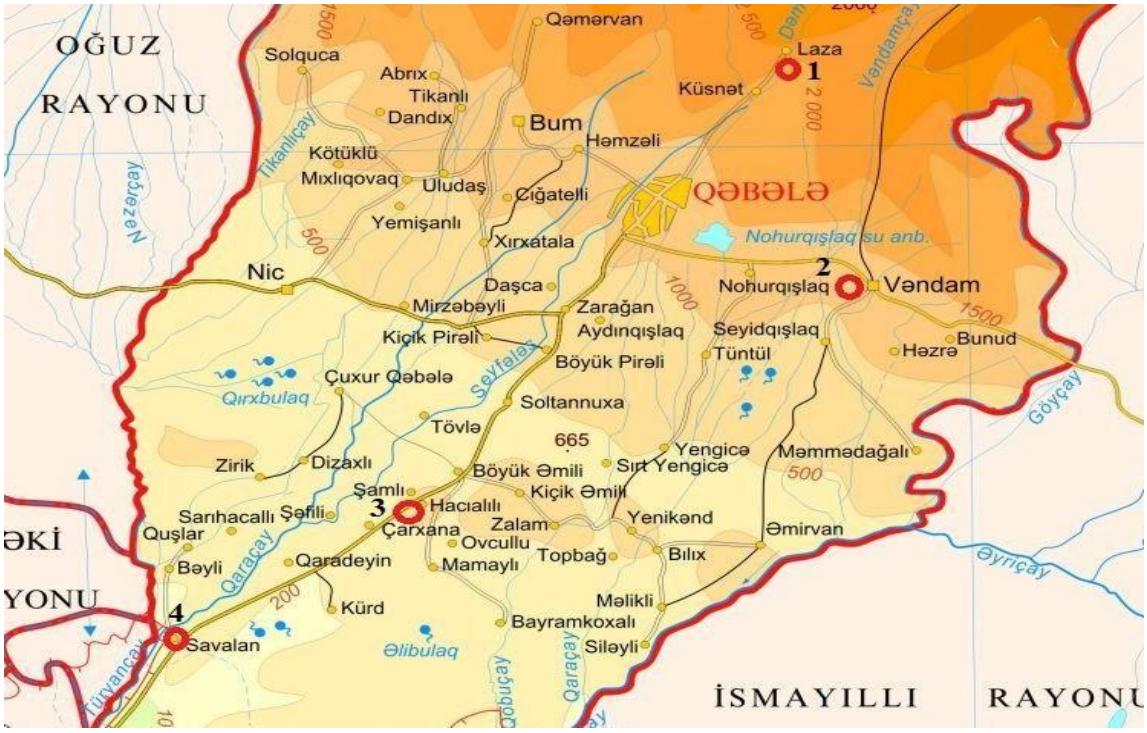
Mountain brown-forest soils spread between Bumchay and Vandamchay basins, at altitudes from 1100 to 2200 m above sea level, and cover a wide area. These soils are characterized by thick and dark humus (8.0−15.0 %) forest substrate, high water retention capacity, and heavy clayey mechanical composition.

On the northern slopes of the plateau ridges located here, along with the usual hardened and carbonated, mountain-black soils, dark chestnut and chestnut soils are also common in small areas.

In all altitudinal zones, the composition of the original vegetation has changed and been destroyed, and has been replaced by derived plants.

Map-scheme – 1

Physical map of Gabala region. The areas where soil and silt samples were taken are shown on the map



The climate is mainly temperate and humid. The amount of abundant sunny days in the area is 2200-2300 hours and the total solar radiation fluctuates between 120-135 kcal/cm^2.

Research

The mountainous terrain in Gabala region presents a number of geomorphological and geological problems. Here, it manifests itself with extensive severe erosion, washing, landslides, avalanche processes, flood events and high seismicity.The most extensive mineral resources of this region are building materials. Among them are clay (Karkhana, Savalan), which has large reserves in the rocks of the Upper Jurassic and Cretaceous periods, as well as clay shales and sandstones. There are large amounts of river stone, sand and gravel reserves in the catchment areas of the Bumchay, Hamzalichay, Damiraparanchay and Vandamchay rivers.They are used in the production of bricks, ceramic tiles, and drainage pipes, as well as in concrete production and road construction (Regional geographical problems of the Republic of Azerbaijan, 2002; Mustafabeyli et al., 2020).

During landscape diagnostic monitoring, soil samples were also taken from a number of different forest and meadow landscape types. All soil and silt samples were prepared in accordance with the general research methodology for determining the amount of biophilic macro and

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microelements (Mustafabeyli, 2023, pp. 474-491; Mustafabeyli & Gahramanov, 2022, pp. 301-307).

Table 1

Coordinates of silt and soil samples taken from the territory of Gabala region

№	Sampling stations	Examples	Coordinates
1.	Gabala region, Damiraparanchay. Turbaza. Absolute height 1200 m.	Sandy-silt	N – 41.00.58. E – 47.53.40.
2.	Gabala region, Vandamchay. Gabala - Baku highway. Absolute height 800 m.	Sandy-silt	N – 40.57.09. E – 47.55.57.
3.	Gabala region, Damiraparanchay. Charkhana.Absolute height 220 m.	Sandy-silt	N – 40.47.48. E – 47.37.54.
4.	Gabala region, Turyanchay. Damiraparanchay. Savalan. Absolute height 180 m.	Sandy-silt	N – 40.46.39. E – 47.36.20.

As a result of landscape diagnostic studies, it was determined that the desertification process in the Gabala region is mainly dependent on the semi-arid climate in the Amirvan Plateau and Turyanchay Valley in the southern part of the region.

In the areas located on the southern slope of the Greater Caucasus Range (between the settlements of Bum — Gabala — Vandam) in the Gabala region, the desertification process is manifested with greater intensity, depending on the anthropological factor.

The chemical composition of the silt and soil samples submitted for chemical analysis to the laboratory of the Sheki Regional Center of the Agrarian Services Agency is given in *Table 2*.

Table 2

Chemical composition of sludge and soil samples taken from the territory of Gabala district

№	Stations	Indicators	Unit of measure	Analysis result	Norm	Evaluation
1.	Damiraparanchay. Turbaza.	pH	—	9.06	6.6-7.5	Alkaline
		Salinity	—	0.169	0-2	Non-salt
		Humus	%	0.12	2-3	weak
		P_2O_5	kg/ha	49.22	60-120	Very weak
		K_2O	kg/ha	76.5	250-550	Very weak
		Na	mg/kg	30.9	81-120	Very weak
		N	%	0.006	0.09-0.17	Very weak
		Fe	mg/kg	10.9	2.5-4.5	High
		Lime	%	19.7	5-15	High
		Mn	mg/kg	7	14-50	Weak
		Cu	mg/kg	1.2	≥ 0.2	Adequate
		Zn	mg/kg	0.36	1.0-2.4	Weak
2.	Vandamchay. Gabala — Baku highway.	pH	—	8.76	6.6-7.5	Alkaline
		Salinity	—	0.203	0 -2	Non-Salt
		Humus	%	1.87	2-3	Very weak
		P_2O_5	kg/ha	8.575	60-120	Weak
		K_2O	kg/ha	105	250-550	Very weak
		Na	mg/kg	10.4	81-120	Very weak
		N	%	0.093	0.09-0.17	Medium

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		Fe	mg/kg	12.01	2.5-4.5	High
		Lime	%	10.04	5-15	Medium
		Mn	mg/kg	7.4	14-50	Weak
		Cu	mg/kg	1.7	≥ 0.2	Adequate
		Zn	mg/kg	0.74	1.0-2.4	Weak
3.	Damiraparanchay. Charkhana.	pH	—	8.54	6.6-7.5	Alkaline
		Salinity	—	0.592	0-2	Non-Salt
		Humus	%	1.02	2-3	Very weak
		P_2O_5	kg/ha	5.075	60-120	Very weak
		K_2O	kg/ha	87	250-550	Very weak
		Na	mg/kg	77.2	81-120	Weak
		N	%	0.051	0.09-0.17	Weak
		Fe	mg/kg	14.4	2.5-4.5	High
		Lime	%	6.32	5-15	Medium
		Mn	mg/kg	8.4	14-50	Weak
		Cu	mg/kg	3.3	≥ 0.2	Adequate
		Zn	mg/kg	0.55	1.0-2.4	Weak
4.	Turyanchay. Damiraparanchay. Savalan.	pH	—	8.67	6.6-7.5	Alkaline
		Salinity	—	0.984	0-2	Non-Salt
		Humus	%	0.87	2-3	Very weak
		P_2O_5	kg/ha	4.95	60-120	Very weak
		K_2O	kg/ha	103.75	250-550	Very weak
		Na	mg/kg	255.7	81-120	Very high
		N	%	0.043	0.09-0.17	Very weak
		Fe	mg/kg	13.1	2.5-4.5	High
		Lime	%	7.04	5-15	Medium
		Mn	mg/kg	10.6	14-50	Weak
		Cu	mg/kg	1.9	≥ 0.2	Adequate
		Zn	mg/kg	0.64	1.0-2.4	Weak

As it appears from *Table 2*, the following regularities were found in the silt samples taken along the middle reaches of Damiraparanchay and Vandamchay:

1. Silt substrates are typically characterized by alkaline environmental conditions with pH values ≥ 8.0. The amount of assimilated Fe element is also found in very high quantities.

2. The amount of humus, phosphorus, nitrogen, and assimilated Mn and Zn elements in the silt substrate is significantly lower than normal.

3. In most cases, the carbonation and Cu content of the silt substrate were represented at an average level.

4. While the amount of Na element is below the norm in the upper and middle reaches of the Damiraparanchay River, which corresponds to a semi-humid climate (Mustafabeyli, 2023, pp. 457-469), it is sharply above the norm in the Turyanchay area, which has semi-arid climatic conditions.

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Scheme 2
Salinity and carbonation indicators in Damiraparanchay and Vandamchay river bed silts of Gabala region

Salt	Lime	Sample 1	Sample 2	Sample 3	Sample 4
20	1.0	L			S
18	0.9				
16	0.8				
14	0.7				
12	0.6			S	
10	0.5		L		
8	0.4				L
6	0.3		S	L	
4	0.2	S			
2	0.1				
0	0				

As can be seen from *Scheme-2*, the following regularities were identified in the silt samples as they descended along the Damiraparanchay and Vandamchay riverbeds:

1. The amount of salinity (mS/cm) is approaching the normal limits from low values, while the amount of lime (in % carbonate content), on the contrary, is significantly decreasing from the normal in this direction.

2. As the Damiraparanchay and Vandamchay rivers descend along the riverbed, the alkalinity-acidity indicators in the sludge samples are usually pH ≥ 8.0, which is due to the leaching of alkaline elements (Na, Ca, K, Mg, etc.) from floodplains in high mountainous areas.

3. The decrease in the ratio of carbonation to salinity indicates an intensification of the desertification process in the area (Mustafabeyli & Gahramanov, 2023, pp. 506-515; Mustafabeyli &Gahramanov, 2023, pp. 248-254).

4. Since the amount of K and P elements absorbed in silt samples is significantly lower than the norm, silting of agricultural fields as a result of floods and inundations creates serious difficulties for agricultural activities.

5. The closeness of the nitrogen element to the norm allows for the cultivation of nitrogen-loving plants for a while in soils silted up by floods and inundations.

6. As the Damiraparanchay and Vandamchay rivers descend along the riverbed, the amount of Fe absorbed in the silt samples is significantly higher than normal, the Cu element is sufficient, and the Mn and Zn elements are below normal.

7. Over time, this silt material turned into soil, causing an increase in humus and biophilic elements such as K, P, Mn, Cu, and Zn associated with humus, and a decrease in carbonation, salinity, and alkalinity.

8. When comparing the chemical composition of silt samples from the Damiraparanchay river beds of Gabala region and Dashagilchay river beds of Oguz region, it is revealed that the former have a more alkaline environment. This situation may be associated with greater erosion of flood hotspots in the Damiraparanchay basin.

Thus, desertification is a complex process that occurs as a result of the interaction of biological, physical, chemical and ecological characteristics of the territory (Mustafabeyli, 2023, pp. 255-265;

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Mustafabeyli & Gahramanov, 2023, pp. 248-254). Physical, chemical, biogeochemical and ecological indicators are used for analysis of this process. These indicators help to determine how the territory has changed and the extent to which ecosystems have been disrupted as a result of both natural and anthropogenic influences.

Conclusion

In the territory of Gabala region, the desertification process is manifested with greater intensity in the southern part of Amirvan plateau and partly in the Turyanchay valley, depending on the climatic conditions, and on the southern slope of the Main Caucasus Range (in the area between the villages of Nij and Vandam) depending on the anthropological factor. Therefore, while the amount of Na element is below the norm in the upper and middle reaches of the Damiraparanchay, which corresponds to the semi-humid climate, it has sharply increased above the norm in the Turyanchay area, which has semi-arid climatic conditions.

The alkalinity-acidity indicators in the sludge samples are often pH ≥ 8.0 as the Damiraparanchay and Vandamchay rivers descend. This is associated with the leaching of alkaline elements (Na, Ca, K, Mg, etc.) from the high mountainous regions. That is why declining silt samples' carbonate to salinity ratio suggests that the desertification process in the southern plateau region is getting stronger.

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