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RESEARCH ARTICLE

Soil Erosion and Control Measures in the Mountainous Agricultural Zones of Azerbaijan

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ABSTRACT

As a result of the erosion process, most of the mountainous and foothill areas of the country have lost their fertility. The need for comprehensive control measures to restore lost fertility is as important as the demand of the day, and its scientific and economic effectiveness is determined. For this purpose, the soil vegetation of the natural zones, climatic conditions, and ecological conditions of the landscapes were studied and analyzed based on the results of the monitoring. In the example of Gusar region, the object of research was selected and cuts were made, and the corresponding field-soil-erosion study was carried out. Analytical laboratory researches were carried out on soil samples taken in the area and the results were analyzed. Based on the results of the comparative analysis, it was determined that these gray-brown soil types, which are widespread in the area, are mostly eroded to a moderate degree. The fertility of these lands has been lost and productivity has declined. In the process of soil erosion in the mountainous and foothill regions of the country, many of them have lost their productivity. It is recommended to take comprehensive measures to restore soil fertility. To this end, it is necessary to have the honor of climatic conditions, vegetation landscapes, and other natural ecological aspects.

Key words: Land cover, landscape, slope, soil erosion, water flow regime

INTRODUCTION

Ensuring the dynamic development of various sectors of the economy is one of the key issues in the Republic of Azerbaijan, which is confidently advancing on the path to independence, to fully meet the needs of the population in food and industry in raw materials.[1,2] To this end, the development of the agricultural sector in our country has always been and remains in the focus of our state. With all this, many state programs are being developed and implemented. Of these, the State Program for Socio-Economic Development of the Regions of the Republic of Azerbaijan has been successfully reflected. In this program, the directions of the economy in these regions were determined by combining the territory of the republic into ten economic regions, taking into account its economic and geographical position, natural conditions and resources, level of population, sectorial and territorial structure, and historical development features of the regions. 1.45 million hectares of land are irrigated in Azerbaijan. Cultivated lands in Gusar region are also irrigated. The area of the district is 187646 hectares. Of this, 94.80 thousand hectares or 50.6% were subject to various degrees of erosion. Of this, 49.7 thousand hectares or 53.3% were weakly 24.6 thousand hectares or 25.6% were moderately eroded, and 20.5 thousand hectares or 21.1% were severely eroded.[3-5]

Most of the lands in the mountains and foothills of Azerbaijan have lost their fertility due to erosion. To restore and protect the fertility of eroded soils, comprehensive zonal anti-erosion control measures

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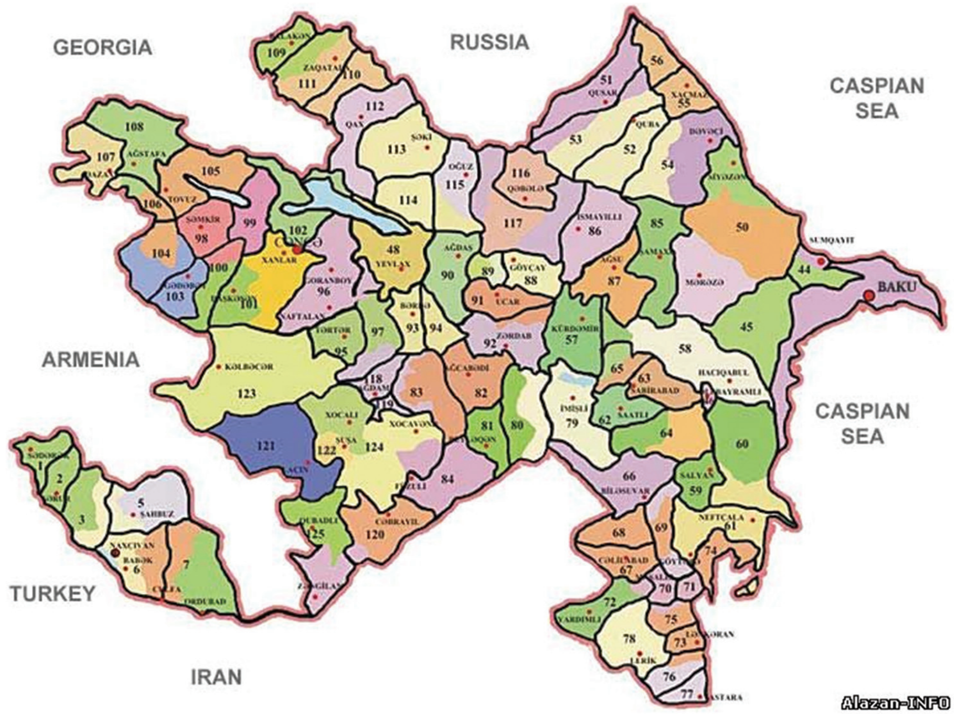

should be implemented. When applying control measures, the soil and vegetation of natural areas, climatic conditions, the degree of soil erosion, the slope of the slopes, and the ecological conditions of the landscape must be taken into account.

In the territory of the republic, including the Lesser and Greater Caucasus, the soil-vegetation, and bioclimate change as the sea level rises. Accordingly, different natural zones are separated. In these areas, it is necessary to eliminate the factors that cause its occurrence in the soil solution. To do this, first of all, it is important to use economic and organizational measures, to restore and increase the fertility of eroded soils, the correct placement of farmland, perennial plantations, forest strips and roads, taking into account the structure of the terrain, and soil conditions.

Large-scale soil research should be carried out in the area to design anti-erosion measures, properly organize the area, and place agricultural crops on a scientific basis. A map of erosion factors and a map of erosion control measures should be developed for the study areas.

The maps shown for a number of farms in the mountainous and foothill regions of the country were prepared by the Scientific Research Institute of Erosion and Irrigation.[6-10]

MATERIALS AND METHODS

The area under perennial grasses in soil-protective crop rotations should be 25–30%. On slopes with a slope of 10–15%, the planting of intercropped crops should be stopped completely, and the area under perennial grasses should be increased to 60% in the rotation system. In severely eroded areas, the planting of cereals should be stopped completely. Only perennial grasses should be planted in such areas. This measure protects the soil well from erosion and is economically viable very useful. It is more expedient to stop planting field crops in areas with an inclination of more than 15% and use them as natural hay.

Agrotechnical measures against erosion on slopes (plowing and other cultivation works should be carried out in the direction of the width of the slope, water-retaining furrows and buffer strips should be made, deepening of strips, etc.) improve soil water-physical properties, prevent surface runoff and soil moisture slope. It is possible to completely prevent the erosion process only if the plowing is carried out in the direction of the width of the slope. It is necessary to take additional measures to combat erosion on such slopes. One of these measures is the opening of water-retaining furrows in the direction of the width of the slope when plowing and freezing. The furrows prevent surface water runoff and leaching, increase soil moisture reserves, and increase crop yields.

It has been determined that deep soil softening with strips is of great economic importance in preventing the erosion process. This measure prevents 75–80% of surface runoff, the sediment is well absorbed into the soil, and thus the water-physical properties of the soil are significantly improved.

Among the soil-protective agro-technical measures, the opening of cracks on the slopes is of great importance. Semi-plowing, grazing, grazing, and mowing, etc., give very good results in areas.

Cracks in perennial grassland areas should be made in the fall when the soil is compacted, and in autumn cereal fields before sowing or when the soil freezes. Half-life reduces the water flow of the soil, prevents its leaching, increases the amount of moisture in the soil and thus significantly increases the productivity of agricultural crops.

Therefore, to meet the high fodder needs of livestock in pastures and pastures, it is necessary to organize the protection of grass cover from degradation to obtain quality fodder.

Proper adherence to grazing time and norms is recommended for surface and substantial improvement of areas where vegetation is thinned and lost.

About 90% of the country's forests are located in mountainous areas. Their role of water regulator and soil protector is irreplaceable. Forests do not allow water to flow and regulate the water regime. In addition, forests are of great resort importance. However, forest lands are eroded as a result of deforestation or grazing by livestock. For this reason, about 20% of the forests in the study area have been eroded. More than 80% of the forest lands have been eroded. Therefore, special attention should be paid to the protection of forests, conditions should be created for natural regeneration, and measures should be taken to establish new forests in open, non-forested areas.

Gorge erosion is also widespread in the country. As a result of ravine erosion, planting, grazing, etc., areas were fragmented and rendered unusable. Therefore, measures to combat ravine erosion are important economic issues.[11]

In the mountainous and foothill regions of the republic there are many extinct, that is, underdeveloped goblins. On the slopes of these goblins, it is possible to create hayfields by sowing the seeds of perennial grasses, which also strengthens the walls of the goblins.

Particular attention should be paid to the establishment of forests inside and around the goblins. Trees and shrubs should be planted to strengthen the rocky areas.

To prevent landslides on mountain slopes, it is necessary to divert the direction of surface water flow. To do this, you need to build ditches on the slopes.

Hydrotechnical constructions should be used to protect the river basins of the republic from erosion and floods. These structures prevent flooding by protecting the riverbank from erosion by precipitating coarse materials formed as a result of erosion and floods. Along with water erosion, wind erosion is widespread in the country.

Deflation is one of the main causes of erosion and is found in the foothills of the Lesser Caucasus. Comprehensive control measures must be developed to prevent winds and sand being blown away. When planting protective forest strips, the directions, strength, etc., of the prevailing winds are determined. Conditions must be taken into account. To protect the land cover and increase the efficiency of its use, the above measures should be combined and applied in a comprehensive manner. Properly implemented control measures in each farm protect the soil from degradation, increase its fertility, and, as a result, create conditions for high and stable yields from agricultural crops.[12]

Over the past 30 years, more than 20% of the territory of the republic has been invaded by Armenia. As a result, it was occupied and for a long time turned into a bloody battlefield. Military erosion has developed on a large scale here. Toxic bombs, artillery, and mortar shells devastated hundreds of villages, settlements, and districts, disrupted landscapes, destroyed land structures, and devastated thousands of acres of crops and gardens. During the war, he poisoned and polluted the lands that created a toxicological situation using toxic substances.

After the liberation of such lands, they should be thoroughly cleaned by systematic and reclamation measures and the lands should be treated with special care. Complex measures must be taken to return the lands to agricultural use. Soils must undergo toxicological testing.

Zoological genocide also took place in the area that has become a battlefield. Hence, all living beings have fled in the war zones, and even sparrows cannot be found here. All this has destroyed ecosystems, disturbed the natural balance, and created an ecosystem that has had a major impact on the ecological situation.

There is a great need to take complex melodic and special measures in the areas to be liberated from occupation.

Gusar region is located in the north-eastern part of the Greater Caucasus, Dagestan AR in the north, north and east, Guba region in the south-west and south-east, Khachmaz region in the north, east border, Bazarduzu, the highest point of the Greater Caucasus in the south-west, and Gabala in the west district is located.

The north-eastern part of the Greater Caucasus has a complex geological-geomorphological structure. Rainy or dry years do not allow to increase productivity. On the other hand, the increase in erosion is one of the factors. Therefore, the fertility potential, agrophysical, and agrochemical properties of soils have weakened, and their biological activity has significantly decreased.

To investigate the regularity of the erosion process, it was considered expedient to increase the research work in these areas.

Numerous studies have shown that the north-eastern mountainous part of Azerbaijan, including the Gusar region, consists mainly of Mesozoic sediments. The western part of the area (close to the Main Range) is dominated by dark Lower Jurassic shales, Middle Jurassic gray-brown shale, sandy rocks, upper Jurassic (lateral range) limestone conglomerates, and lower Cretaceous limestones. Cretaceous limestones and sedimentary conglomerates are more common as the rocks that make up the soil change to the east. Eroded rocks are more widespread in the central mountainous areas of the north-eastern part. The territory of Gusar region, located on the north-eastern slope of the Greater Caucasus, mainly covers the basins of the Samurchay, Gusarchay, Ugurchay, Susachay, and Tahirchay rivers. These rivers and their tributaries formed a dense river network, dividing the region in different directions, causing the erosion process to intensify and the lands to collapse. Occasional strong floods from these rivers cause great damage to the region’s farms. The vegetation of the area plays a key role in the formation and formation of soils; they form the organic composition of soils, improve their physical properties, and enrich their chemical composition by creating a sustainable structure. Studies have shown that on the north-eastern slope of the Greater Caucasus, as well as in the Gusar region, all plant species vary from high mountain meadows to semi-desert.

The study was conducted in heavily eroded areas. Field and laboratory research methods were used in the study of the research object. The boundaries of the survey were determined on the maps of the lands of Gusar region, the object of study was compared with 1: 100,000 and 1: 50,000, field research routes were carried out within the boundaries defined on the topographic map, the location was selected according to the number of plots and geographical coordinates. On the basis of the obtained topographic maps, the natural-ecological conditions of the region where field researches were carried out were determined, the relief, climatic features, vegetation, hydrography, and geological-geomorphological structure were studied within these conditions.

The study area is located in Yasab, Laza, and Shahdag-Laza villages of Gusar region. The cut area has a flat relief and is located in a raw area outside the planting area. The thickness, granulometric composition, color, structure, hardness, and a number of morphological features of the soils were noted. In different years, various agricultural crops such as barley, wheat, alfalfa, corn, sunflower, and other crops were planted in this area. Studies have shown that precipitation falls mainly in winter and autumn. After visual inspection, the washing process was specified here. Determining the degree of soil erosion SS Sobolayev methods for mountainous areas and KA Alakbarov methods for plain areas were used for cultivation. In soil samples taken with potentiometer in pH-aqueous solution, general humus IV Tyurin, nitrogen (expulsion method) mobile phosphorus B.P. Machigin, exchange of potassium P.V. Protasov, absorbed bases K.K. Hedroyts, carbonate-calcimeter, soil structure was determined according to NA Kachinsky, RG Mammadov. Phenological observations were made during plant development: Plant height, plant age and dry weight, accuracy of experiment, and probability of reliability of the obtained product were studied by AM Mesheryakov, mathematical-statistical analysis of correlation between traits by GF Lakin. During the soil researches on the north-eastern slope of the Greater Caucasus, as well as in the Gusar region, many research works were studied, including ME Salayev (1966), Q.Sh. Mammadov (2003–2007), K.A. Alakbarov (1955, 1961), H.A. Aliyev (1961), 1964, BGShakuri (1965–2012, IM Nasibov (1965, 1970), HA Giyasi (2010), and others they are.

In the early eighteenth century, A.N. Izyumov studied the causes of erosion in the Gusar region and described the slopes eroded in the Gusarchay basin in 1940.

B.A. Budagov (1957, 1961) studied the phenomena of landslides and erosion in the Shahdag massif and showed that gobu erosion is widespread in the Samur River and Gusarchay basin.

YEAH. Aliyev, S.B. Farajova, and YA Salamov (1961) based on their research in the Gusar region, they showed that the rivers starting from Shahdag (Tahirchalchay, Gusarchay) washed the bare slopes for a long time and turned them into deep and impassable ravines. Gradual deforestation in the Tahirchalchay and Ugruchay basins has intensified surface washing and severe fragmentation of the terrain.

In the future, based on scientific research, a system of control measures has been developed for the efficient use of land resources and the prevention of erosion, depending on the direction of the economy.

In 1925, IZ Imshenieski conducted a soil survey in the Gusar region of the North-Eastern slope of the Greater Caucasus to conduct zoning. During the research, he described the mountain-meadow lands along the Laza Shahdag route.

In 1956–1957 in the territory of Gusar region H.A. Aliyev, S.B. Farajov, and KA Salamov conducted soil research. As a result of the research, the following semi-types of soils were distributed in the mountain-meadow zone of the region: Peat, thick mountain-meadow, grassy mountain-meadow, primitive mountain-meadow soils, as well as their distribution and genetic features.

In 1961–1967, I.M. Nasibov conducted soil erosion research on a scale of 1: 100,000 in Gusar region, including the mountain-meadow zone. As a result of the research, the following subtypes of soils were divided into: Primary mountain-meadow, grassy mountain-meadow, and steppe mountain-meadow.

Starting from 1997, Prof. Under the leadership of BH Aliyev, employees of the Scientific Research Institute of Erosion and Irrigation of the Ministry of Agriculture of Azerbaijan: ZH Aliyev, AA Ibrahimov, S. Isgandarov, A. Isayev, and FA Sadigov conducted extensive soil erosion studies.

The survey covered 46,223 hectares. The following types of soils were identified during the generalization of the results of field research and laboratory analysis.

1. Primary mountain-meadow lands
2. Soft mountain-meadow soils
3. Dense grassy mountain-meadow lands
4. Underdeveloped mountain-meadow lands
5. Steppe mountain-meadow lands
6. Mountain-meadow lands similar to black soil
7. Cultivated mountain-meadow lands

Crop productivity in Gusar region does not meet today's requirements. One of the reasons for this is soil erosion. Erosion is also different in different areas of the region.

Primary mountain-meadow soils are spread over solid rocks in areas with very poor vegetation at an altitude of 3200 m above sea level. The total area is 4592.5 ha, which is 9.92% of the area. These lands are widespread in the mountain-meadow zone of Gusar region, in Shahdag massif, in Laza village around Tufan mountain, in Kechelbash, Aclurgan, Degyush, Shah Abbas, and Azakyan, in the upper part of Shahnabad river basin.

The hydroscopic moisture and specific gravity of some soils distributed in the territory of Gusar region are reflected in Table 1, mechanical composition in Table 2, agrochemical composition in Table 3, and structural aggregate composition in Table 4.

The results of the analysis showed that the specific gravity of the soil in the upper layer of the brownish mountain-forest soils spread over the area is 2.60 g/cm^3. Toward the lower layers, this amount increases slightly (0.2 g/cm^3), and the specific gravity does not exceed 2.69 g/cm^3 along the profile [Table 1]. This corresponds to the organic residue index of those soils indicate ni.

The described soils also correspond to the mechanical composition according to the amount of hydroscopic moisture [Table 2]. Thus, the amount of hydroscopic moisture along the soil profile was 4.85–5.60%, and the amount of physical clay (20.01 mm) was 52.80–62.00%.

Table 2 shows the agrochemical composition of the soils in the area.

Table 1: Hygroscopic moisture and specific gravity of soils in certain layers in the territory of Gusar region

Research area	Land use	Of the land name	Cut №	Depth cm	Specific gravity, in g/cm³
Gusar district; Wild brown mountain-forest	Pasture	The mountain is gray-brown	1	0–12	2,60
				12–25	2,62
				25–40	2,64
				40–60	2,66
				60–120	2,69

Table 2: Widespread brown mountain-forest soils in Gusar region mechanical composition (absolutely dry soil, in%)

Research area	Land use	Cut №	Depth cm	Hygroscopic humidity, in%	Particle size, in mm, quantity						
					1–0.25	0.25–0.05	0.05–0.01	0.01–0.005	0.005–0.001	<0.001	<0.01
Gusar DISTRICT The territory of Yasab village	Mountain gray-brown	1	12	5.12	0.50	11.50	35.20	13.20	28.00	11.60	52.80
			12–25	4.85	0.41	17.59	26.80	6.00	31.20	18.00	55.20
			25–40	5.60	0.47	14.33	28.00	16.00	23.20	18.00	57.20
			40–60	5.52	0.80	4.40	35.20	5.60	35.60	18.40	59.60
			60–150	5.47	0.18	2.62	35.20	4.80		32.40	62.00

Table 3: Widespread brown mountain-forest soils in Gusar region some agrochemical composition

Research area	Land use	Cut №	Depth in cm	Humus	General nitrogen	Motor P_2O_5 in mg/kg	CO_2	$CaCO_3$ for CO_2, in%	Absorbed bases, in mg/eq.		Total	In total, in%	
				%-lə					Ca	Mg		Ca	Mg
Gusar district the territory of Yasab village	Mountain gray-brown	1	0–12	1.66	0.098	32.22	no	no	23.5	5.5	29.0	81.03	18.97
			12–25	1.24	0.078	33.75	"____"	"____"	21.0	5.0	26.0	80.77	19.23
			25–40	0.72	0.048	26.66	8.86	20.13	18.0	4.5	22.50	80.0	20.00
			40–60	Not specified	Not specified	23.33	9.60	21.82	16.5	3.5	19.50	84.62	17.95
			60–150	"____"	"____"	not specified	10.89	24.75	14.0	3.0	17.0	82.35	17.65

Table 4: Widespread mountain-forest lands in the territory of Gusar region structural (form) and aggregate (denominator) composition

Research area	Land use	Cut №	Depth in cm	Particle size, mm, quantity,%							Skeleton in%
				>7	7–5	5–3	3–1	1–0.5	0.5–0.25	>1.7	
Gusar district the territory of Yasab village	Mountain gray-brown	1	0–12	30.02 1.72	7.75 3.28	12.32 9.96	16.58 10.75	23.72 8.56	4.94 16.60	4.67 39.13	66.67 25.71
			12–25	52.83 0.32	17.52 1.52	15.48 6.40	7.17 9.18	5.29 13.20	1.40 26.00	0.31 43.38	93.00 17.42
			25–40	72.62 3.68	9.43 4.00	8.31 6.68	3.69 8.60	3.87 12.48	1.55 18.20	0.53 46.36	94.05 22.96
			40–60	44.33 2.52	16.34 4.04	17.91 4.60	4.47 8.20	9.08 14.40	6.40 16.84	1.47 49.40	83.05 19.36
			60–150	33.52 2.36	11.67 5.80	16.09 6.72	10.25 8.20	14.86 11.60	5.51 12.52	8.10 52.80	71.53 14.92

The analysis of the table shows that the amount of humus in the upper layer (0–12 cm) of the described soils fluctuates between 1.66%, and in the lower layers between 0.72 and 1.24%. Soils are characterized by very low humus content.

In all cases, the total amount of nitrogen varies according to the humus. Thus, while the amount of humus in the top layer of soil (0–125 m) is 1.66%, the amount of total nitrogen in soils with 0.098%–1.24% humus is 0.0078%–0.72% in humus. The total nitrogen content was 0.048%.

The amount of P_2O_5, one of the nutrients that can be assimilated in the topsoil (0–12 cm), is 32.22 mg/kg. The amount of P_2O_5 decreases toward the lower layers, and in the subsoil (12–25 cm) this figure was 33.75 mg/kg. Toward the lower layers, this figure decreased slightly to 26.66 mg/kg, and at 40–60 cm did not exceed 23.33 mg/kg.

The soils were selected for their lack of carbonate in the upper layers. However, starting from 25 cm of soil, $CaCO_3$ content is observed in the soil. Thus, the amount of CaCO3 in 25–40 cm of soil is 20.14%, in 40–60 cm – 21.82%, and in 60–150 cm – 24.75%.

According to the evaluation distribution, these soils are distinguished by their close to medium carbonate and medium carbonate content.

In the top layer of soils (0–12 cm) the absorbed bases are only 29.00 m/eq., the main part of which is Ca (90.00–82.50%) cations, and the rest is Mg (17.50–20.00%) cations. holds.

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CONCLUSION

Soils are characterized by poor performance on the basis of absorbed.

The lands described above are also N.I. The composition of the structural aggregate was investigated with reference to the Savinov method [Table 4].

The results of laboratory analysis showed that the structural-aggregate composition of the described soils is satisfactory. This is confirmed by both structural and aggregate components of the topsoil, which is agronomically stable and has a diameter of 5–3 and 3-–1 cm. Thus, 12.32% of structural particles with a diameter of 5–3 mm in the top layer of the soil were 9.96%, 10.75% of 16.58% of structural particles with a diameter of 3–1 mm were resistant to the destructive effects of water. The most important indicator was the particle size <0.25 mm. It was found that such particles were more numerous than other particles, which indicates that these particles have a high aggregate (water resistance). Such a comparison is also significant for structural and aggregate indicators >1 mm.

The analysis of the collected materials suggests that the complexity of the geological and geomorphological structure of the Gusar region in the north-eastern part of the Greater Caucasus, mainly rainfall, intensive deforestation on slopes, non-compliance with soil protection, and agro-technical rules in the fields .

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