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ANTHROPOGENİC TRANSFORMATİON OF FOREST LANDSCAPES ON THE NORTH–EASTERN SLOPPE ON THE LESSER CAUCASUS AND İTS ASSESMENT

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Abstract

It is known that the biggest and most dangerous factor affecting the forest landscapes of the northeastern slope of the Lesser Caucasus is the spontaneous deforestation of forests by humans for various economic purposes. Analysis of materials and figures from different periods also shows that as the degree of human settlement increased, the decrease in forest density also changed accordingly. Although deforestation was random in periods of low settlement, unfortunately, this figure has increased over time and has taken on a dangerous character today. Most importantly, forests are being intensively reduced in order to increase settlements and agricultural areas.

Keywords: technogenic, forest, landscape, anthropogenic, density.

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Introduction:

The study of dynamic processes in the forest landscape and their direction allows for the early assessment of negative anthropogenic impacts and their prevention. Therefore, it is important to comprehensively study the current state and dynamics of the forest complex in historical terms in order to develop a system of measures for the effective use, protection and restoration of mountain forest landscapes.

The oldest and main factor affecting the forest landscape on the northeastern slope of the Lesser Caucasus is the natural deforestation of forests for various economic purposes. Analysis of historical materials shows that the volume of forest harvest has constantly increased in accordance with the gradual increase in the number and density of the population. The relatively smooth surface of the inter-river anticlinal uplifts in the studied area has led to the deforestation of the forests that once existed here since ancient times and their transformation into agricultural lands and residential areas. Currently, isolated remains of ancient forests can be found in the fields, as well as forest elements in the soil.

Deforestation in the area was of varying intensity in different historical periods. When settlement was relatively weak, anthropogenic impacts on forests were random. Trees in the forest were cut down individually or in groups. However, the strong natural regeneration of the forest during this period did

not cause serious changes in the structure of the landscape. In later periods, the plasticity of the relief on the northeastern slope of the Lesser Caucasus, the smooth bottom, wide, and favorable intermountain depressions for agriculture and cattle breeding led to the increase in settlements in the mountain-forest landscape belts. Unlike the Greater Caucasus, the main occupation of the population of these villages was cattle breeding and agriculture. It should be noted that this type of occupation continues to this day. Cattle breeding and agriculture have created serious changes in the structure of the forest landscape. Forests were cut down in large areas to increase arable land, and natural forest regeneration gradually weakened. The development of cattle breeding played a major role in the degradation of the forest landscape.

The presence of rich minerals in the northeastern part of the Lesser Caucasus has led to the development of industry in the region since ancient times. The development of industry has also led to massive deforestation in the region. Historical documents show that the forests that once existed in the Gadabay region were cut down on a large scale from 1865 to 1883, that is, until the construction of the Transcaucasian railway, for the Gadabay and Galakand copper smelting plants of the Siemens brothers. Each of these plants produced 40 thousand pounds of copper per year. By the way, it should be noted that the Galakand plant was the first plant in Russia to smelt copper by electrolysis. The Siemens had permits to cut down 19.2 thousand dessiatines in the Shamkhorchay basin in 1866-1879. The Gadabay copper plant used 21.4 thousand cubic sajins of wood and 4.4 million poods of charcoal during the years 1871-1882 (there is no data for the years 1865-1870). Currently, in the Shamkhorchay basin, places where former charcoal was made can be found in 90-100-year-old beech forests. From the report written by a forest inspector found in the archive documents, it is known that 5 times more trees were cut in the forest allocated for the Siemens brothers' copper smelting plants. That is, instead of 3 thousand cubic sajins, 15 thousand cubic sajins of wood were cut per year.

The area of the destroyed forest was widely used mainly for agriculture and animal husbandry. This gradually reduced the reforestation and mountain meadow and mountain-shrub complexes were formed in the place of the former forests. During the research, forest complexes that had re-emerged after mass deforestation were discovered in the Shamkirchay and Zayamchay basins.

The upper and lower boundaries of the forest landscape in the studied area have been subjected to serious anthropogenic changes. With intensive anthropogenic influences, the upper boundary of the forest has shifted significantly downwards, and the lower boundary upwards. Currently, the climatic boundary of the forest on the northeastern slope of the Lesser Caucasus passes much higher. This is also clearly shown by the analysis of the vertical variation of climate data. The upper boundary of the forest on the northeastern slope of the Lesser Caucasus corresponds to the July isotherm of 15-17°C. This means that the natural climatic boundary of the forest passes 500-600 m, and in some areas 800-1000 m higher. Unlike the Greater Caucasus, the development of livestock breeding, along with agriculture, has played a major role in lowering the climatic boundary of the forest on the northeastern slope of the Lesser Caucasus. Therefore, the upper boundary of the forest on the northeastern slope of the Lesser Caucasus has undergone serious changes.

According to M.Y. Khalilov, as a result of the combined influence of long-term agriculture and cattle breeding, the forest has almost nowhere remained within its natural boundaries. In many places, subalpine forests have completely disappeared, and they have been replaced by mountain meadows, meadow thickets, and sometimes rocky outcrops complicated by decaying materials. As a result of all this, the percentage of forest cover on the northeastern slope of the Lesser Caucasus has gradually decreased over historical periods, and now it has reached the threshold of an ecological crisis.

In the basins of the Ganja and Tartar rivers, at an altitude of 2200-2400 m above sea level, in relatively inaccessible areas, a thick oak-birch forest has been preserved in small areas. However, traces of cattle grazing are also found in the structure of the forest here. The mentioned altitude corresponds very well to the upper climatic boundary of the subalpine type forest. Intensive anthropogenic influences

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Observations show that mountain forest landscapes are characterized by high dynamism and poor stability. Even minor anthropogenic impacts cause long-term changes in the structure of the mountain forest landscape. Forests on steep slopes are more quickly destroyed by external impacts. Anthropogenic degradation of the forest landscape of the northeastern slope of the Lesser Caucasus has accelerated over the past 10-15 years. The deterioration of the supply of natural gas to the population and farms has led to the use of firewood as fuel. With the expansion of construction in recent years, part of the demand for wood material is also met by local forest resources. Both users are primarily interested in healthy straight-stemmed trees in the forest. As a result, the number of old, sick, crooked-stemmed trees that do not participate in natural regeneration increases in the forest. Observations conducted in forest quarters 18, 24, 35 and 41 of Gadabay district, 23 and 31 of Shamkir district, 7, 14, 26 and 35 of Dashkesan district, 5, 14, 36 of Goy-gol district show that the mentioned spontaneous debris has brought the ecological state of the forest to a critical point. In the observation sites, it was found that out of every 100 mature trees, 10-15, and sometimes even 4-5, were 40-60 years old, healthy, with straight trunks, and relatively untouched. The density of the forest here was 0.3-0.4 and lower. Mass felling of straight branches was observed in existing trees. The intensification of anthropogenic impacts on forest landscapes reduces its recreational potential. The richness of the forest's fauna and flora has decreased, and in some areas, there are almost no recreational beech and oak trees, and valuable fruit bushes left. In most areas, especially in areas close to settlements, the ecological aesthetics of the forest landscape have been completely destroyed. Observations show that in the studied area, healthy trees, which are the future of the forest, are being cut down under the guise of sanitary felling. We have observed this in the lower mountain-forest belt in the areas of Gadabay, Dashkesan, Goy-gol, Shamkir forest farms. The degree of anthropogenic forest degradation was studied in sample areas separated at an absolute altitude of 950 m above sea level on the northwestern slope of Mount Sariyal. In the first observation site, out of 352 oak trees in 1 ha of forest, 171 (49%) are secondary trees that have formed on the site of the felled forest. Up to 75% of the existing trees are damaged to one degree or another. The average distance between trees is 2-3.5 m, and the average density is 0.3-0.5.

Observations show that the recreational potential and ecological state of forests with a density of less than 0.4-0.5 have reached critical levels. The area between Kurekchay and Ganjachay is the most developed part of the studied area. There are several large cities and more than 20 villages here. Therefore, the forests in the area have been subjected to more anthropogenic impacts. There is a wide valley in the area between the villages of Uchbulag and Ganja. These valleys are covered with forest. These forests, which were once protected due to their soil protection importance, have been subjected to serious deforestation over the past 15 years. Beech-oak forests have developed around the village of Zurnabad on the left bank of the Ganjachay. The main factor affecting the ecology of these forests is illegal deforestation and spontaneous grazing of livestock. The proximity of the forest to the village has a significant impact on the change in its habitat. These forests have relatively high stability and natural regeneration properties. Many glades with an area of 0.2-2.5 ha have formed within the forest. The

southern slope here was once covered with dense forests. Currently, this deforested slope is sharply dissected by ravines and ravines, and piles of stones and debris reach the village along the slope. Here, the right bank of the Ganja River has changed relatively little. The slope, with an inclination of 35-400, is covered with forests. The less inclined areas have been completely freed from the forest and have been turned into hayfields and pastures. In the sparse forests here, various bushes grow alongside the trees of the holm oak, oak, beech, mountain ash, and other trees. On slopes with intensive grazing and frequent livestock movements, even the bushes after the forest are about to disappear. The area is in danger of turning into almost bare rocks.

The valley of the Belajur River consists of highly developed arid and semiarid mountain steppes. The slopes on the right bank of the river with an absolute height of 1000-1200 m were once covered with dense beech-oak forests. Currently, up to 115 km² of forests have been completely cut down and this area has been turned into pastures and hayfields. In place of the former forest, hawthorn, rose hips, pears, etc. bushes are found. Here, various legumes and cereals create more than 90% cover. Over time, terraces built for cultivation on the mountain slopes have deteriorated due to neglect and become a source of erosion. A little west of the Gilazar spring in the area, ancient terraces have slid over each other, disrupting the surface of the entire slope, and a special wave-like washed, bare stepped terrace background has been created on the slope. The massif between the Goshgarchay and Belajurchay rivers is covered with dense forests. The northern slopes at an altitude of 1250-1350 m are covered with stable oak-alder forests with a density of 0.7-0.8. The right bank of the Goshgarchay consists of shrub-meadows after a sparse forest that has been sharply disturbed and has lost its ecological balance and aesthetic appearance, while the right bank consists of forest-shrubs. In deforested areas, the anthropogenic factor reaches 0.7-0.8.

The area between Almali and Zinjahal is a former forest area. Currently, there are gardens, fields, etc. cultural landscapes on the terraced slopes. In the northeast of Almali, on the mountain slopes with an altitude of 1500 m and a slope of 450, reforestation has occurred in place of the felled forests. Although the natural regeneration of the forest on the slopes of different directions is quite rapid, anthropogenic influences do not allow the normal development of the forest ecosystem. On the slope facing northwest, the number of felled pahd-velas tree stumps per 1 ha was more than 300, and the number of tree crowns was more than 400.

The areas south of the village of Dastafur, including the slopes on the left bank of the Dastafur River, are covered with dense forests. The density of the forests here, spread at an altitude of 1200-1700 m, reaches 0.5-0.8. In areas close to the village, the density drops sharply. Our observations here show that the number of felled oak and alder trees per 1 ha (375) is approximately 1.5 times higher than the number of existing trees (195). Most of the existing trees are also damaged to one degree or another. Most oak trees are the tops of broken stumps. Old, healthy trees are almost never found. In the area where the Dastafurchay and Ganjachay rivers meet, a stable forest complex has been formed that has relatively well preserved its natural structure. The forests here have great recreational and tourism opportunities due to their microclimate characteristics, species richness and favorable location. It is unacceptable for such forests to be cut down and converted into agricultural and pasture areas. The entire watershed from Chaygovushan (1250 m) to Zinzahal (1800 m) is covered with forests. The mountain slopes north of the Dastafur village have been subjected to intensive anthropogenic impacts. The soil cover has been washed away in many places, and numerous irregular terraced roads and trails have formed on the stony and gravel surface. On the slopes to the northeast of the village, thickets and forest-bushes rise to 1700-1800 m. These thickets were formed on the site of the felled oak-alder forests. Along the Dastafur River, all the mountain ridges and slopes to the south, east and northeast of Kiyigly are covered with dense oak-alder, birch and beech forests. Most of the forest landscapes here have high stability, stable structure and relatively good natural regeneration. The upper border of the forest rises to a height of 1600-1950 m, depending on the intensity of anthropogenic impacts. Currently, these forests are subject to heavy deforestation.

The slopes of the valleys surrounding the plateau where the Narimanli village is located in the Shamkirchay basin are covered with forests. The anthropogenic coefficient of the plateau surface is 0.8-0.9. From here, the road to the Zuytul village is surrounded by oak-alder forests on all sides. The slopes of the plateau descending to the southeast are covered with sparsely wooded thickets and forests. These forests have different degrees of stability and natural regeneration properties. In order to study the ecological characteristics of the forests here, research was conducted in semi-stationary conditions at observation sites separated on slopes with different inclinations and orientations.

Anthropogenic impacts are sharply manifested in the sharply disturbed, broken, relatively stable oak-alder forest landscape in the watershed of relatively smoothed mountain ridges. Here, approximately 205 broken tree stumps and 175 trees with varying degrees of damage were recorded per hectare. 144 trees were severely damaged, and 31 were slightly damaged. The distance between trees varied from 3 m to 25 m. Approximately 130 trees had a diameter of more than 40 cm, and 50 trees had a diameter of 15-20 cm.

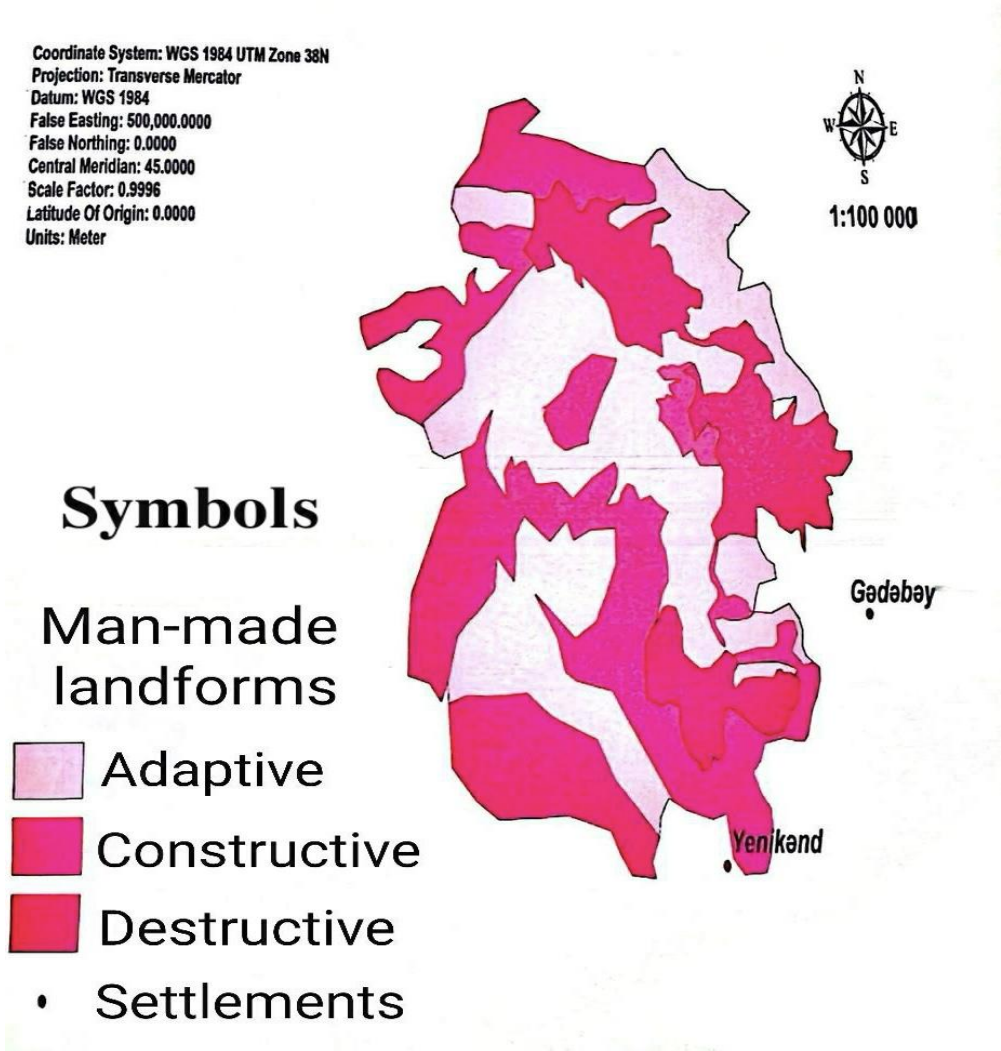

Figure 1. Technogenic landforms within the Gadabay region

The ground cover was disturbed by 45-80%. All 8 recorded shrub species were damaged. The understory living substrate forms a cover of 50-90%. Mountain steppe plants predominate among understory herbaceous plant species. This indicates that the forests are gradually degrading. Medium-sustainable forests have formed on the western slopes of the mentioned area with an inclination of 30-350. The number of fallen trees in the observation sites here was 135, and the number of existing trees was 105. The living forest floor forms a 40-55% cover. All trees are damaged, with an average diameter of 35 cm. The characteristics of the secondary forest are excellent. Almost no straight-stemmed, healthy, old trees remain. The ecological condition of the forest is unsatisfactory.

In the observation sites allocated on the western slopes with a slope of 50-550, the forest density is 0.6-0.8, the height of the trees is 18-22 m, and the diameter is up to 25-30 cm. Unlike the previous slopes with a low slope, the ecological condition of the forest here is relatively satisfactory. The number of felled trees per hectare was 35, the number of trees with a diameter of more than 20 cm was 260, and the number of trees with a diameter of less than 20 cm was 355. 320 undamaged trees were recorded. The reason for the good preservation of these forests is that the slope is unsuitable for felling and the forest has poor ecological stability.

A forest landscape has formed along the Kurekchay valley of the studied area. The forests have been severely degraded in a 10-15 km distance from the village of Agsu to the Omar pass. Despite this, these forests, which have valuable recreational potential, have managed to preserve their natural state. The main factor disrupting the ecological balance of the forest landscape here is the irregular mass recreation of people. Recently, some parts of these forests have been given over to private use for business purposes. Such users, who view the forest only as a source of income, are of little interest in the ecological state of the area. There are many clean water springs in the part of the Kurekchay valley corresponding to the tectonic fault. The cool forest microclimate and the mentioned springs also attract vacationers. In the summer months, vacationers set up temporary camps around these springs. Approximately 100-150 people rest along the river at a distance of 1 km. Vacationers have a sharp negative impact on the forest. In flat areas, the forest floor is destroyed, small trees are broken, and the biodiversity of the forest is gradually reduced. In such forests, old trees with crooked trunks predominate. The number of vacationers increases sharply, especially on Saturdays and Sundays. After such rest, which is organized in groups, an unsanitary situation arises in the forest.

The Shamkirchay valley is rich in forest complexes with a complex structure and varying degrees of degradation. The forests extend from 500-600 southeast of Yukhari Chaykend to the northern, northeastern and northwestern slopes of Goturdagh (3048 m), Aggaya (3057 m), Bugdadag (3101 m). Forests are spread at altitudes of 1200-1800 m on mountain slopes of varying inclination. However, low-growing forests along the Sarisu River rise to 2400 m, in the Aggaya river valley to 2400-2600 m, and in the Kayyurd river valley to 2300-2350 m. In addition, forests remain in small areas on the northeastern and northwestern slopes of the Chobandag, Ganlidag, and Boyuk Hasannane mountains, usually at altitudes of 2200-2300 m and higher. Small forest areas in the mentioned areas correspond to the highest bioclimatic boundary of forests that have spread over time. Forests along the Shamkirchay valley have a width of 1 km to 3-4 km. The expanding areas of the valley, terraced slopes are devoid of forest cover. Since the 19th century, forests here have been intensively cut down. Depending on the intensity of economic activity, the integrity of the forest landscape is often violated. Recently, forests have been destroyed more ruthlessly for fuel purposes. In the eastern and southeastern parts of the settlements of Gadabay, Ayitala, Dayagarabulag, Rustam Aliyev, Galakand, etc., sharply cut down, damaged, thinned, and lost their aesthetic appearance forests have been replaced by shrub forests and shrub-meadow ecosystems. Analysis of the data from the observation sites shows that the volume of debris in the forest landscapes of the Shamkirchay basin sharply exceeds the productivity of the forest. In some areas, the number of felled trees (more than 300) per 1 hectare was 3 times higher than the number of existing trees (95). Practically all trees in this area were damaged. The branches of most trees were broken, and new trees grew in place of the cut trunks. Only in the difficult-to-reach parts of the Shamkirchay River and its tributaries did the forest landscape maintain its ecological balance.

Various forest ecosystems with high resilience and natural regeneration capabilities have formed in the Shamkirchay basin. Although these forests have been cut down for many years for industrial, domestic, construction, etc. purposes, they have been re-formed thanks to natural regeneration. Only in intensively used hayfields, pastures and agricultural areas have the natural regeneration conditions for occupations been almost destroyed.

Conclusions:

Recreational activities carried out on the northeastern slope of the Lesser Caucasus have a significant impact on the ecological state of the forest landscape. According to most researchers, the mechanism of change in natural landscapes under the influence of recreational activities and grazing livestock is similar. Damage to soil and vegetation under the influence of both anthropogenic activities leads to]transformation.

References:

[1] Alexandra Paige Fischer. Forest landscapes as social – ecological system and implications for management, 2018

[2] Jennifer Rietbetgen, Alastair Sarre – The forest landscape restoration handbook, 2017

[3] Simon Bell, Dean Apostol. Designing sustainable forest landscapes, 2018

[4] https://intactforests.org/

[5] https://www.fs.usda.gov/pnw/pubs/r6-forest-landscape-analysis-and-design.pdf

[6] https://www.sciencedirect.com/science/article/pii/S0169204618302755

[7] https://lesley.edu

[9] https://science-teaching.org