



CURRENT STATE OF FOREST ECOSYSTEMS IN THE NORTHEASTERN PART OF THE GREATER CAUCASUS

Elman Isgandar¹, Minara Hasanova¹, Ilhama Mircalalli¹, Nigar Badal-zada^{1*}, Shabnam Hajiyeve¹, Seyfaddin Taghiyev¹, Sadaqat Aliyeva¹

¹Institute of Botany, Ministry of Science and Education of the Republic of Azerbaijan, AZ1073, Baku, Azerbaijan

Abstract: The article covers the study of the Greater Caucasus mountains in the northern and northeastern parts of Azerbaijan. The research is dedicated to the analysis of the composition of the phytocoenosis, the anthropogenic factor, and the study of the impact of this factor on the forest flora. It has been determined that the forest vegetation of the area is of particular importance as a gene pool source for ensuring natural forest regeneration.

Keywords: Greater Caucasus, forest ecosystem, phytocoenosis, anthropogenic factor, flora.

*Corresponding author: nigarbadalzade@mail.ru

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Introduction

The Greater Caucasus Mountains cover the northern and northeastern parts of Azerbaijan. The Greater Caucasus Range occupies the central part. To the north of the Greater Caucasus Range lies the Lateral Range; to the south, the Niyaldag and Govdag ranges; and to the southeast, the Langabiz and Gobustan low mountain areas, the Alat Ridge, and the Absheron Peninsula. The Gusar sloping plain and the Samur-Davachi lowland are located in the northeastern part of the Greater Caucasus physical-geographic region. All climate types are found in the province (except for the cold climate type with dry summers). The mean annual temperature ranges from 0°C to 14°C, and mean annual precipitation is 100–1400 mm. The rivers include left tributaries of the Kura (Turyanchay, Alijanchay, Goychay, Ayrychay, etc.) and

rivers that flow directly into the Caspian Sea (Samurchay, Gusarchay, Gudyalchay, etc.). The mountain lakes of the region contain fresh water, while the lowland lakes are saline. All of Azerbaijan's landscape types are found in the Greater Caucasus region. There are nature reserves in Zaqatala, Ilisu, Ismayilli, Pirqulu, Altiagac, and Qobustan.

Materials and Methods

The study was conducted in the northeastern part of the Greater Caucasus, Azerbaijan. The study area is characterized by diverse relief, altitudinal zones, and climatic conditions, which determine the structure and species composition of forest ecosystems.

Field investigations were carried out using route-based observations and ecological monitoring. The floristic

composition, distribution, and abundance of tree, shrub, and herbaceous species were recorded. Dominant, subdominant, rare, and protected plant species were identified based on morphological characteristics and relevant floristic literature.

The vertical structure of forest communities was assessed by distinguishing three vegetation layers, the upper layer consisting mainly of trees 20–30 m high, the middle layer comprising trees and shrubs 2–7 m high, and the lower layer consisting predominantly of herbaceous plants.

The effects of climatic variability were evaluated using temperature, precipitation, seasonal moisture conditions, elevation, and slope exposure as the main environmental factors. Their potential influence on plant growth, regeneration, species distribution, and forest structure was assessed.

Anthropogenic impacts were evaluated through field observations of tree cutting, forest thinning, soil disturbance, and other visible signs of human activity. The collected data were analyzed comparatively to assess changes in floristic composition, forest structure, natural regeneration, and the relationship between climatic and anthropogenic factors.

Results

The article examines the northern and northeastern parts of Azerbaijan and the Greater Caucasus. The study focuses on analyzing the composition of phytocoenoses and investigating the anthropogenic factor and its impact on forest flora. It is established that the forest vegetation of this territory is of particular importance as a gene pool source ensuring natural forest regeneration.

Discussion

It is well known that the existing forest vegetation type holds special significance as a gene pool source for ensuring natural

forest regeneration. The forest phytocoenosis holds great biocenotic significance because, by occupying a specific area, it creates an additional ecological niche for populations.

In this regard, the research attempts to evaluate forest-forming plants not only from an economic perspective (as a source of timber) but also from an ecological standpoint (considering forest protection functions, forest restoration, nutritional and aesthetic values, etc.) (Məmmədov & Xəlilov 2005).

It is well known that the forest ecosystem of the study area is of great importance from sanitary, hygienic, and social perspectives.

The most important hygienic characteristic of such an ecosystem lies in the creation of a microclimate that ensures normal external environmental conditions and the regulation of thermal and radiation effects. The importance of forest photosensors is well understood, given their role as a powerful factor in protecting the area from dust, gas, wind, and noise, as well as in soothing the human central nervous system. In general, the amount of dust in a forest area is two to three times lower than in open, non-forested areas. It should be noted that the dust-filtering role of forest areas also depends on the characteristics of the forest understory. Several researchers note that the absence of a normal grassy area in the forest understory significantly reduces dust deposition within the forest area. Active human economic activity necessitates the preservation of biodiversity and the implementation of monitoring systems, as well as active research into the flora of any given region. As far as we know, the damage to or clearing of forest areas in the study region is not determined by natural factors; it is primarily linked to anthropogenic factors.

These forests, which succeed one



another in a regular pattern according to altitudinal zones, are distinguished by their rare and valuable tree species. Unfortunately, during the initial years of crisis following the attainment of independence, these forests suffered from mass felling due to energy shortages; consequently, they became sparse, and their lower and upper boundaries receded significantly (Ковалев и др. 2024). Fortunately, however, significant progress has recently been made in supplying the population with natural gas in this region, as in all other parts of the Republic, leading to a substantial reduction in deforestation. Furthermore, considerable work is currently underway to establish new forest areas in the Greater Caucasus region, just as in other parts of the country.

However, we must regrettably note that the falling of valuable and rare tree species such as oak, walnut, chestnut, and beech, which are widely used in the construction and furniture industries, continues to this

day (Figure 1). We have investigated the anthropogenic impacts on the forest ecosystems of the northeastern part of the Greater Caucasus (within the territory of Azerbaijan), specifically examining the structure and dynamics of the forest phytocoenoses in the Khizi-Altiaghaj region, as well as the effects of climate variability and anthropogenic factors on plant development and forest ecosystems. Monitoring was conducted in the study area at an elevation of 1,100 m and geographic coordinates of 48°55' N, 37°06' E, with the primary objective of investigating the impact of climate variability and anthropogenic factors on the taxonomic composition of the vegetation. Based on monitoring results and literature data, work was carried out to characterize the forest area, 90.5% of which consists of broad-leaved forests, and to determine the taxonomic composition of the flora, dominant and subdominant species, as well as rare and endangered plant species.



Figure 1. The result of human activity

It is well known that the Altiaghaj forest consists largely of valuable tree species. Based on literature data and conducted monitoring, we have determined that mesophytes thrive on the slopes of the study area specifically on brown mountain forest soils and that the forest is primarily composed of species belonging to genera such as *Acer* L., *Quercus* L., *Populus* L., *Salix* L., *Ulmus* L., *Rhamnus* L., *Cornus* L., *Corylus* L., *Pyrus* L., *Cotinus* L. *Tamarix* L.,

Morus L., *Sambucus* L., *Pyracantha* Roem., *Rosa* L., *Rubus* L., *Euonymus* L., *Sorbus* L., *Carpinus* L., *Mespilus* L., *Fraxinus* L., *Betula* L., *Crataegus* L., *Paliurus* Mill., *Cotoneaster* Medic., and others (Əliyev 2020).

Species belonging to the mentioned genera form distinct plant communities and play a direct role in the formation of mountain-xerophytic vegetation. Thus, in the forest ecosystem we studied, the

conditions of the area where the plants are distributed vary in several respects (**Figure 2**).

The composition and age of the trees

and shrubs that make up the forest, as well as the forest's density, depend on the amount of sunlight, that is, the level of light that reaches them (Желдак и др. 2023).

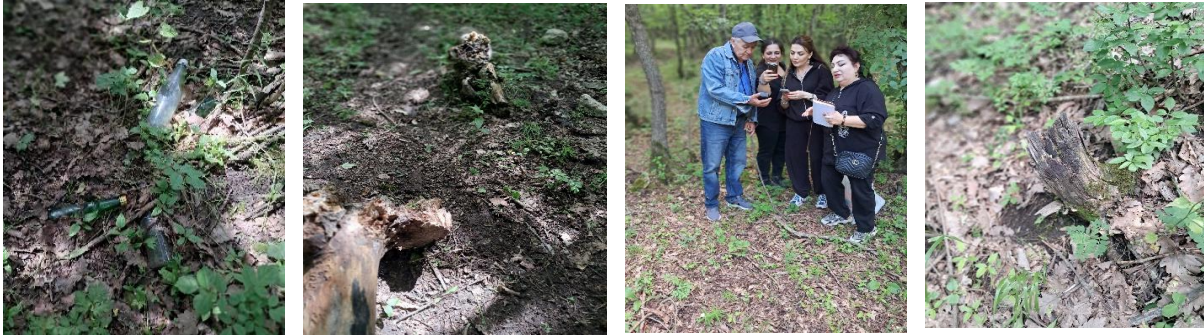


Figure 2: In the study area.

Depending on the level of illumination, the development of species with varying degrees of shade tolerance and a low rate of natural regeneration has been observed in the lower strata of the forest. The seasons have influenced the structural composition and species richness of the flora in the study area; specifically, we observed that ephemeral plants beneath the tree and shrub canopies develop rapidly in early spring—reaching the flowering stage before the trees become fully leafed out while the growing season of certain winter and typical (typical mesophyte) ephemeral species concludes (**Figure 3**). Such plants were not encountered in the vicinity of juniper species, as ephemerals could not develop under shaded conditions. The prevailing climate types in the Khizi-Altiaghaj study area are temperate-warm with dry winters and temperate-warm with dry summers. Plant species found in mountain forests, mountain meadows, semi-desert, and forest-steppe areas: Caucasian hornbeam (*Carpinus caucasica* Grossh.), ash.

Fraxinus excelsior L., Oriental beech (*Fagus orientalis* Lipsky), medlar (*Mespilus germanica* L.), barberry (*Berberis vulgaris* L.), hawthorn (*Crataegus pentagyna* Willd.), wayfaring tree (*Viburnum lantana* M.B.),

feathery asparagus (*Asparagus setaceus* (Kunth) Jessop), broad-leaved spindle (*Euonymus latifolia* (L.) Mill.), goat-leaf honeysuckle (*Lonicera caprifolium* L.), warty spindle (*Euonymus verrucosus* (L.) Mill.), rowan (*Sorbus aucuparia* L.), spiny milk-vetch (*Astragalus pycnophyllus* Stev.), etc. We recorded and photographed species included in the "Red Book," such as juniper (*Juniperus foetidissima* Willd.), Caucasian violet (*Viola caucasica*), and sharp-lobed iris (*Iris acutiloba* C.A. Meyer).

In the areas studied, woody plants such as medlar (*Mespilus germanica* L.), hawthorn (*Crataegus* sp.), cherry plum (*Prunus divaricata* Ledeb.), and quince (*Cydonia oblonga* Mill.) were observed in the understory shrub layer.

Species belonging to genera such as *Paliurus* Mill., *Frangula* Mill., *Cotoneaster* (including *C. saxatilis*), *Corylus* L., *Spiraea* L., *Crataegus* L., *Rhus* L., *Acer* L., *Quercus* L., *Ulmus* L., and *Carpinus* L. were studied in the riparian area.

The objective of studying the forest types and phytocoenotic structure of the research area was to identify the species composition of tree and shrub plants (dominant and subdominant) distributed within the area's forest ecosystems, as well



as the forest types formed by these plants (Лабoxa 2018). We observed a three-tiered structure in the forests covering the region's mountain slopes, which are composed primarily of mixed broad-leaved tree species.

A large part of the study area (approximately 90%) is covered by forest

phytocoenoses formed by broad-leaved tree species. The first tier of the forest phytocoenosis consists of trees 20–30 meters tall; the second tier comprises trees and shrubs reaching heights of 2–7 meters; and the third tier consists of herbaceous plants.

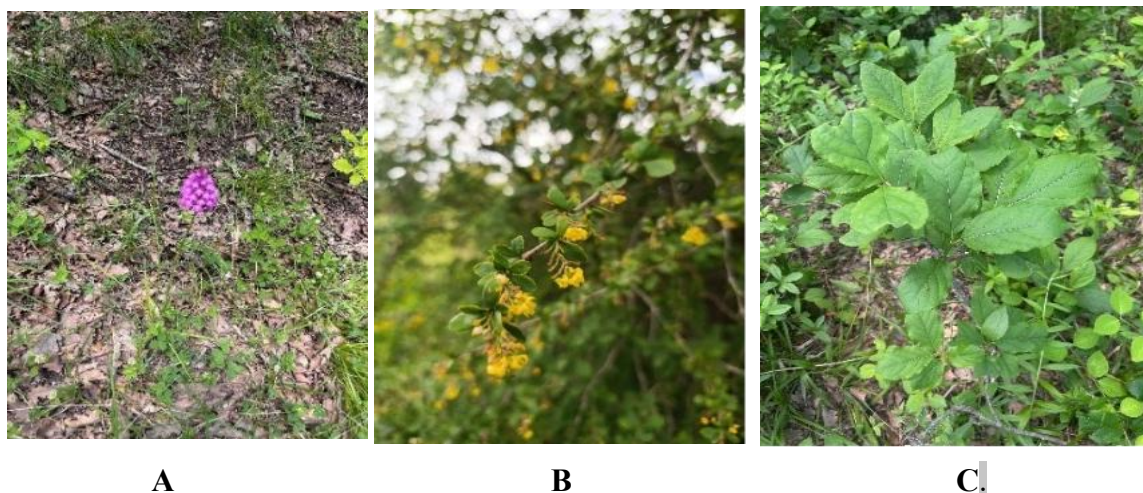


Figure 3. Some species of understory vegetation. **A.** *Tropaeolum majus* L.; **B.** *Berberis vulgaris* L.; **C.** *Euonymus latifolius* L.

The plants of the first tier of the forest phytocoenosis in the study area include *Quercus iberica* Steven ex M. Bieb., *Carpinus orientalis* Mill., *Fagus orientalis* L., *Fraxinus excelsior* L., *Acer platanoides* L., *A. laetum* C.A.Mey, and others (Өсгєrov 2016).

The tree species mentioned above often form mixed forest phytocoenoses; in other words, forests of uniform composition are rarely encountered in the area. Shade-tolerant tree and shrub species predominate in mixed forest phytocoenoses; the soil cover in such forests is rich in humus, and humid microclimatic conditions develop beneath the forest canopy (Горбунов и др. 2020).

In the area, the vegetation of the second tier consists primarily of shrubs, such as *Crataegus* spp. *Rosa canina*, *Rubus* subg. *rubus*, *Mespilus germanica*, *Lonicera*

caprifolium, *Sorbus torminalis*, *Euonumus velutina*. Tree species such as *Pyrus communis*, *P. georgica*, *P. salicifolia*, and *P. vsevolodi* are also found in open forest clearings. Furthermore, perennial herbaceous plant species predominate in such open meadows. The forest type of the study area consists primarily of mixed deciduous trees. The species composition of the trees varies according to their altitudinal distribution. The forest cover of the Khizi-Altiaghaj region retains its natural state. It has been determined that the dominant species, Georgian oak and Caucasian hornbeam, maintain stable populations. However, thinning is observed at the edges of forests and in areas close to human settlements. In the Khizi-Altiaghaj region, the entry of livestock from surrounding villages into forest areas leads to the consumption of young saplings and the

destruction of shoots, thereby weakening the forest's capacity for natural regeneration. As a result, the forest is "aging" because a new generation to replace the old trees is not developing. However, in recent years, the process of natural forest regeneration has accelerated. The growth of naturally regenerating hornbeams and birch saplings has led to the rejuvenation of the forest. The development of oak and beech species is proceeding slowly.

The areas surrounding the Khizi-Altiaghach region, where the local population makes intensive use of the forest, are the ones under the greatest stress. Due to the numerous narrow paths and the resulting soil compaction, the understory vegetation (grasses and shrubs) is poorly developed. Observations revealed that in areas where fires had occurred, vegetation failed to regenerate for many years, or successional processes were noted in specific forest sections. We are investigating how rising temperatures resulting from climate change alter the phenology of trees, specifically their flowering, leafing, and budding periods, thereby making them more vulnerable to early frosts and pests, and how temperature variability directly affects radial growth dynamics, the process of photosynthesis, and root system development. Carving various inscriptions into the trunks of old beech and oak trees, or damaging them with an axe, reduces the tree's resistance to fungi and diseases.

This, in turn, results in the thinning of forest areas over time. Forest areas damaged by anthropogenic impact (due to fire, illegal logging, overgrazing, or hay mowing in clearings) recover within 2 to 5 years after the activity ceases, depending on the plant species and the severity of the damage. It takes 15–25 years for fast-growing trees (such as hornbeam, maple, etc.) to establish themselves in a forest ecosystem. It takes 50–80 years, or sometimes even a century,

for slow-growing, primary tree species (such as beech and oak) to form a fully developed forest canopy.

Conclusion

As a result of monitoring conducted in the Khizi-Altiaghach study area, the vegetation cover was partially surveyed, and we identified 120 plant species belonging to 54 genera and 36 families across various stages of plant development.

It has been determined that anthropogenic impact has caused damage to forest areas, and the rehabilitation of these areas—depending on the plant species and the extent of the damage—may span a period of years.

Conflict of Interest

The authors declare that there is no conflict of interest.

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