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OAK FOREST OF THE CHECHEN REPUBLIC: ECOLOGICAL AND GEOGRAPHICAL ANALYSIS

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Abstract

This study presents a comprehensive assessment of the current state of oak forests in the mountainous forest area of the Chechen Republic, which do not form a distinct belt. The ecological condition of these forests raises concerns, particularly focusing on the fresh ash oak groves along the southern macroslopes of the Wooded Ridge and the Tersko-Sunzhenskaya upland. The research employs geobotanical field route studies at reference points, along with cartographic and descriptive methods. The investigation facilitates an ecological and geographical analysis of the entire oak forest complex, offering detailed insights into soil cover characteristics and undergrowth features. The study reveals the natural mechanisms governing the functioning of oak ecosystems. In the context of escalating anthropogenic pressure on landscape complexes, understanding degradation processes becomes crucial, especially considering the irreversible replacement of geocomplexes. The findings contribute to a better comprehension of the intricate mechanisms at play in the degradation processes, providing essential knowledge for effective ecosystem management. The study confirms the troubling ecological state of oak forests in the mountainous forest zone of the Chechen Republic, highlighting the specific challenges faced by the fresh ash oak groves influenced by diverse slope exposures. The obtained results encompass a range of characteristics, including soil composition and undergrowth features, crucial for the formulation of more effective management and restoration strategies for this complex ecosystem. The insights gained from this research contribute significantly to the understanding of degradation mechanisms, offering valuable knowledge for sustainable landscape management and conservation efforts.

1. Introduction

Forests, as is known, play a huge biospheric role and many processes in nature depend on their condition, and the main one is photosynthesis – the process of formation of organic substances from carbon dioxide (CO_2) and water (H_2O), proceeding using solar energy, in which living organisms receive oxygen necessary for respiration, and plants create useful organic substances for their vital activity.

In scientific literature, both in domestic and foreign literature, works are well presented, in which assessments of the current state of forest lands are given. At the same time, the forests of the Chechen Republic are poorly studied and all the materials of complex field research were carried out in the 60s of the last century.

Galushko (1980) made a huge treasure in the study of the vegetation cover of the Chechen Republic. In his work (Bebiya, 2002), he devoted little space to forest vegetation, moreover, an analysis of their condition was not made, but nevertheless the work is relevant today.

Fragmentary data on the array of the Chechen Republic can be found in the works, highlighting the vegetation zones and belts, they limited themselves to describing the selected zones and belts. In these works there is no information about possible changes in plant communities in the past under the influence of various factors, including anthropogenic (Bezrukova & Rozlomiy, 2020).

2. Problem Statement

The oak forests situated in the mountainous forest area of the Chechen Republic do not constitute a clearly defined belt, and their existing ecological condition raises significant apprehensions. Particularly, the lower regions of the ridges are undergoing substantial erosive processes, resulting in the prevalence of dry snowdrifts. This environmental situation prompts a compelling need for a thorough evaluation of the present state of oak forests in the Chechen Republic. The primary objective of this assessment is to address concerns related to the ecological well-being of these forests and to enhance their species composition.

3. Research Questions

1) Current Ecological State:

i. What is the present ecological state of oak forests in the mountainous forest area of the Chechen Republic?

2) Soil Cover and Undergrowth Characteristics:

ii. What are the specific characteristics of the soil cover and undergrowth in oak forests within the Chechen Republic?

3) Natural Mechanisms of Functioning:

iii. How do oak ecosystems naturally function in the Chechen Republic? What are the key mechanisms that govern their ecological processes?

4) Mechanism of Degradation Processes:

iv.   What is the underlying mechanism of degradation processes occurring in oak forests within the Chechen Republic? Answering these research questions will contribute to a comprehensive understanding of the current state and dynamics of oak ecosystems in the specified region. It will provide valuable insights into the ecological factors influencing these forests and help in formulating strategies for sustainable management and conservation.

4.   Purpose of the Study

The primary objective of this study is to conduct a comprehensive assessment of the current state of oak forests in the Chechen Republic. This assessment will be carried out through geobotanical field route studies at reference points, complemented by cartographic and descriptive methods. The specific purposes include:

1) Ecological and Geographical Analysis:

i.   Undertake an ecological and geographical analysis of the entire forest complex of oak forests in the Chechen Republic.

2) Characteristics of Soil Cover and Undergrowth:

ii.   Examine and document the characteristics of the soil cover and undergrowth within the oak forests of the region.

3) Natural Mechanisms of Functioning:

iii.   Investigate and elucidate the natural mechanisms governing the functioning of oak ecosystems in the Chechen Republic.

4) Species Composition Improvement:

iv.   Provide insights and recommendations to enhance the species composition of oak forests in the Chechen Republic.

The study aims to contribute valuable knowledge essential for addressing the challenges posed by the current ecological state of oak forests. By understanding the intricate mechanisms of oak ecosystems and the impact of anthropogenic pressure, the findings will aid in formulating strategies for sustainable forest management and conservation. The ultimate goal is to mitigate the irreversible changes often triggered by escalating anthropogenic activities in landscape complexes.

5.   Research Methods

This research is grounded in over 25 years of extensive work on the primary forest ecosystems of the Chechen Republic, covering various forest biocenoses, including hardwoods (Fāgus orientālis, Quércus róbur, Cárpinus Fraxinus, Ácer), softwoods (Bétula, Ánus, Pópulus trémula), and one conifer species (Pínus sylvéstris). The nomenclature of plant names follows the conventions of "Field Geobotany" (1964) (Lavrenko & Korchagina, 1964) and the "Red Book of the Chechen Republic" (Umarov, 2007).

5.1. Objectives

The research aims to develop methods for identifying key biotopes within oak forests and grassy terrestrial associations through geospatial analysis of ground survey data on topographic terrain elements. The study focuses on the mountain-forest belt in the western region of the Chechen Republic, specifically in two model territories within the Vedensky forestry.

5.2. Research Procedures

1) Ground Reconnaissance Surveys:
   i. Method: Ground reconnaissance surveys of plantings were conducted, including the laying of test areas in virgin forests and logging areas of various ages (0.25–1.0 hectares).
2) Age Structure and Structure Analysis:
   i. Methods: Standard forestry and taxation methods were employed to study the age structure, structure, growth characteristics, and productivity of plantings.
3) Vegetation Cover Descriptions:
   i. Method: Descriptions of the vegetation cover were performed within the subcron, subcron, and outer zones. Dominant plant species and their general projective cover were determined.
4) Ecological and Geographical Analysis:
   i. Approach: An ecological and geographical analysis of the current state of forest community components (stand, undergrowth, living ground cover, soil) of oak biocenoses was conducted. This analysis covered areas experiencing long-term anthropogenic impact and background conditions.
5) Condition Assessment:
   i. Results: The condition of oak associations was assessed as good, revealing positive findings such as good oak renewal.

The comprehensive use of ground surveys, geospatial analysis, and established forestry methods contributes to a robust understanding of the ecological dynamics and conditions of oak forests in the specified region.

6. Findings

The study identifies the presence of fresh hornbeam sudubrava in all mountain forestry regions of the Chechen Republic. This type of forest is predominantly distributed along the southern, eastern, and western macroslopes of the Montenegrin and Pasture ranges. Additionally, it is observed along the northern macroslopes of the Advanced Ridges and is well expressed on the southern slope of the Mashtak ridge and the slopes of the Pasture Ridge.

The fresh hornbeam sudubrava occupies primarily the middle and upper level parts of the southern exposures, at altitudes ranging from 500 to 1500 meters within the dissected macroslopes. The steepness of the slopes where it is found ranges from 20 to 500. In contrast to dry sudubravas, areas of the fresh

hornbeam sudubrava type are less susceptible to erosive phenomena, and their plantings exhibit better preservation.

This finding underscores the ecological significance of fresh hornbeam sudubrava forests in mitigating erosive processes and highlights their potential importance for conservation efforts in the Chechen Republic's mountainous regions.

Soils of sod–brown-earth type, less often humus–carbonate medium–thick (up to 60 cm), strongly crushed, loamy on eluvium-deluvium of marls, conglomerates, sandstones and clay shales. The litter is discontinuous, concentrated at natural obstacles.

The indigenous stands are formed by petiolate and rocky oak with an admixture of hornbeam, ash, birch, linden, holly and field maple.

Plantings are always single–tiered, mainly of overgrown origin, III -V bonita. The trunks of oak trees are poorly cleaned of branches, twisted. The worst condition of oak stands on talus plots. Constant rockfall damages the trunks and increases their fautiness. At the limestone outcrops, the roots of trees are often exposed. The trunks are strongly curved; almost all of them are dry (Table 1).

Table 1. Taxation characteristics of oak trees of fresh hornbeam

Age, years	Composition stands of trees	Height, м	Diameter, centimetre	Bonitet	Completeness	Reserve, m³/ha
20	9D1YASEDG	7	6	II	0,5	30
30	6D4G	8	10	III	0,7	60
40	7D3G	12	16	IV	0,7	80
50	8D2G	12	18	IV	0,5	70
60	9D1G	10	12	V	0,5	70
80	8D2G	12	18	V	0,3	50
100	8D2Lp	15	26	V	0,5	80
110	7D1G1Cl1Lp	16	24	V	0,7	150

The steepness of the slopes and their condition have a great influence on the participation in the composition of oak forests of other breeds. An increase in steepness, which entails even greater impoverishment of the soil, the appearance of scree reduces the presence of hornbeam in the stands. Sometimes there are pure oak forests (Papikyan, 2021).

The undergrowth is extremely unevenly developed. The degree of development and closeness vary greatly and depend on the closeness of the tree canopy and the condition of the slopes. With the closeness of the tree canopy of 0.9 and on steep talus areas with the exits of the parent species, shrubs are isolated, and in low–canopy stands and sparsely, the closeness of the undergrowth reaches 0.6 - 0.7. After continuous logging, the undergrowth can form a closed tier. It is represented by azalea, warty birch bark, scumpia, hazel, gordovina, dogwood, medlar. Azalea is confined to the ridges of the ridges, where it forms dense thickets. There are continuous thickets of hazel and dogwood in the cuttings.

The development of the herbaceous cover is decisively influenced by the closeness of the tree–shrub canopy and the degree of erosion of the slope. In areas overgrown with azalea, the living ground cover is represented by single specimens. With a sparse canopy on relatively gentle slopes, the coverage

reaches 80-90%. With the closeness of the tree canopy – 0.6 and shrubby – 0.2 – 0.3, herbaceous vegetation covers 20-40% of the area.

More than 70 species have been recorded as part of the herbaceous cover. The most constant are: purple–blue sparrow, soul, common oregano, strawberry, golden rod, willow-leaved damask, Caucasian cupena, Transcaucasian lily of the valley, softest honeydew, large-leaf primrose, valantiiform bedstraw, five-leaved sickle, sticky sage.

Derived plantings make up an insignificant part (2-3%) of the forested area of the type and are represented by hazelnuts and dogwoods. Natural seed renewal of all breeds is unsatisfactory, there are single specimens of oak and hornbeam. The total number of undergrowth of all breeds reaches 3 thousand per hectare.

Plantings of fresh hornbeam sudubrava due to their placement in small areas, severe disturbance, low productivity and low availability do not have operational significance, they only play an important soil protection and water-regulating role. Forestry measures here should first be aimed at strengthening the protective role and improving the sanitary condition of plantings of the type. The preserved oak forests must be protected from unauthorized felling and fires, and their natural seed renewal should be promoted (Shcherbina, 2019; Storozhenko et al., 2020).

6.1. Fresh ash oak grove

It is found along the southern elephants of the Black Mountains, on the Tersk and Sunzhensky ridges it is formed in the middle and upper parts of the slopes of the northern, north–eastern and north–western exposures, which differ in shape. On the lower parts of the eroded slopes of the northern exposures, as well as on the southern slopes of the Tersk ridge, a dry snowdrift is formed. On the Aldin upland and the Black Mountains, fresh ash oak grove is found on the slopes of the southern rhumb mountains, being replaced in shaded places by hornbeam and oak grove. The steepness of the slopes ranges from 5 to 300, the average is -170. The average height of the formation type is 500 m with limits of occurrence from 300 to 750 m/ (Sazonov, 2020; Sergeeva et al., 2004).

The litter capacity is about 2 cm. It is composed of the fall of tree and shrub species with a slight participation of the remains of the grass cover, loose, dry. During the year, the fresh fall almost completely decomposes, leaving only twigs, petioles and leaf veins.

The soils are humus–carbonate, gray forest and turf–brown-earth type. Their profile is well developed, poorly protected, power up to a meter.

The indigenous stands are formed by petiolate and rocky oak with the participation of ash and birch bark. A single admixture of field maple, pear, hornbeam and linden is less common. The stands are single–tiered, of the same age, their completeness is uneven due to the group arrangement of trees and rarely exceeds 0.5 - 0.6. Stands under the age of 40 predominate. To characterize the oak trees of the fresh pile, we give in Table 2.

Table 2. Taxation characteristics of oak trees of fresh ash oak grove

Age, years	Composition stands of trees	Height, м	Diameter, centimetre	Bonitet	Completeness	Reserve, m³/ha
10	7D3Br	3	3	IV	0,7	14
20	6D1BR2YAS1KL	7	8	IV	0,5	32
30	7D2YAS1BR	9	10	IV	0,5	42
40	9D1YAS	11	13	IV	0,6	60

The reserves of wood in oak forests of fresh ash oak are very small, but they exceed the reserves of oak forests of dry sudubrava by one and a half to two times. The marketability of plantings is also higher. Trunks, due to their vegetative origin, are fleecy, crooked, poorly cleaned of twigs, saber-shaped curved in the lower part.

The undergrowth is well developed, its average closeness is 0.4 (0.2 – 0.7). The most constant are hawthorn (constancy 94%), dogwood (60%) and privet (60%). Much less common are svidina, buckthorn brittle and laxative, medlar, hazel, thorn, and gordovina. Hawthorn prevails most often, dogwood, warty birch bark, privet much less often. Hawthorn, dogwood, and privet bear fruit better than other breeds in the undergrowth. Svidina, hazel, European birch bark, medlar, gordovina do not bear fruit or almost do not bear fruit (Alexandrova, 2021; Doronina & Kalugina, 2020; Doronina & Strakhova, 2019).

The coverage of herbaceous plants on average is 50 – 60% (1- -100%). 60 species have been noted. The most constant are: short–haired violet (constancy 67%), variegated pearl barley (73%), purple dubrovnik. Less constant are: millennial common, whorled asparagus, willow–leaved damsel, forest cupid, purple-blue sparrow, tenacious bedstraw, five-leaved sickle. The pearl barley is usually variegated, the violet is short-haired, sometimes the Dubrovnik is purple.

Natural regeneration in fresh ash oak forest proceeds unsatisfactorily, although the average total number of undergrowth of all breeds and age groups is 40 thousand per hectare. But most of it falls on the share of ash and other related species, the participation of oak does not exceed 10-15%.

As a result of improper farming and haphazard logging in the past, almost half of the area of the type oak stands were replaced by birch bark and ash trees. Oak is almost always found in birch bark. Much less often and in smaller quantities – field maple and pear. Stands of vegetative origin, single–tiered and of the same age with a fullness of 0.5. Mainly the age of birch bark is up to 40 years, the bonus is IV, the reserves are slightly higher than in oak forests (in 40-year-old plantations up to 70 m3/ha. The trunks of birch bark are even than those of oak, they are better cleaned of twigs.

The yasmennik dominates in the stand of trees. It occupies more than a third of the forested area of the type. Ash trees were formed on the site of continuous felling and rarefied oak stands. They are single-tiered, overgrown or mixed in origin. Together with ash, there is an oak. Field maple, birch bark and hornbeam are observed less frequently and in small quantities, sometimes you can find pure ash stands. Ash trees are characterized by a fullness of 0.4–0.6. Stands older than 30 years are rare (Table 3).

Table 3. Taxational characteristics of ash trees of fresh oak

Age, years	Composition stands of trees	Height, м	Diameter, centimetre	Bonitet	Completeness	Reserve, m³/ha
10	8YAS2B r	5	6	II	0,4	20
20	7YAS1D1BR1KL	6,5	7	IV	0,6	31
30	7YAS2D1KL	8	10	IV	0,6	34

30–year-old trees begin to dry hard. The reserves are almost the same as the reserves of ash trees of the dry snowdrift.

Plantings of the type have mainly a protective value. To increase their productivity, it is necessary to reconstruct overgrown stands and replace them with oak and pine plantations.

6.2. Fresh hornbeam oak grove

It is rarely found in all types of forests. On the Tersk and Sunzhensk ridges, it is formed only in the upper and middle part of the slopes of the northern exposures; on the Gudermess ridge and the Aldin upland – in the lower parts of differently oriented sections of the southern macro slopes. On the Montenegrin ridge, the type is found on the northern and southern macrosclines.

The lower limit of the type distribution is determined by the lower limit of the preserved forests at an altitude of approximately 400 m . Below, plantings of the type have long been exterminated, and their remains in the form of shiblyakov thickets were described by Prokofieva and Borisov. The upper limit of the type distribution is determined by the height of the ridges (900-1000 m), but starting from 500-700 m, the fresh hornbeam oak forest occupies areas of mesoscopes oriented to the south. The steepness of the slopes ranges from 10-300. On the southern macrosclines of the Montenegrin and Pasture ridges, the type is in most cases formed in combination with dry and fresh sudubrav. Significant independent massifs of it are described only on Mount Erdy–Kort (Bayrakov, 2007; Bayrakov et al., 2006).

Very rarely oak forests and sudubraves are found between Fortanga and Argun. Fresh hornbeam oak forests are formed in the mountainous part of the republic in the upper and middle parts of the flat and less steep slopes (up to 300) of exclusively southern points at altitudes from 500 to 1300 m. In the Argun Valley, it is described on the well-lit eastern slopes.

The soils are humus–carbonate and brown mountain–forest, and in the foothills, in addition, gray forest with a capacity of more than 70-80 cm. The litter is often solid 2-3 cm thick, loose, decomposes well.

The indigenous stands form a petiolate and rocky oak with an admixture of hornbeam, ash, birch bark, linden, beautiful and holly maple, pear, cherry. Most of the current oak plantations are upset by unsystematic and unauthorized logging. Basically, these are single-tiered oak trees of the III bonitet. The best areas of the forest have the composition: 10DedG, closeness 0.8, at the age of 90-100 years, their height is 24-25 m, diameter is 28-32 cm, stock is 280 m3/ ha. As a result of the increased thinning of the maternal canopy, a younger generation of the forest may appear, forming the second tier, and it is mainly seed and its bonitet (I) is two units higher than the overgrown oak forests (III). The age of stands usually does not exceed 50-60 years, but stands younger than 20-30 years are not marked. From the derived stands, grabniaks, ash trees and birch bark, as well as thickets of hazel, dogwood can be formed.

Undergrowth usually does not form a tier. Its composition includes dogwood, birch bark, hawthorn, svidina, lischina, medlar, in some cases scumpia and azalea. Dogwood or hazel usually dominates. Dogwood bears fruit well.

The living ground cover is well developed. The coverage is 60% (10-100%). There are about 60 species, in some descriptions there are no more than 15. There is a constant occurrence of urban gravel, spiky sedge, variegated pearl barley, five-leaved sickle, forest violet and short-haired. Often there are

purple–blue sparrow, the mildest honeydew, large-scale primrose, Transcaucasian lily of the valley, sweet-smelling ash, sticky sage. Short-haired violet, variegated pearl barley, five-leaved sickle dominate.

Forestry measures should be aimed at restoring complex oak stands by promoting natural regeneration, creating forest crops and logging care. The restoration of indigenous plantings in areas occupied by thickets of shrubs is urgent. When creating crops in a belt up to 500 m, the walnut deserves attention, and in depleted habitats, Crimean and Sosnovsky pine should be introduced into the crops.

The mountain-forest complex of the Chechen Republic is a region that has been little studied and those few publications of the middle of the last century do not provide complete information about the state of forests. The conducted research, both field and analysis of literary sources showed that area logging, starting from the 19th century. by the 80s of the last century led to a decrease in the area of forests decreased almost 4 times (Cherepanov, 1995).

"Great importance is attached to the effective use of natural renewable forces of nature through the use of appropriate logging systems, preservation of undergrowth during logging, which ensures the natural renewal of forests over large areas" (Sergeeva et al., 2004, p. 224).

The destruction of oak forests and the growth of shrubs, and vice versa, the restoration of oak associations, can occur only after the removal of anthropogenic impact for a significant period."

Reproduction of oak forests is seed-based due to the biological characteristics of oak, as a shade-tolerant breed, which is well renewable under the mother canopy in fresh and moist types of growing conditions under the canopy of plantings (Chernyshov, 2020, 2021).

7. Conclusion

The comprehensive studies conducted reveal that the ecological state of oak ecosystems within the mountain forest belt is currently experiencing active degradation. The native forest-forming species, including oaks and ash, are being surpassed by less valuable species such as maple and hornbeam.

The primary contributing factor to the degradation of these ecosystems is identified as continuous logging, representing a significant economic impact. This continuous logging has led to substantial areas of oak forest ecosystems being replaced by meadow and shrub vegetation, as documented in the work by Gorbunov et al. (2020).

These findings emphasize the urgent need for intervention and sustainable management practices to mitigate the ongoing degradation. The results of this study can serve as a foundational basis for the development of permanent monitoring systems aimed at assessing and addressing the state of forest ecosystems promptly. The implementation of such monitoring measures is crucial for the timely adoption of interventions to neutralize external influences and ensure the long-term health and sustainability of the oak ecosystems in the mountainous regions of the Chechen Republic.

Acknowledgments

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